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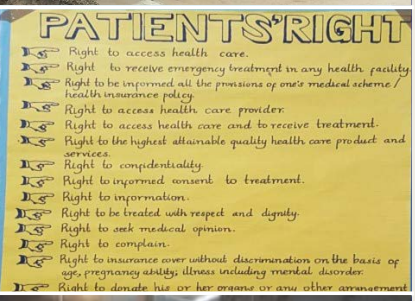

Photos top to bottom: (1) Bakuza: Sample collection materials distributed to participants at their homes in Tanzania, (2) Sitienei: Patients' rights poster in health facility in Kenya and, (3) Zadoks: Broiler poultry production.

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ORIGINAL ARTICLE

Victims and Perpetrators of Intimate Partner Violence Among Sexually Active Youth in a Community With a High HIV Prevalence in Western Kenya

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ABSTRACT

Background: Physical intimate partner violence (IPV) is an important risk factor for sexually transmitted infections, including HIV. We set out to determine the prevalence and correlates of IPV among youth aged 15 to 24 years – in a community with a high HIV prevalence – with a view to recommending strategies to address IPV.

Methods: We analysed data from an HIV seroprevalence survey, which included participants aged 13 years and above and was conducted between November 2012 and December 2014 in Gem Subcounty, Siaya County, Western Kenya. Participants between 15 and 24 years old (youth) were described as "perpetrators of IPV" if they had done anything to physically hurt their sexual partners in the previous year and as "victims of IPV" if they had been physically hurt by a sexual partner in the same timeframe. Logistic regression was used to determine factors associated with being either a victim or perpetrator of IPV.

Results: Of 1,957 participants included in the analysis, 142 (7%) were victims of IPV, and 77 (4%) were perpetrators of IPV. Victims were likely to be women (adjusted odds ratio [AOR] 7.9; 95% CI, 3.6 to 17.5), in a relationship or married (AOR 3.1; 95% CI, 1.8 to 5.4), and to have had multiple lifetime sexual partners. Victims of IPV were also more likely than not to have been subjected to sexual violence in the past (AOR 1.9; 95% CI, 1.0 to 3.4) or recently (AOR 3.9; 95% CI, 2.2 to 6.8). Perpetrators were likely to be men (AOR 2.1; 95% CI, 1.2 to 3.7), with 5 or more lifetime sexual partners (AOR 2.8; 95% CI, 1.3 to 6.3), and to have committed sexual violence recently (AOR 2.9; 95% CI, 1.1 to 7.7).

Conclusion: There was a high prevalence of IPV among sexually active youth in this rural community. Study participants were recurrent victims or perpetrators and reported behaviours that put them at risk of HIV acquisition. Health programmes should screen for IPV victims and perpetrators using identified characteristics. Existing policies regarding gender-based violence should be enforced, and future research should focus on the impact of IPV prevention programmes.

INTRODUCTION

In 2017, 1.8 million new HIV infections and 36.9 million people living with HIV were reported worldwide. Two-thirds of those new infections and 25.7 million of the people living with HIV were from in sub-Saharan Africa.[1] Youth aged 15 to 24 years accounted for 42% of new HIV infections in people aged 15 years and older. In 2012, globally, young women aged 15 to 24 years had HIV infection rates twice as high as young men and accounted for 22% of all new HIV infections, including 31% of new infections in sub-Saharan Africa.[2]

Globally, 10% to 69% of women report having been assaulted by an intimate male partner.[3] Physical intimate partner violence (IPV) is an important risk factor for sexually transmitted infection and HIV transmission.[4,5] Research has shown that interrelationships between IPV and other forms of violence also increase the risk of HIV transmission.[6] In Zambia, among ever-married women, those who had experienced any form of IPV were twice as likely to be HIV-positive compared with those who had not experienced IPV.[7] IPV has also been linked to poor HIV testing and antiretroviral therapy uptake[8] as well as poor antiretroviral therapy outcomes.[9]

In 2015, HIV acquisition among youth aged 15 to 24 – who formed 20% of the population – constituted more than half of all new HIV infections and one-fifth of people living with HIV in Kenya.[10] Low HIV testing uptake

and linkage to care rates have been shown among children, adolescents, and young adults in Kenya.[11] Combating IPV is likely to reduce the spread of HIV and improve the uptake of HIV health services. The general strategy to combat IPV can be either preventative or therapeutic[6]; however, this requires identifying actual or potential victims and perpetrators of IPV.

We set out to determine the prevalence of IPV among youth within the Kenya Medical Research Institute and U.S. Centers for Disease Control and Prevention (KEMRI/CDC) Health and Demographic Surveillance Area (HDSA). We also aimed to determine factors that correlate with IPV, with a view to recommending strategies to prevent and address IPV in the Western Region of Kenya, an area with a high HIV burden.

METHODS

Study Design and Setting

KEMRI/CDC's research and public health collaboration conducted a cross-sectional survey within its HDSA in Gem Subcounty, Siaya County, Western Kenya, between January 2013 and February 2014. The KEMRI/CDC HDSA has a population of approximately 218,376 people living in 70,505 households within 3 regions: 61,707 in Asembo, 78,874 in Gem, and 77,795 in Karemo. As there had been minimal research and intervention activities rolled out in Gem, it was an ideal community for assessing the effects of new interventions. Gem's population is culturally homogeneous and survives on subsistence farming and fishing; over 95% are members of the Luo tribe, and 50% are younger than 13 years of age. Detailed descriptions of the study design and methods are described in our other papers.[12,13] The survey aimed to evaluate HIV risk behaviours, HIV serostatus, and HIV prevention interventions.

Study Population

The study population in the main survey included all persons aged 13 years of age or older, who lived within the selected compounds, had spent the previous night in the designated households, and consented to participate in the study. Individuals who did not consent to participate were excluded. We restricted our analysis to youth aged 15 to 24 years,[14] who had been sexually active in the past year, and had answered questions about ever having been a victim or perpetrator of IPV.

Sampling

Of 14,501 compounds registered in Gem in 2010, we randomly selected 6,000, partly by community sampling (750 households) via a participatory community event and partly by computer-generated statistical sampling (5,250 households) conducted by the HDSA data team. The study statistician randomly sampled the remaining compounds using a computer. Details of these sampling methods are described by Phillips-Howard et al.[15]

Data Collection

For all participants, interview topics included participant demographics, sexual behaviour, and utilisation of HIV health services. From data collected during the survey, we extracted a database of persons aged 15 to 24 to address our research questions.

Outcome Variable Definitions

For this analysis, we adapted the United Nations definition of IPV to include only 'physical harm from a current or former intimate partner'.[16] Participants were described as "victims of IPV" if they answered "yes" to the question, 'Has any of your sexual partners, in the last year, hit, slapped, kicked, or done anything else to hurt you physically?' Participants were identified as "perpetrators of IPV" if they answered in the affirmative to the question, 'Have you, in the last year, hit, slapped, kicked, or done anything else to physically hurt any of your sexual partners?'

Definitions of Independent Variables of Interest

A sexual partner was described as a "recent sex partner" if he or she had been a sexual partner of the interviewee within 1 year preceding the interview. Study participants were described as "single" if they reported not having a romantic or cohabiting partner or spouse at the time of interview, including if they were separated or widowed. "In a relationship or married" was defined as participants who were in a monogamous or polygamous relationship, cohabiting, or married.

Participants were characterised as having ever been subjected to "sexual violence in the past" if they answered "yes" to the question, 'Have you ever been forced to have sex?' Participants who had been subjected to "sexual violence recently" were those who answered in the affirmative to the question, 'In the last 12 months, has partner X forced you to have sex?' Depending on the interviewee's sexual history, "partner X" referred to any of the interviewee's 3 most recent sexual partners in the year preceding the interview. Conversely, participants had committed "sexual violence recently" if they answered affirmatively to the question, 'In the last 12 months, have you forced any of your sexual partners to have sex?'

Participants were described as ever having experienced "a condom error" with a recent sexual partner if they answered "yes" to the any of the following questions: 'While using condoms with partner X, did you ever put on the condom after you had already started having sexual intercourse?', 'Did you ever take off the condom before you were finished having sexual intercourse?', 'Did the condom you were using ever slip off during sex or while pulling out?', or 'Did the condom you were using ever break or leak during sex or while pulling out?'

Data Analysis

Proportions were used to describe participant characteristics. Chi-square or Fisher's exact tests were used to compare participants according to their history of having been subjected to or having perpetrated IPV. Logistic regression was used to determine factors associated with being either victims or perpetrators of IPV. Variables that attained a *P* value less than .2 in the univariate analysis were included in the multivariate logistic regression model. Using backward elimination criteria, variables that had a *P* value less than .1 were retained in the multivariate model. Variables that had a *P* value less than .05 were considered significant. Crude odds ratios, which explained the relationship between a given variable and the outcome, were reported. Adjusted odds ratios (AORs), which included the influence of other variables on the outcome, were also reported. All estimates were reported with 95% confidence intervals (CIs).[17] Analysis was done using Statistical Analysis Software (SAS), version 9.2 (SAS Institute Inc., Cary, NC, USA).

Ethical Approval

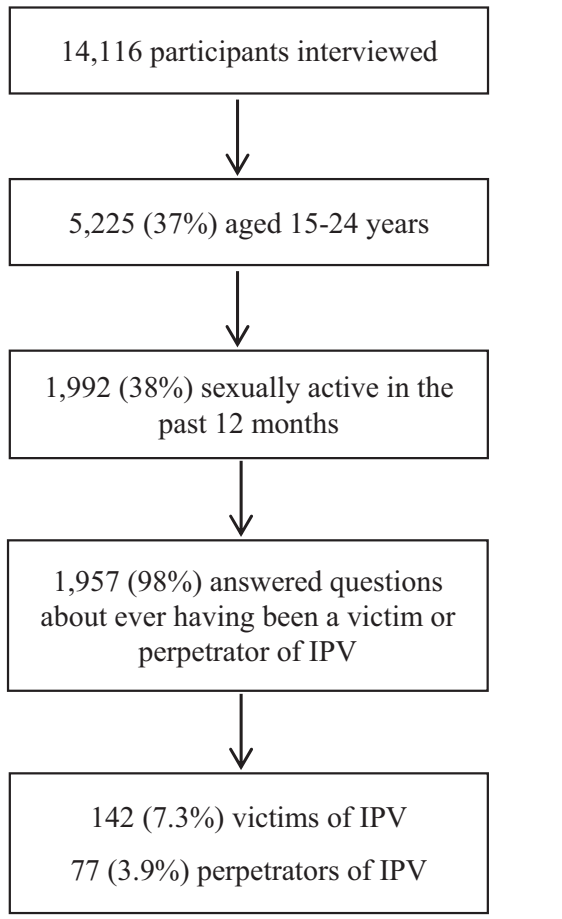
Permission to conduct this study was granted by the Kenya Medical Research Institute Ethics Review Committee (SSC No. 1801).

RESULTS

Participant Selection

Of 14,116 interviewees, 5,225 (37%) were youths, 1,992 (38%) of whom had been sexually active in the previous 12 months. Among these, 1,957 (98%) answered questions regarding having ever been subjected to or having ever perpetrated IPV (Figure).

FIGURE. Participant Selection



Abbreviation: IPV, intimate partner violence.

Participant Characteristics

Of the 1,957 participants included in the analysis, the majority were aged 19 to 22 years (n=1,002; 51%), female (n=1,174, 60%), single (n=993, 51%), had primary or below primary-level education (n=1,349, 69%), and engaged in some form of employment (n=1,054, 54%).

At the time of their respective interviews, participants frequently reported having had 2 lifetime sexual partners (n=563, 31%) and 1 recent sexual partner (n=1,687, 86%). Some participants reported having a sexual partner who had other concurrent sexual partners (n=267, 14%) or had newly acquired other sexual partners (n=233, 12%). Regarding experience with sexual violence, 131 (7%) participants reported that they had been subjected to sexual violence recently, 134 (7%) had been subjected to sexual violence in the past, and 48 (3%) had recently committed sexual violence.

The majority of participants had previously used a condom during sexual intercourse (n=1,239, 63%) or had at some point asked a sexual partner to use a condom (n=996, 51%). Conversely, less than half (n=842, 43%) had used condoms during their most recent sexual intercourse, and 205 (11%) reported having experienced condom errors with a recent sexual partner (Table 1).

In the year preceding the survey, a minority of participants reported that they themselves (n=45, 2%) or their sexual partners (n=51, 3%) had taken drugs or mind-altering substances. Few participants reported having consumed alcohol before sex or being drunk during sex (n=67, 3%) or having had sexual partners who had consumed alcohol before or been drunk during sexual intercourse (n=77, 4%) (Table 1).

Victims of Intimate Partner Violence

Of the 1,957 participants, 142 (7%) reported having ever been victims of IPV. Of the 142 past victims of IPV, 29 (22%)

TABLE 1. Characteristics of Youth Interviewed in Gem, Siaya County, Western Kenya, 2013–2014 (N=1,957)

Characteristics	n (%)
Age group, years	
15–18	410 (21)
19–22	1,002 (51)
23–24	546 (28)
Gender	
Male	784 (40)
Female	1,174 (60)
Marital status	
Single[a]	993 (51)
In a relationship or married	964 (49)
Education level	
Primary or below	1,349 (69)
Above primary	608 (31)
Occupation	
Employed	1,054 (54)
Unemployed	905 (46)
Lifetime number of sex partners[b]	
1	449 (25)
2	563 (31)
3–4	548 (30)
5 and above	264 (14)
Number of sex partners in the last 12 months	
1	1,687 (86)
2 and above	268 (14)
Primary sexual partner has other partners	
Yes	267 (14)
No	1,692 (86)
Primary sexual partner recently acquired a new partner	
Yes	233 (12)
No	1,726 (88)
Subjected to sexual violence in the past[c]	
Yes	134 (7)
No	1,825 (93)
Subjected to sexual violence recently[d]	
Yes	131 (7)
No	1,828 (93)
Committed sexual violence recently[e]	
Yes	48 (3)
No	1,911 (97)
Ever used a condom	
Yes	1,239 (63)
No	720 (34)
Ever asked partner to use a condom	
Yes	996 (51)
No	963(49)
Used a condom during last sexual intercourse	
Yes	842 (43)
No	1,117 (57)
Experienced condom error in the past 12 months	
Yes	205 (11)
No	1,754 (89)
Ever consumed alcohol before sex or been drunk during sex	
Yes	67 (3)
No	1,892 (97)
Partner ever consumed alcohol before sex or been drunk during sex	
Yes	77 (4)
No	1,882 (97)
Used drugs or mind-altering substances in the past year	
Yes	45 (2)
No	1,914 (98)
Partner used drugs or mind-altering substances in the past year	
Yes	51 (3)
No	1,908 (97)

[a] Includes 32 participants who were either divorced or widowed.
[b] Responses missing for 135 respondents.
[c] Participants were characterised as having ever experienced 'sexual violence in the past' if they answered "yes" to the question, 'Have you ever been forced to have sex?'
[d] Participants were characterised as having been subjected to 'sexual violence recently' if they answered in the affirmative to the question, 'In the last 12 months has partner X forced you to have sex?'
[e] Participants were characterised as having ever committed sexual violence if they answered "yes" to the question, 'In the last 12 months have you forced any of your sex partners to have sex?'

reported having been subjected to sexual violence within the 12 months before being interviewed, and 40 (31%) said they had been subjected to sexual violence recently (AOR 3.9; 95% CI, 2.2 to 6.8; $P<.01$). Victims of IPV were more likely to be female (n=131, 92%) than male (n=11, 8%; AOR 7.9; 95% CI, 3.6 to 17.5; $P<.01$), and to be in a relationship or married (n=118, 83%) than single (n=24, 17%; AOR 3.1; 95% CI, 1.8 to 5.4; $P<.01$). Overall, 11% of females were victims of IPV, compared to 1% of males (Table 2).

According to 135 available records, victims of IPV were also more likely to have had either 2 (n=34, 25%; AOR 1.2; 95% CI, 1.9 to 8.4), 3 to 4 (n=59, 43%; AOR 2.1; 95% CI, 1.2 to 3.9), or 5 or more (n=25, 19%; AOR 4.0; 95% CI, 1.9 to 8.4) lifetime sexual partners than to have had 1 (n=17, 13%) lifetime sexual partner ($P<.01$). Furthermore, among victims of IPV, 32 (23%) had primary sexual partners who had additional concurrent partners, and 39 (27%) had primary partners who had recently acquired new sexual partners. There were 29 (20%) victims of IPV who reported having been subjected to sexual violence in the past, compared with 113 (80%) who had not been subjected to sexual violence more than 12 months prior (AOR 1.9; 95% CI, 1.0 to 3.4; $P<.01$).

Perpetrators of Intimate Partner Violence

Of the 1,957 participants, 76 (4%) reported having ever been perpetrators of IPV. Perpetrators of IPV were more likely to be male (n=52, 68%) than female (n=24, 32%; AOR 2.1; 95% CI, 1.2 to 3.7; $P<.01$). Among 66 available records, perpetrators of IPV were more likely to have had 5 or more (n=27, 41%) lifetime sexual partners than 1 (n=10, 15%; AOR 2.8; 95% CI, 1.3 to 6.3, $P<.01$) lifetime sexual partner. Among the 76 participants who identified themselves as perpetrators of IPV in the previous year, 7 (9%) also reported committing sexual violence within the same period, compared to 69 (91%) who reported that they had not recently committed sexual violence (AOR 2.9; 95% CI, 1.1 to 7.7; $P=.02$). Overall, 7% of males and 2% of females identified themselves as perpetrators of IPV (Table 3).

DISCUSSION

Among the 1,957 sexually active youths in our study population, 7% were victims and 4% were perpetrators of IPV. The prevalence of IPV was lower than what was found in a 2005 survey conducted in 10 countries by the World Health Organization. That study revealed that 13% to 61% of women who had ever been in an intimate partnership had been subjected to physical violence by a partner.[6] A Kenyan national survey, conducted in 2014, found that one-fifth of all women aged 15 years and older had experienced some form of physical violence.[18] It is important to highlight that our study sample was limited to youth aged 15 to 24 years, as opposed to other studies that may have included broader age ranges. Nevertheless, younger individuals have been shown to have higher rates of IPV,[19] and intervening at this stage is therefore likely to reduce the chances of lifetime victimisation and perpetration, which increase the risk of HIV transmission.[5]

While being interviewed, victims of IPV – who were mostly female and of low educational status – were likely to be in a current relationship with a partner whose abuse qualified the partnered individuals to be a victim and perpetrator of IPV, according to the study definitions. In the 2014 Kenya Demographic and Health Survey, more than half (57%) of women who had ever experienced physical violence stated that the perpetrator was the current spouse.[19] Similar results have been reported in India and South Africa.[20,21] This could be related to a high level of economic dependency by women on men,[16] which may make many women reluctant to report IPV.[22] In Uganda, a decrease in IPV has been associated with the empowerment of women, providing evidence to support the importance of education and delayed partnering for young women.[19,23]

Our assessment corroborated the presumption that perpetrators are usually male. In the literature, the perpetrators of IPV are typically men living in communities where violence is routinely used to resolve problems. Perpetrators in such communities often feel their male identity being challenged by factors related to poverty.[16] Although our study found higher rates of IPV perpetration among males, other sources report similar rates of IPV perpetration by men and women, with women less likely than men to commit severe violence. IPV inflicted by women on men is likely to be underreported due to social desirability bias, and limited information exists in the literature about male victims of IPV.[19]

Many victims and perpetrators reported having had more than 1 lifetime sexual partner and having been subjected to or having committed IPV over a duration that extends earlier than the preceding 12 months considered in the study definition of IPV. In India[20] and South Africa,[21] women who reported IPV were more likely to have been abused in the past. As both IPV[5] and multiple sex partners[24] are risk factors for HIV transmission, it is important to screen for IPV and provide interventions that may mitigate future occurrences. This has been the basis for second responder programmes in the United States.[25]

While both victims and perpetrators reported several lifetime partners, only victims reported that their partners had concurrent sexual partners. This finding is similar to reports from Togo and South Africa, where HIV-infected women who were victims of IPV also reported that their partners had multiple partners.[26,27] This may be related to a common double standard regarding the sexual behaviour of men and women: while women with multiple sex partners are viewed as promiscuous, men receive praise for their sexual experiences with multiple partners. In South Africa, teenage girls stated that victims have multiple sexual partners to find solace or as a form of resistance.[28] Conversely, perpetrators may seek multiple sexual partners as a form of male dominance.[29]

TABLE 2. Factors Associated With Being a Victim of Intimate Partner Violence[a] in the Past Year Among Youths in Western Kenya, 2013–2014[b]

Characteristics	Victims of IPV[c] n/Row Total (%)	Crude Odds Ratio[d] (95% CI)	*P* Value	Adjusted Odds Ratio[e] (95% CI)	*P* Value
Age group, years					
15–18	19/410 (5)	Ref	.03		
19–22	73/1,001 (7)	1.6 (0.9–2.7)			
23–24	50/546 (9)	2.1 (1.2–3.6)			
Gender					
Male	11/784 (1)	Ref	<.01	Ref	<.01
Female	131/1,173 (11)	8.8 (4.7–16.4)		7.9 (3.6–17.5)	
Marital status					
Single[f]	24/969 (2)	Ref	<.01	Ref	<.01
In a relationship or married	118/964 (12)	5.6 (3.6–8.8)		3.1 (1.8–5.4)	
Education level					
Primary or below	119/1,349 (9)	2.5 (1.6–3.9)	<.01		
Above primary	23/608 (4)	Ref			
Occupation					
Employed	90/1,053 (9)	1.5 (1.1–2.2)	.02		
Unemployed	52/904 (6)	Ref			
Lifetime number of sex partners[g]					
1	17/432 (4)	Ref	<.01	Ref	<.01
2	34/563 (6)	1.6 (0.9–2.9)		1.2 (1.9–8.4)	
3–4	59/546 (11)	3.1 (1.7–5.4)		2.1 (1.2–3.9)	
5 and above	25/264 (9)	2.7 (1.4–5.0)		4.0 (1.9–8.4)	
Number of sex partners in the last 12 months					
1	129/1,685 (8)	1.6 (0.9–2.9)	.10		
2 and above	13/268 (5)	Ref			
Primary sexual partner has other partners					
Yes	32/233 (14)	2.3 (1.5–3.6)	<.01		
No	110/1,724 (6)	Ref			
Primary sexual partner recently acquired a new partner					
Yes	39/267 (15)	2.6 (1.8–3.9)	<.01	2.7 (1.7–4.2)	<.01
No	103/1,690 (6)	Ref		Ref	
Subjected to sexual violence in the past[h]					
Yes	29/105 (22)	4.2 (2.7–6.6)	<.01	1.9 (1.0–3.4)	<.01
No	113/1,823 (6)	Ref		Ref	
Subjected to sexual violence recently[i]					
Yes	40/131 (31)	7.4 (4.9–11.3)	<.01	3.9 (2.2–6.8)	<.01
No	102/1,724 (6)	Ref		Ref	
Committed sexual violence recently[j]					
Yes	9/48 (19)	3.1 (1.5–6.5)	<.01		
No	133/1,909 (7)	Ref			

Continued

TABLE 2. Continued

Characteristics	Victims of IPV[c] n/Row Total (%)	Crude Odds Ratio[d] (95% CI)	*P* Value	Adjusted Odds Ratio[e] (95% CI)	*P* Value
Ever used a condom					
Yes	73/1,238 (6)	Ref	<.01		
No	69/719 (10)	1.7 (1.2–2.4)			
Ever asked partner to use a condom					
Yes	70/995 (7)	0.9 (0.7–1.3)	.70		
No	72/962 (7)	Ref			
Used a condom during last sexual intercourse					
Yes	37/842 (4)	Ref	<0.01		
No	105/1,115 (9)	2.2 (1.5–3.3)			
Experienced condom error reported in the last 3 months					
Yes	15/204 (7)	1.0 (0.6–1.8)	.90		
No	127/1,753 (7)	Ref			
Ever consumed alcohol before or during sex or been drunk during sex					
Yes	9/67 (13)	2.0 (0.9–4.2)	.05		
No	133/1,890 (7)	Ref			
Partner ever consumed alcohol before or during sex or been drunk during sex					
Yes	21/77 (27)	5.5 (3.1–9.3)	<.01		
No	121/1,880 (6)	Ref			
Used drugs or mind-altering substances in the past year					
Yes	1.45 (2)	Ref	.20		
No	141/1,912 (7)	0.3 (0.03–2.1)			
Partner used drugs or mind-altering substances in the past year					
Yes	15/51 (29)	5.8 (3.1–10.9)	<.01		
No	127/1,906 (7)	Ref			

[a]Participants were described as "victims of IPV" if they answered "yes" to the question, 'Has any of your sexual partners, in the last year hit, slapped, kicked, or done anything else to hurt you physically?'
[b]Responses are missing for 2 participants who did not answer questions about ever having experienced physical IPV.
[c]There were 142 (7%) victims of IPV; the numerators in this column are the number of victims of IPV who fulfilled the criteria described in the respective rows, and the denominators are the total number of participants who fulfilled the criteria mentioned in each row.
[d]Crude odds ratios refer to the odds of an outcome given the response status of a particular variable.
[e]Adjusted odds ratios are crude odds ratios adjusted after considering the influence of all other variables.
[f]Includes 32 participants who were either divorced or widowed.
[g]Responses missing for 135 participants.
[h]Participants were characterised as having ever been subjected to "sexual violence in the past" if they answered "yes" to the question, 'Have you ever been forced to have sex?'
[i]Participants were characterised as having been subjected to "sexual violence recently" if they answered in the affirmative to the question, 'In the last 12 months has partner X forced you to have sex?'
[j]Participants were characterised as having committed "sexual violence recently" if they answered "yes" to the question, 'In the last 12 months have you forced any of your sex partners to have sex?'
Abbreviations: CI, confidence interval; IPV, intimate partner violence.

TABLE 3. Factors Associated With Being a Perpetrator of Intimate Partner Violence[a] in the Past Year Among Youths in Western Kenya, 2013–2014[b]

Characteristics	Perpetrators of IPV[c] n/Row Total (%)	Crude Odds Ratio[d] (95% CI)	*P* Value	Adjusted Odds Ratio[e] (95% CI)	*P* Value
Age group, years					
15–18	12/410 (3)	Ref	.50		
19–22	41/1,001 (4)	1.4 (0.7–2.7)			
23–24	23/546 (4)	1.5 (0.7–2.9)			
Gender					
Male	52/784 (7)	3.4 (2.1–5.6)	<.01	2.1 (1.2–3.7)	.01
Female	24/1,149 (2)	Ref		Ref	
Marital status					
Single[f]	39/993 (4)		.92		
In a relationship or married	37/964 (4)	Ref			
Education level					
Primary or below	50/1,349 (4)	0.8 (0.5–1.4)	.50		
Above primary	26/608 (4)	Ref			
Occupation					
Employed	51/1,053 (5)	1.8 (1.1–2.9)	.02		
Unemployed	25/904 (3)	Ref			
Lifetime number of sex partners[g]					
1	10/449 (2)	Ref	<.01	Ref	<.01
2	9/563 (2)	0.7 (0.3–1.8)		0.7 (0.3-1.6)	
3–4	20/546 (4)	1.7 (0.8–3.6)		1.3 (0.6–2.9)	
5 and above	27/264 (10)	5.0 (2.4–10.5)		2.8 (1.3–6.3)	
Number of sex partners in the last 12 months					
1	50/1,685 (3)	Ref	<.01		
2 and above	25/268 (9)	3.4 (2.0–5.5)			
Primary sexual partner has other partners					
Yes	16/233 (7)	2.0 (1.2–3.6)	.01		
No	60/1,724 (4)				
Primary sexual partner has a new partner					
Yes	21/267 (8)	2.5 (1.5–4.3)	<.01		
No	55/1,690 (3)	Ref			
Subjected to sexual violence in the past[h]					
Yes	8/134 (6)	1.6 (0.8–3.5)	.20		
No	68/1,823 (4)	Ref			
Subjected to sexual violence recently[i]					
Yes	9/131 (7)	1.9 (0.9–3.9)	.07		
No	67/1,826 (4)	Ref			
Committed sexual violence recently[j]					
Yes	7/48 (15)	4.6 (1.9–10.5)	<.01	2.9 (1.1–7.7)	.02
No	69/1,909 (4)	Ref		Ref	

Continued

TABLE 3. Continued

Characteristics	Perpetrators of IPV[c] n/Row Total (%)	Crude Odds Ratio[d] (95% CI)	*P* Value	Adjusted Odds Ratio[e] (95% CI)	*P* Value
Ever used a condom					
Yes	54/1,238 (4)	1.4 (0.9–2.4)	.20		
No	22/719 (3)	Ref			
Ever asked partner to use a condom					
Yes	49/995 (5)	1.8 (1.1–2.9)	.02		
No	27/962 (3)	Ref			
Used a condom during last sexual intercourse					
Yes	35/842 (4)	1.1 (0.7–1.8)	.80		
No	41/1,115 (4)				
Experienced condom error in the last 3 months					
Yes	17/2,014 (8)	2.6 (1.5–4.6)	<.01		
No	59/1,753 (3)	Ref			
Ever consumed alcohol before or during sex or been drunk during sex					
Yes	4/67 (6)	1.6 (0.6–4.5)	.40		
No	72/1,890 (4)	Ref			
Partner ever consumed alcohol before or during sex or been drunk during sex					
Yes	5/77 (6)	1.8 (0.7–4.5)	.20		
No	71/1,880 (4)	Ref			
Used drugs or mind-altering substances in the past year					
Yes	5/45 (11)	3.2 (1.2–8.5)	.01		
No	71/1,912 (4)	Ref			
Partner used drugs or mind-altering substances in the past year					
Yes	1/51 (2)	Ref	.50		
No	75/1,906 (4)	0.5 (0.1–3.6)			

[a]Participants were described as "perpetrators of IPV" if they answered in the affirmative to the question, 'Have you, in the last year, hit, slapped, kicked, or done anything else to physically hurt any of your sexual partners?'
[b]Responses missing for 2 participants who did not answer questions about ever having perpetrated physical IPV.
[c]There were 77 (4%) perpetrators of IPV; the numerators in this column are the number of perpetrators of IPV who fulfilled the criteria described in the respective rows, and the denominators are the total number of participants who fulfilled the criteria mentioned in each row.
[d]Crude odds ratios refer to the odds of an outcome given the response status of a particular variable.
[e]Adjusted odds ratios are crude odds ratios adjusted after considering the influence of all other variables.
[f]Includes 32 participants who were either divorced or widowed.
[g]Responses missing for 135 participants.
[h]Participants were characterised as having ever been subjected to "sexual violence in the past" if they answered "yes" to the question, 'Have you ever been forced to have sex?'
[i]Participants were characterised as having been subjected to "sexual violence recently" if they answered in the affirmative to the question, 'In the last 12 months has partner X forced you to have sex?'
[j]Participants were characterised as having committed "sexual violence recently" if they answered "yes" to the question, 'In the last 12 months have you forced any of your sex partners to have sex?'
Abbreviations: CI, confidence interval; IPV, intimate partner violence.

Limitations

This study's limitations included the sole focus on physical violence without consideration of sexual or psychological forms of IPV. This analysis was also limited by recall and respondent biases; participants may have felt embarrassed to admit to the interviewers that they had been subjected to or had perpetrated IPV. For these reasons, our estimates of the burden of IPV in this population may be underestimated.

RECOMMENDATIONS AND CONCLUSION

There was a high prevalence of IPV among sexually active youth in this rural community. Study participants were recurrent victims or perpetrators and reported behaviours that put them at risk of HIV acquisition. Victims and perpetrators also possessed characteristics that could be used by screening programmes to identify and target them for specific interventions.

There is a need to reduce gender inequality and to enhance the livelihoods of young women via upstream interventions. The Ministry of Health in Kenya provides structural prevention approaches to bolster resilience among women and girls through behavioural interventions, including evidence-based behavioural HIV prevention strategies to equip young girls with the skills to negotiate safe sex. The Ministry also conducts targeted sensitisation about IPV, for example, in conjunction with the United States Agency for International Development and the Determined, Resilient, Educated, AIDS-free, Mentored, and Safe (DREAMS) mentorship programme for adolescents and young women.[30]

Downstream interventions to address IPV could include screening and provision of gender-based violence and recovery centres and services. Health-care workers should also screen for other forms of IPV among women presenting to health-care facilities with physical injuries, depression symptoms, and miscarriages, or for routine care.[31] The potential benefits of health-care screening programmes rely on client expectations of compassionate, nonjudgemental, and effective care delivery from health-care providers.[32] If this is accomplished, health workers can provide appropriate referrals to further reduce exposure to IPV and its consequences.[32] Fragmented care has been identified as a barrier to effective management of IPV. Because gender-based violence services are not routinely offered as part of standard care, victims of IPV are often lost along the referral cascade. Gender-based violence services should, therefore, be diversified to include legal services and professional counselling in addition to health services.[22] There should also be clear laws related to IPV to enhance legal reporting and clear guidelines on the management of all forms of IPV – not just physical violence.[33]

Health-care programmes should also publicise the availability of gender-based violence and recovery services to both health-care providers and communities to encourage reporting of IPV. Information campaigns have been shown to enhance clients' perspectives on the availability of facilities to assist victims of IPV.[34] Furthermore, community mobilisation of gender-based violence service campaigns in Kisumu County, Kenya, led to an increase in the number of cases that were seen at the gender-based violence centre there (HIV Prevention Coordinator, KEMRI Centre for Global Health Research, personal communication, 12 June 2014).

Several integrated approaches can be used to prevent IPV. Upstream approaches include legislation to deter potential offenders and punish reported offenders.[33] Policy makers should enforce existing legislation, such as the Sexual Offences Act in the Constitution of Kenya, which will deter potential perpetrators of IPV and reprimand identified perpetrators.[35] Policy makers also ought to address other determinants of IPV, including poverty, drug abuse, economic dependency on men by victims of IPV, and societal norms. The provision of life skills training to address known risk factors for perpetrating IPV – such as alcoholism and unemployment – and the use of renowned male role models as ambassadors against IPV, would also contribute to preventing IPV.[6,36]

Upon identification of IPV perpetrators, downstream interventions should include needs and risk assessments of the perpetrators and their immediate family environments. The findings of such evaluations should then be incorporated into programmes to motivate the perpetrators to change their maladaptive behaviours.[37] Perpetrators should also enrol in batterer intervention programmes.[38] In the United States, a second responder intervention focused on assessed police outcomes of previous perpetrators randomised to an intervention group that provided risk profiling, interventions based on men's criminogenic triggers, and responsivity. Compared to a control group, men in the intervention group reported lower rates of domestic violence.[25] This exemplified the effectiveness of interventions that are tailored to the learning styles and motivations of intervention participants. As more than one-tenth of perpetrators reported having ever committed sexual violence recently in our evaluation, there is a need for targeted interventions. Communities should be sensitised to the dangers of IPV and other means of improving communication and conflict resolution within partnerships.[30]

In 2010, voluntary HIV counselling and testing centres were proposed as ideal places to identify victims of IPV, because these centres offer opportunities to discuss risky sexual behaviour and HIV prevention.[24] However, without adequate skills to discuss gender inequality issues, lay counsellors conducting screening for IPV were unable to offer solutions.[39] In response to this, in 2014, a couples HIV risk-reduction programme implemented by South African community health centre workers achieved IPV reduction over a period of 1 year.[40] Couples counselling and testing would, therefore, be an ideal setting to broach the issue of IPV in the context of HIV risk reduction counselling and HIV testing.

Further research is required to assess the proportion of IPV incidents that are reported, quantify the burden of IPV (including other forms of violence in the definition of IPV), determine the motivating and contributing factors behind IPV, and assess the impact of any programmes that address IPV perpetrators.

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ORIGINAL ARTICLE

The Implementation of Governance Attributes in Health in Uasin Gishu County, Kenya

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ABSTRACT

Background: Globally, good governance is increasingly recognised as an important factor in health systems. Governance is a key determinant of performance, particularly towards achieving targets that ultimately affect economic and social development. However, conceptually and practically, governance is poorly understood by decision makers at various levels. Governance is also difficult to measure, but it is critical in assessing responsive, inclusive, effective, and efficient services. We examined the extent to which governance attributes have been implemented within the Department of Health in Uasin Gishu County, Kenya.

Methods: A cross-sectional research design was adopted, with 108 decision makers forming the target population. The study period was between April and July 2016. Select documents relating to governance were reviewed; subsequently, data were collected using a self-administered, semi-structured questionnaire, with 5-point Likert-type questions and open-ended questions. We calculated proportions related to agreement levels to establish the decision makers' perceptions on the implementation of governance attributes. Cronbach's α for the items was between 0.72 and 0.84. Qualitative data were coded and categorised using a framework approach.

Results: Of the 93 decision makers who responded, most (n=64, 68.8%) had been in their current position for less than 5 years. Regarding governance attributes, over half of the participants agreed on the implementation of good governance in terms of strategic vision as well as regulation and oversight. Around half of the participants were undecided on the implementation of good governance in terms of intelligence and information, transparency, participation, and consensus orientation. Almost two-thirds believed that accountability and equity were poorly implemented. A minority rated the overall governance score as good, while two-thirds considered governance to be poor. Corruption, nepotism, lack of transparency, political interference, and inadequate use of information were all reported to affect the implementation of good governance.

Conclusion: Decision makers reported poor implementation of governance attributes at public health facilities, especially in terms of accountability, equity, community participation, consensus orientation, strategic vision, and regulation and oversight. It is feasible and critical to evaluate implementation of governance attributes to help improve governance; the successful implementation of each attribute depends on the successful implementation of all others.

INTRODUCTION

Globally, governments are increasingly concerned with how to improve the performance of health services. Governance is increasingly considered to be a key determinant of performance,[1,2] particularly towards achieving targets that ultimately affect economic and social development.[3–5] Governance can be understood from a political, developmental, and health systems perspective,[3] and it has been defined as the process of creating an organisational vision and mission; defining the goals and objectives that should be met to achieve the vision and mission; and defining the structures in that need to be place to achieve, monitor, and evaluate the performance of the desired outcomes.[4] In the Action Plan for Universal Health Coverage, the World Health Organization defined governance as including:

> The traditions and institutions by which authority in a country is exercised for the common good, including the processes by which those in authority are selected, monitored and replaced; the capacity of the government

to effectively manage its resources and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them.[6]

Although this definition arguably privileges organised governance structures through the agency of the state, the definition includes the involvement of civil society.[7] Good governance is among the building blocks of any health system, yet the implementation and evaluation of governance – as well as research on governance – are often neglected at the national and international levels due to lack of clarity on operationalising governance, its complexity, and the sometimes sensitive issues that arise in determining it.[4,8]

The concern with governance in government-operated services arose from an interest in the private sector in the 1970s, when managers began to focus on the impact of governance on performance as a result of the interplay between shareholders, consumers, company executives, and boards to maximise returns.[2] Subsequently, concern with governance was extended to consider the broader contexts – judicial, regulatory, social, and cultural – in which corporations operated. Governance in the public sector was adapted from the private sector, with the terminology of shareholders and managers replaced by that of citizens and public officers. Because the public sector is large, with a larger number of interest groups than is typical for a private corporation, the ability of the public sector to attain various goals has been seen to be diluted by contestations among various interest groups and by the vulnerability of the sector to control by those with strong interests and power.

Over the past 3 decades, due to the poor economic and social performance of many countries receiving international aid, the focus of governance in such countries has been on international development and growth to benefit citizens.[2,9–11] At the same time, in order to fully realise the goals of development, concerns related to governance have extended to the heath sector. Investing in the governance of the health-care system is considered to be critical for the realisation of health-care investments.[1–3,12–14] Reporting on this necessitates being able to measure, monitor, and evaluate the implementation of governance at different levels of the system.

Although the current literature on governance has emphasised the importance of the evaluation of the implementation of governance, there is still little empirical research on this due to the complexity of governance and its role within health-care systems. A wide range of international bodies, including financial agencies and multilateral and bilateral programmes,[1] have historically championed for sensitisation about the value of implementing good governance. These actors have proposed ways of measuring governance using different frameworks in an attempt to develop an acceptable way of measuring and monitoring governance.[1,2,4,8,15,16] Siddiqi et al, for example, proposed 10 attributes and principles of governance: strategic vision, participation and consensus orientation, rule of law, transparency, responsiveness, equity and inclusiveness, effectiveness and efficiency, accountability, intelligence and information, and ethics.[4] Ruhanen, in contrast, after analysing over 40 articles, identified the most commonly used governance process indicators to be accountability, transparency, involvement, structure, effectiveness, and power.[17] These indicators serve as a guide when evaluating governance, although each attribute needs to be operationalised, and this, in turn, may vary according to local context.

In general, the attributes of governance are operationalised as follows.[1,2,4,18] *Accountability* is arguably the strongest governance attribute, and it cuts across many other attributes. It involves answerability and the imposition of sanctions. Accountability is defined as "obligations of individuals or agencies to provide information about, and/or justification for, their actions to other actors, along with the imposition of sanctions for failure to comply and/or to engage in appropriate action."[18] Three types of accountability can be distinguished: financial, performance, and political accountability.[18] There is also the distinction between internal and external accountability.[19] Internal accountability deals with institutional bureaucratic control mechanisms, while external accountability involves mechanisms wherein the community or public hold those in public institutions answerable.[19] *Strategic vision* provides a long-term perspective on health and development. *Participation and consensus orientation* provide a voice to the citizenry directly or through representation. *Regulation and oversight* provide the institutional and legal frameworks. *Transparency* involves the accessibility of institutional processes and information as required. *Intelligence and information* are essential for understanding how an institution or system is operating, and the decision-making processes that are involved in everyday and strategic operations. *Equity* refers to the idea that all citizens should have an equal opportunity for participation, although this may be determined through a variety of mechanisms.

Within the public sector, the drivers of governance are classified in 2 primary ways, although these are not mutually exclusive. Governance determinants or attributes – also referred to as rules-based attributes – are key processes or rules that need to exist for good governance and may include laws, regulations, procedures or similar forms of authority. Governance performance, also referred to as outcome-based indicators for measuring governance, is the expected effect or outcome of good governance,[2] and such indicators measure the degree to which rules are being implemented.[2,20]

Siddiqi et al highlighted the problematic pathways to good governance,[4] and yet in Kenya no identified empirical studies have been conducted on governance attributes in the health-care system at the county level, where interactions between the state and citizens are most frequent. In a systematic review to identify which governance frameworks are available and have been used to assess health system

governance, Pyone et al allude to the paucity of evidence related to the assessment of governance and argue for the adoption of existing frameworks to assess governance or components of it.[21] Of the 16 frameworks they identified from political science as well as developmental and public management, only 5 had been applied; in health-related programmes, Brinkerhoff and Siddiqi applied proposed frameworks to empirical examples.[4,18] However, while a variety of frameworks exist that might be used to assess health systems governance, few have been applied. Given the lack of application of such frameworks and lists of good governance attributes, there is a need for research to test their practicality.

The theoretical and descriptive literature also reveals that health system governance is complex and multidimensional. No single agreed upon framework can serve all purposes; accordingly, this study sought to identify and apply frameworks that might be applicable in the context of the Kenyan health system. To define good governance, therefore, in this study we drew both from frameworks found in the literature and from what was practical in the context of the study. We defined good governance according to attributes detailed by Siddiqi – characterised by the extent to which 7 groups of attributes were implemented; these were: *strategic vision*; *regulation and oversight*; *intelligence and information*; *participation and consensus orientation*; and *equity, accountability, and transparency*.[2,22]

Kenya, like many other developing countries, strives to implement governance practices to achieve its developmental goals. Vision 2030, Kenya's long-term development blueprint, is anchored on 3 pillars: social, economic, and political.[23] The goal of the health sector is to provide equitable, affordable, and quality services. Good health is expected to play an important role in boosting economic growth, reducing poverty, and realising social goals, such as equity and efficiency.[24] Governance is an important factor guiding the realisation of universal health care, which is 1 of the 4 major agendas of the current Kenyan government.

In this study, information was drawn from government-published reports and guidelines and a semi-structured questionnaire. The main purpose of this study was to assess the extent to which the governance attributes, listed above, were implemented in the Department of Health in Uasin Gishu County, Kenya.

METHODS

Study Setting

This study was undertaken in Uasin Gishu County, 1 of 47 counties in Kenya. The county – which has its headquarters in Eldoret, Western Kenya – has a total population of over 1 million (513,649 males and 509,292 females) according to 2016 population estimates.[25] It is divided administratively into 6 subcounties and 30 wards.[26] Services are organised into a 4-tier system: community, primary health care, county hospitals, and national referral hospitals.[24,27] There are only 2 national referral hospitals – 1 in the capital city, Nairobi, and the other in Eldoret. According to the 2013 Kenya Service Availability and Readiness Assessment Mapping (SARAM) Report, there were 146 facilities providing health care, of which 90 were public primary health-care facilities.[26] The county health service is headed by the county chief executive officer, with a deputy chief officer and 2 directors of health. Different department heads constitute the county and subcounty management teams, which participate in decision making on a range of health issues (Figure 1).[24]

Study Design

We adopted a cross-sectional research design to examine the extent to which governance attributes were being implemented by decision makers in health. The cross-sectional survey design was suitable for our focus on decision makers, who belong to the constitutional level in the multilevel framework of governance (the other levels are collaborative and individual, according to Abimbola[28]), as this research design is appropriate when the data collection strategy is broader in scope and involves systematic data collection.[29] This work was part of the first author's PhD research, looking at community participation in the governance of primary health-care facilities in the same study setting. Other aspects of governance were examined at individual and collaborative levels.

Data Collection

Data were collected between April and July 2016. A document analysis guide (ie, a checklist used to identify governance-related material in the reviewed documents) and semi-structured questionnaires were used for data collection.

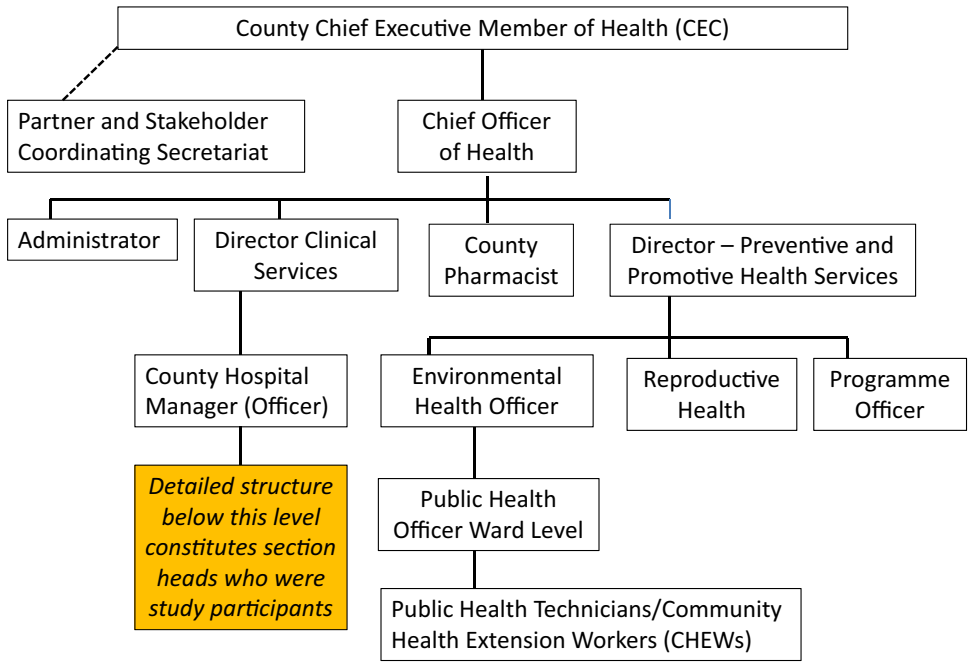
Desktop Review

The Uasin Gishu County Development Plan, the Uasin Gishu Strategic Plan 2013–2018, the National Health Sector Strategic Plan 2014–2018, the Kenya Health Improvement Policy, the Strategy and Plan of Action 2015–2030, and the Kenya Constitution of 2010 were reviewed for the extraction of information related to governance.

Survey

A semi-structured questionnaire was given to 108 constitutional-level decision makers from the county executive committee, the county health management team, and the subcounty health management team, including partners and managers of primary health-care facilities selected for the study. These were members of the Department of Health who all had the mandate to put into place the structures and processes for the implementation of good governance practices.[30,31] The questionnaire was self-administered by all office holders willing to participate. For those whose

FIGURE 1. Organisational Structure of Health Services Leadership in Uasin Gishu County[25]



Shows how services were organised into different sections from which participants (who constituted decision makers) were drawn.

schedules were tight, the questionnaire was delivered and collected – once completed – at a predetermined time. The first part of the questionnaire captured biographical information, and the second part was designed to elicit information on the main study objective. The second section employed a 5-point Likert-type scale and consisted of 42 statement items. These included statements like, "The objectives of the County Strategic Plan are adequate for achieving set targets"; "There are mechanisms in place to address differences in access to care by vulnerable or marginalised groups, such as women, youth, elderly, disabled"; and "The analysed data are used in planning and decision making." On the Likert scale, 1 denoted "strongly disagree", 2 denoted "disagree", 3 denoted "neither agree nor disagree", 4 denoted "agree", and 5 denoted "strongly agree". Open-ended, self-administered questions were used to complement the Likert-type responses, to clarify responses and provide an opportunity for participants to elaborate on particular issues. Examples of such questions included, "How is information and evidence used in decision making both at the planning and implementation levels", "What are the issues affecting implementation of good governance practices", and "Which are the mechanisms in place that ensure that there is equity in resource allocation and access to the health-care facility by all, including the marginalised?"

Data Analysis

Quantitative data were cleaned and entered using Microsoft Access and exported to Stata, version 13 (Stata Corp., College Station, TX, USA) for analysis. Univariate analysis was undertaken for the demographic data, with the results presented in tables. Factor analysis was carried out for the Likert responses to explore the data before further analysis and to obtain broad explanations of the data.[32] Varimax and Kaiser Normalisation[33,34] were used in the factor analysis. After factor analysis, statements that had a coefficient of 0.6 and above were retained.[32] Data were categorised into proportions to establish the extent of the implementation of governance attributes as good, undecided, or poor, and to determine an overall governance score.[32,35]

To gain a sense of the direction and extent of implementation of governance attributes, we categorised responses into 3 groups of agree, disagree, and neutral or undecided, allocating them different scores depending on the number of variables in the group. In the analysis of Likert scale responses, it is generally accepted that responses can be categorised into 2 categories, with strongly disagree, disagree and

neutral treated as negative, and agree and strongly agree as positive.[36] However, following Sullivan and Armstrong,[34,35] we chose to summarise responses with 3 categories,[37] with strongly agree and agree as good; undecided indicating neither good nor bad; and strongly disagree and disagree as poor, consistent with recommendations guiding researchers to expand Likert Scale response options to increase accuracy but maintain the option to condense the response range during data analysis.[32,37,38] This allowed us to recognise efforts that reflected progress in the implementation of good governance. Governance scores were computed to obtain aggregate scores by calculating the minimum and the maximum scores.[38]

Qualitative data were cleaned, coded, and categorised into emerging themes using a framework approach. At the first level of analysis, descriptive codes were applied to gain familiarity with the emphasis that participants placed on questions of governance. Working through these broad codes, we then identified emerging themes by examining relationships and establishing linkages within and between responses, and through a process of iteration, developed primary themes. These themes were refined and finalised, with the results used to explain the findings from the Likert scale responses.

Ethical Considerations

Ethical approval for this study was granted by the Moi Teaching and Referral Hospital, Moi University Ethics Review Committee (approval number 0001593), and University of the Witwatersrand Human Research Ethics Committee (Medical) (clearance certificate number M170497). Written permission to conduct the study was also provided by the Uasin Gishu County Department of Health. Participant consent was sought prior to the study, with all participants given an opportunity to withdraw from the study, without jeopardising their careers, if they so wished. Participants were assured of confidentiality, and the questionnaires were allocated numeric identifying codes without indicating the names of the participants.

RESULTS

Demographic Characteristics

Out of 108 questionnaires administered, 93 were completed and returned, yielding a response rate of 86%. There were approximately equal numbers of women and men, with the majority of participants being over 30 years old (Table 1). In terms of educational level, 67 participants had an undergraduate degree or a higher qualification, and 26 were educated no higher than the postsecondary diploma level. Most participants had been employed at their current place of work for less than 5 years. Finally, 69 participants were members of the subcounty health management team, 12 were members of the county health management team, 5 were members of

TABLE 1. Demographic Characteristics of Study Participants

Variable	Category	n (%)
Sex	Male	51 (55)
	Female	42 (45)
Age group (years)	26–30	5 (6)
	31–35	6 (7)
	36–40	21 (23)
	≥41	58 (64)
Level of education	Undergraduate degree or above	67 (74)
	Diploma course and below	24 (26)
Time in current position (years)	0–5	62 (68)
	6–11	23 (26)
	≥11	5 (6)
Position	County Health Management Team	12 (13)
	Subcounty Health Management Team	69 (74)
	Private sector	5 (5)
	Other (elected representative, civil society)	7 (8)

the private sector, and others held positions, such as elected representative of a civil society organisation (Table 1).

Desktop Review

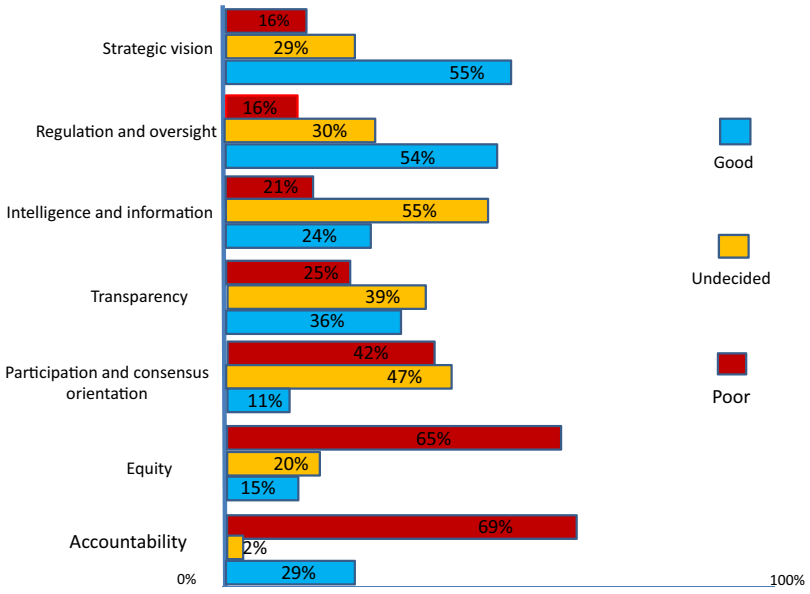
The review of official government documentation revealed that regarding accountability, research evidence informed service delivery. A preview of the policy direction framework revealed that among other things, social accountability, participation, equity, and people-centred and efficiency principles guided service delivery in the health system. Kenya's quality model for health emphasises regulations and stakeholder involvement to enhance quality in service delivery. The Constitution of Kenya 2010, Part 2 on Rights and Fundamental Freedoms, Article 27, emphasises the need for equality and freedom from discrimination. In Chapter[6] on leadership and integrity, public office bearers are charged with the responsibility of demonstrating respect for the people, bringing honour to the nation, dignity to the office, accountability to the public for decisions and actions, and discipline and commitment in service to the people. Chapter[12] of the Constitution emphasises openness and accountability, including public participation in financial matters; it also emphasises that leaders should promote equitable development by making provisions for marginalised groups and areas.

Data reviewed from the Uasin Gishu County Integrated Development Plan 2013–2018 highlighted indicators for improving services and identified constant drug stock-outs as the major challenge in delivering health services, while low community involvement and limited participation in health facility governance was identified as affecting service provision. The County Health Strategic and Investment Plan detailed the roadmap on accelerating the attainment of both short-term and long-term health targets. A health system framework approach was used to define the expected outputs on leadership and governance. It encouraged public participation in preparing the county health budget and placed emphasis on stakeholder meetings, regular facility meetings, and regular meetings of the county and subcounty health management teams to monitor performance.

Implementation of Governance

The responses to the Likert scale questions revealed that there was good implementation of 2 groups of attributes: *strategic vision* and *regulation and oversight*. Over half (n=51, 55%) of the participants reported good implementation of

FIGURE 2. Governance Scores According to Attribute



Shows the extent to which participants had a positive (good), negative (poor), or neutral (undecided) perception of the implementation of governance attributes.

TABLE 2. Cronbach's Alpha (α) Reliability Scores for Each Governance Attribute

Attribute	Items	Maximum	Median	Cronbach's α
Strategic vision	5	25	20	0.72
Participation and consensus orientation	8	40	25	0.82
Transparency	6	30	18	0.76
Regulation and oversight	6	30	20	0.84
Intelligence and information	8	40	26	0.75
Accountability	3	15	10	0.60
Equity	5	25	15	0.87

strategic vision, while 29 (27%) participants were neutral. Fifty (54%) participants reported good practice of regulation and oversight.

On the other hand, participants neither agreed nor disagreed on 3 groups of attributes. Almost half (n=44, 47%) of the participants were neutral (neither agreed nor disagreed) about participation and consensus orientation practices in health governance, while 39 (42%) participants disagreed.

Slightly above one-third (n=36, 39%) of the participants were neutral about practices of transparency while another third (n=33, 36%) agreed that there were good practices of transparency in county health services. However, a quarter (n=24, 25%) of the participants perceived transparency practice as poor. Over half (n=51, 55%) of the participants were neutral regarding intelligence and information. Additionally, many participants thought that implementation of governance attributes were poor in terms of accountability (n=64, 69%) and equity (n=60, 65%) (Figure 2).

Governance Aggregate Score

Thirty-nine (42%) participants indicated a perception that the implementation of governance attributes was poor, while 45 (48%) were neutral, and 9 (10%) participants thought implementation of governance attributes was good.

In terms of reliability (Table 2), all groups of items in the tool had Cronbach's α values between 0.72 and 0.87, except for *accountability*, which had a Cronbach's α of 0.60, and this was attributed to the low number of variables in the questionnaire.[39]

Findings from factor analysis yielded 7 latent factors. *Regulation and oversight* had 6 items, with the highest loading of 0.77 for the statement, "The facility managers ensure that health workers follow protocols, standards, and codes of conduct." Two items which had been earlier placed under *intelligence and information* were also loaded in this latent factor: "The health facility collects local data," and, "The health facility has guidelines and operating procedures for essential services from the Ministry of Health."

Four items loaded on *intelligence and information*, with the highest, 0.75, for the statement, "Health facility managers rely on research data from the health facility to plan services." One of the items had been earlier placed under *accountability*: "Systems exist for reporting, investigating, and adjudicating misallocation or misuse of resources (formal or informal systems)".

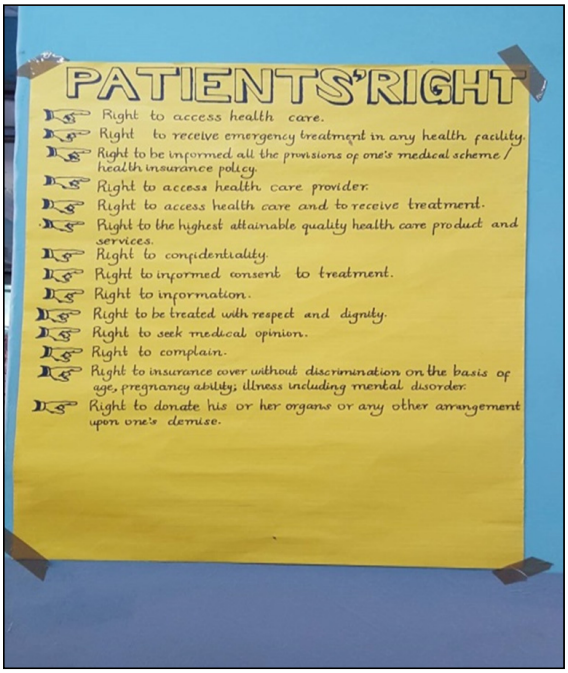
Four items loaded on *strategic vision*, with the highest score, 0.77, for the statement, "Implementation of mechanisms is in line with stated objectives of health policy." Two loaded on *participation and consensus orientation*. The highest score was in *equity*, with 0.90, for the statement, "There are mechanisms in place to address differences in access to care by vulnerable or marginalised groups, such as women, youth, elderly, disabled." Other statements that scored high were, "There are structures in place to empower marginalised voices, including women, by giving them a voice in formal decision-making structures and processes" (0.84) and, "The analysed data is used in planning and decision making" (0.81).

Qualitative Findings

The majority of participants cited nepotism, tribalism, and patronage as hindering the implementation of good governance attributes. Corruption, lack of transparency, political interference, and lack of equity in the distribution of resources were also mentioned as inhibiting good governance. Poor morale was attributed to low salaries and the delayed payment of salaries, as various participants explained:

> *There is a problem in governance of our health facilities in this county*. (Male, 36–40 years old)

FIGURE 3. Rules and Guidelines



Pictures taken in 1 of the facilities showing standard operating procedures, guidelines, or rules that guide implementation of services at the facility level. This falls under the rules and regulations attribute.

There is bias and incompetence arising from people who are not qualified being employed in positions they cannot manage. (Female, ≥41 years old)

The devolution of health services at the county level has reduced morale for staff performance due to challenges of delayed salary payment and injustices in promotions. (Female, 26-30 years old)

Regarding *regulation and oversight* and *strategic vision*, the participants identified several measures in place. These included yearly work plans with specific targets. The county and subcounty management teams supported the attainment of these targets by conducting meetings, providing support for the supervision of facilities, and discussing service provision progress with staff at the various facilities. Professional bodies provided standards and registered staff to ensure that high professional work standards were maintained. However, not all participants agreed:

Yes, the targets are there, but they are not always followed or honoured. (Male, 36–40 years)

The participants agreed that information was analysed by county and subcounty management teams in review meetings, for developing work plans, writing reports, identifying issues, and setting priorities. Respondents also indicated that information was used to allocate resources, such as budgeting for equipment, commodities, and drugs. Some participants thought information was used as a tool for transparency; others thought that it provided evidence for programmes:

Interventions are derived from data. (Male, ≥41 years old)

All reports generated are used to plan for the future. (Female, 26–30 years old)

There were contrasting opinions regarding the good use of information, however, and some participants thought that data were not being used appropriately. Respondents maintained that:

Information procedures are not followed as they are supposed to be. (Female, 31–35 years old)

The use of information is minimal. Mostly they use guidelines and information from national level. (Male, ≥41 years old)

Occasionally, the information is followed, but sometimes it is not as it is supposed to be done. (Male, ≥41 years old)

There is no clear way of passing information. (Female, 26–30 years old)

Participants reported that mechanisms were employed – involving community members, health facility in-charge, and political leaders – concerning the distribution of resources to ensure inclusion and equity. These mechanisms included waiver systems for poor people to ensure that they were not discouraged from seeking care for economic reasons, participatory budgeting, and the allocation of resources by political representatives (with devolution, members of the County Assembly – who are elected by the people – made decisions about resource allocation). Some participants, however, thought that these mechanisms were not clear.

According to participants, there were mechanisms in the county to ensure equity in resource allocation and access by marginalised people. The main way of including marginalised populations was during yearly participatory public budgeting activities. Sometimes, a member of the County Executive Committee on Health assessed the requirements of each facility. It was reported that all facilities were allocated money according to their budget. Several participants stated that the allocation of funds was based on population density, targets, and workloads at different facilities.

We treat all people. (Male, 36–40 years old)

[We include] all stakeholders in the budget [allocation]. (Female, ≥41 years old)

Those who are considered marginalised, such as people with disabilities, reportedly did not pay for care when seeking treatment at the facility:

Marginal communities like the disabled are exempted, or fees are waived when they seek medical services. (Female, 31–35 years old)

There is a waiver system for the poor and paved roads to ease movement for the disabled. (Male, 26–30 years old)

Participants reported that the facilities with which they were associated had 5-year strategic plans developed from the National Health Strategic Plan. Every year, annual operational plans were developed with set indicators, which were monitored monthly and quarterly by management teams. There were also audit departments that monitored the progress of the implementation of health policies and strategies to ensure set guidelines and procedures were followed. Reports were submitted, and meetings were held to facilitate the implementation of set activities. Additionally, various laws, regulations, and guidelines from the constitution, professional bodies, and the public service guided and regulated service implementation.

Respondents identified different ways in which accountability and transparency were achieved. Among these were having plans to guide performance, inviting different stakeholders to participate in the planning and implementation of activities, having professionals work, using receipts (accountable documents), following regulations like the Government of Kenya rules and procedures by introducing technology (computers and mobile phones). Participants emphasised:

Staff are answerable at each level. (Female, 26–30 years old)

Staff sharing of work stations . . . (Male, ≥41 years old)

[Accountability] through audits (Male, 31–35 years old)

Some participants thought that procedures were not being followed, leading to comments on the "misappropriation of finances" and a belief that "accountability and transparency was poorly achieved in the county."

DISCUSSION

The purpose of this study was to examine the implementation of governance attributes as reported by decision makers of the Department of Health in Uasin Gishu County, Kenya. This was achieved by carrying out a desktop review and administering a semistructured questionnaire with 42 Likert-type questions and additional open-ended questions. The results suggest general dissatisfaction with the governance of health-care services in Kenya.

Most of the participants had a negative or neutral opinion about the implementation of governance attributes, with only one-tenth of the participants holding a positive view. Some of the reasons cited by the participants for poor implementation of governance were tribalism, corruption, conflicts of interest, inequitable sharing of resources, and political interference. Our findings differ from those of Mutale et al,[31] who conducted research in Zambia and identified that 80% of participants thought that the implementation of governance attributes was good. One possibility for these contrasting results was that the Zambian study calculated mean scores generated from 4-point Likert scale responses, while our study established proportions. But at the same time, Gakuru et al argue that the Kenyan State has never been structured to represent or respond to the interests of the masses and the public good, but rather to serve the "interests of the incumbent political elite".[40,41] In Kenya and many other African countries, including South Africa, Botswana, Ghana, and Nigeria, governance is poor at the state level.[15,42,43]

The majority of participants thought that the implementation of accountability was poor, and two-thirds acknowledged that implementation of equity was poor.

This suggests that accountability and equity have not been fully implemented in the context of health care in Uasin Gishu County. This contrasts with the findings of a study carried out in Ontario, Canada, where equity had been significantly implemented in primary health-care facilities. The health-care facilities had adopted physician services agreements, which incorporated different financial incentives that included bonuses. In Ontario, reporting requirements for physicians were voluntary and were limited to performance tied to incentivised tasks.[44] In our context, further research needs to be undertaken to determine the factors that can improve equity in health-care facilities.

The use of information was also scored weakly among our participants. It can be deduced that when information and evidence are not clear to decision makers, there will be problems with transparency and accountability. Additionally, resources which were devolved were expected to be equitably distributed. Further, the Constitution of Kenya provides the legal framework to ensure more comprehensive, people-centred, and equitable provision of health services founded on a human rights approach.

The challenges of poor governance and lack of accountability in the use of public resources, including health, are not new.[45] Kenya's Health Sector Strategic and Investment Plan (2015–2030) proposes a people-centred, more inclusive, and engaging approach to governance and proposes mechanisms to manage clients' issues and strengthen social accountability and stakeholder involvement. This implies that some challenges are being faced in the implementation of equity and accountability. According to the World Bank, when internal mechanisms of accountability are inadequate and fail to function, the situation calls for external accountability to ensure social accountability, that is, to ensure that the government is answerable for its decisions. This allows for constructive engagement between citizens and the government in monitoring the use of public resources for the purposes of service delivery, protection of rights, and community welfare protection. However, Cleary et al argue that internal bureaucracy interferes with external accountability.[19,22]

Notwithstanding this, there were positive perceptions from study participants about the implementation of elements related to *strategic vision* and *regulation and oversight* in the provision and administration of health care. This is not surprising because the participants were highly trained and had a good understanding of the factors contributing to the implementation of governance attributes. Based on the qualitative findings of the study, the participants demonstrated their understanding of governance as including a strategic vision, providing regulation and oversight, and being transparent and accountable. More research needs to be carried out to understand the effectiveness of the implementation of governance attributes. With the devolution of power to the county level, oversight and supervision were also devolved closer to the health-care facilities. This had the effect of increasing the focus on the performance of health-care workers and on the fact that they had to know the strategic direction and the regulations in place for effective service delivery. In this regard, our study findings were in concordance with the findings of Siddiqi et al who asserted that, in Pakistan, health service governance, participation, and consensus orientation were growing across the levels of assessment: local, regional, and national.[4] Further research is required to assess how *participation and consensus orientation* will perform as the implementation of devolution continues to mature in Kenya.

Limitations

Methodologically, our study sought to explore a complex concept of governance, but this complexity resulted in variability of understanding among the participants. As this study explored only Uasin Gishu County, the findings cannot be generalised. Furthermore, the number of decision makers in health was not large enough for complex analyses; generally, undertaking factor analysis requires a large sample size to make firm conclusions with confidence.[46]

Questionnaires that use Likert scales should include a mix of positive and negative statements.[36] However, in this study, the outcome was good governance, and it was necessary to frame questions positively so that participants could assess the extent to which good governance was being implemented. The questions were framed to cover both rules-based and outcome-based indicators of governance to elicit perceptions on their availability and implementation. Perspectives on implementation of governance attributes for general health-care workers could further enrich available knowledge, and in the larger study from which this substudy emerged, the perspectives of general health-care workers were sought. Governance attributes are intertwined, and, therefore, other critical factors may have been masked by the attributes that were studied and others that were not. The current study attempted to categorise questions into groups for clarity and understanding.

CONCLUSION

This study identified components of health-care governance within the study area that were functioning well at the time of data collection, particularly *strategic vision* and *regulation and oversight*. It can be concluded that devolution of oversight mechanisms closer to facilities in the new system of governance had been effective to that point in time and should be further harnessed. In contrast, *transparency* and *accountability* scored poorly. This means that the public and junior officers did not know how things were done by their senior officers. This in turn resulted in perceptions of nepotism and inadequate use of information. When government works are undertaken with transparency and office holders are held accountable, corruption and other vices are reduced. We

conclude that the success of implementation of an attribute is dependent on the implementation of others. For example, there cannot be good implementation of accountability with poor implementation of transparency. If the health system is to achieve good overall governance, all governance attributes must be well implemented. Caution should, therefore, be taken in interpreting individual and overall scores. We have also illustrated that an expanded tool – with a wide range of clear questions to reduce the complexity of questions – serves to enhance good understanding by participants and provides a basis for measuring governance for other interested researchers.

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ORIGINAL ARTICLE

Perceptions of Mental Disorders and Help-Seeking Behaviour for Mental Health Care Within the Maasai Community of Northern Tanzania: An Exploratory Qualitative Study

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ABSTRACT

Background: Mental disorders are rapidly becoming more prevalent worldwide and are estimated to contribute up to 15% of the global burden of disease by 2020. In Africa, the help-seeking behaviour for mental health care is complex and is hindered by misconceptions and negative attitudes towards mental disorders. This study aimed to explore perceptions of mental disorders and help-seeking behaviour for mental health care within the Maasai community in northern Tanzania.

Methods: This qualitative study enrolled a purposive sample of 41 participants from a Maasai community in Arusha Region, northern Tanzania. Participants included modern health-care providers, religious leaders, traditional practitioners, local government leaders, local Maasai leaders, and workers from nongovernmental organisations dealing with mental health. Local interviewers used interview guides to conduct in-depth interviews and focus group discussions in the local language, Kiswahili. The interviews were completed between April and May 2013. We used content analysis to analyse the qualitative data.

Results: Study participants attributed mental disorders to supernatural causes, such as curses, witchcraft, demons, and God's will. A few participants also mentioned biological causes and risk behaviours, including perinatal insults, head injuries, and drug abuse. Furthermore, we found that the Maasai community seeks mental health care in a sequential and simultaneous manner from 3 sectors, namely, professional health-care providers, traditional healers, and religious leaders. Traditional healers and religious leaders were preferred over professional health-care providers for the treatment of mental disorders.

Conclusion: The Maasai have pluralistic help-seeking behaviour for mental health disorders. Integrating traditional healers in the modern health-care system may be beneficial to addressing mental health issues in this setting.

INTRODUCTION

Mental disorders, defined as a combination of abnormal thoughts, emotions, behaviour, and relationships with others, contribute about 12% of the global burden of disease, and this proportion is expected to rise to 15% by 2020.[1,2] According to the World Health Organization, more than 450 million people worldwide suffer from some form of mental disorder, most of whom live in developing countries.[2,3] Evidence from studies conducted in different settings has shown that the contribution of mental disorders on the burden of disease differs from country to country. For example, in the United States, mental disorders are estimated to contribute 30.9% of the national disease burden, while in Finland the contribution is 32.6%.[3,4] In Japan, mental disorders contribute about 24.6% of the burden of disease, compared to 17.6% in China and 11.6% in India.[3] In sub-Saharan Africa, mental disorders are thought to account for a smaller proportion of the disease burden. For instance, in Namibia, mental disorders are estimated to contribute 6.9% of the burden of disease, compared to 6.6% in Togo and 5.2% in Mali.[3] In Tanzania, mental disorders contribute about 5.3% of the disease burden.[3] The Tanzanian Ministry of Health, Community Development, Gender, Elderly, and Children has integrated mental health in all levels of health-care service.[5–7] Furthermore, in the Tanzanian setting, biomedical as well as traditional healers also provide primary health-care services.[8,9] Previous studies have estimated that

only 24% of people with mental disorders in Dar es Salaam attend modern health-care services compared to 48% who consult traditional healers[8] and spiritual healers.[10]

Help-seeking behaviour refers to the sequence of problem-focused and planned remedial actions that individuals undertake to rectify perceived ill health. Help-seeking behaviour is a complex decision-making process instigated by a problem that challenges personal abilities.[11] The process involves interpersonal interactions at the individual, family, and community levels, including biopsychosocial profiles, past experiences with health-care professionals, and the availability of alternative health-care practitioners, such as traditional or faith healers.[12,13] Other factors that influence help-seeking behaviour include public perceptions regarding the efficiency and quality of health services and belief systems prevalent in the communities, meaning how people conceptualise the causes of health problems and how symptoms are perceived.[14–16] The intersection between culture and help-seeking behaviour among people with mental illness is still a global concern. Sociocultural factors often influence people's decisions to delay seeking professional help or to avoid it altogether, which can, in turn, significantly compromise treatment and care.[11,16,17]

According to Kleinman's explanatory models, all cultures have systems of health beliefs to explain what causes illness, time and mode of illness onset, evolution of the illness, treatment and cure, and who should be involved in the treatment process. Specifically, the explanatory model describes a "somatic illness network", defined as a "syndrome" of symbols and experiences, which typically "run together" for the members of a society.[14] Mental health is a socially constructed and socially defined concept; as different societies, groups, cultures, institutions, and professionals have different ways of conceptualising its nature and causes, determining what is mentally healthy and deciding on which useful interventions, if any, are appropriate.[18,19] It is well documented that culturally sensitive mental health-care interventions are more effective in addressing the complex spectrum of mental disorders. In fact, a goal of culturally sensitive mental health care is to specifically consider the perspectives of local cultural beliefs and practices.[20]

Explanations of mental disorders and their causes vary among individuals and communities. A study in 3 African countries – Burundi, South Sudan, and the Democratic Republic of the Congo – in 2013 showed that the perceived causes of mental disorders varied a great deal within each setting, and attributed causes varied from supernatural to psychosocial and organic. The studies showed that the perceived causes of locally defined mental disorders in these African settings were supernatural forces, natural forces, loss, and worry.[21]

A study conducted in rural Tanzania showed different patterns of explanation about mental disorders in the community.[22] The first category was "no explanation", whereby patients seemed to have few thoughts and explanations about why they had fallen sick and about the character of their illnesses. In the second category, the participants attributed mental disorders to spiritual causes. Finally, physical pain and reduction in daily levels of function – with physical illness presented as a central component – was the last category.

The Maasai is among the few tribes in Tanzania who prioritise culture and tradition in directing day-to-day activities and behaviours. A large proportion of the Maasai community uses traditional healers and traditional medicines to treat several illnesses. The Maasai give great respect and trust to their traditional healers, who also act as local leaders or *olaibons*.[23] Ventevogel et al argued that life for a Maasai with a disability is particularly problematic.[21] Throughout history, communities have reacted strongly by stigmatising, hiding, or even killing mentally and physically impaired people.[19,24] Individuals with disabilities have faced and continue to face prejudice and discrimination in different forms – from restrictions in employment and education to sterilisation and death.[19,24]

Few studies have explored perceptions of mental disorders and help-seeking behaviours related to mental health care in Tanzania, and among the Maasai in particular. This study aimed to do just that. The findings from this study will provide insights into cultural context-specific information on perceptions of mental disorders and help-seeking behaviour for mental health care in Tanzania. The new knowledge may shed light on how the Maasai community understands and perceives mental disorders and what help-seeking behaviours they use for mental health care. The findings may assist policy makers and mental health interventionists to design culturally context-specific mental health-care interventions in the study setting.

METHODS

Study Area

The study was conducted in Monduli District, which is among 7 districts in Arusha Region. The district is located in the northeastern part of Tanzania. It is bordered to the north by Longido District, to the east by Arumeru District, to the south by Manyara Region, and to the west by Ngorongoro and Karatu Districts. Monduli District consists of 15 wards and 73 villages. According to the 2012 Tanzania National Census, the population of Monduli District was 158,929.[25] The majority of people that reside in the study area are Maasai. The Maasai are a nomadic people who keep cattle, goats, and sheep. The main languages used in the district are Maasai, a local dialect, and Kiswahili, which is the national language and is spoken by most Tanzanians. Monduli District was selected because it is inhabited mainly by a Maasai community that has limited exposure to other cultures. The district has 1 public hospital, 1 health centre, and 22 dispensaries.

Study Design

This was an exploratory community-based qualitative study conducted between April and May 2013.

Study Population

The study population consisted of members of the Maasai community, health-care providers, religious leaders, traditional healers, local Maasai leaders, local government leaders, and nongovernmental organisations (NGOs) involved in mental health care in Monduli District.

Sampling and Consent

The study used in-depth interviews (IDIs) and focus group discussions (FGDs) with key informants – religious leaders, traditional healers, health-care providers, local government leaders, and NGO officials – and members of the Maasai community, specifically local Maasai leaders and caretakers of patients. Purposive sampling[26,27] was employed to recruit 21 female and 20 male participants for both IDIs and FGDs. The sampling approach was chosen to ensure the inclusion of a variety of viewpoints and diverse experiences among participants. The study participants were selected based on their involvement, knowledge, and experiences with mental disorders. We conducted an FGD for each of the following groups: caregivers, women from the general population, and men from the general population. We divided groups by gender because gender roles related to health care are very clear in Maasai culture: women are expected to take care of the sick, irrespective of the patient's gender. Additionally, we hoped the women would express themselves more freely when separated from men.[24]

All participants provided informed consent before involvement in the study. For participants who were unable to read or write, a verbal explanation was given and a thumbprint was obtained as a mark of consent. Participants were informed that participation in the study was voluntary and that they were free to withdraw at any point. Participants were assigned numbers to ensure anonymity and confidentiality; no personal identifiers were included in the collected data.

Pretesting

The data collection tools were pretested before the study to check for clarity and internal consistency. Eight participants (4 male and 4 female) were involved in the pretest, which informed minor word use and phrasing adjustments to the final tools.

Data Collection

Interviews with health-care providers – primarily doctors and nurses – and religious leaders were conducted in their respective offices, while the FGDs and interviews with local government leaders, local Maasai leaders, and traditional healers were all conducted in the privacy of different rooms at the village executive officer's headquarters. Interviews were conducted in Kiswahili, except for 2 IDIs that were conducted in the Maasai language for participants who did not speak fluent Kiswahili. Interviews lasted approximately 60 minutes. All interviews were recorded using a digital device, and notes were taken to capture important information. Permission to make audio recordings was obtained from study participants before commencing interviews.

Data Management and Synthesis

Data were analysed manually using a content analysis approach. First, the verbatim transcriptions were translated into English. We then read and critically reviewed all transcripts to identify the themes, patterns, and contexts of each individual response. Using Microsoft Word, we used colour-coded highlighting and italics to identify important quotations and emerging themes from the data.

During the next stage, we organised the highlighted quotations into different categories according to the main themes that arose during the transcript analysis, while also considering the study objectives. The resulting thematic categories included inadequate knowledge, supernatural causes, biological causes, and pluralistic behaviour. We investigated and identified conceptual connections between and within categories, grouping conceptually related phenomena under the appropriate themes.[26,27] Finally, we interpreted our findings in relation to other studies and outlined the study's implications, lessons learnt, conclusions, and recommendations. The important questions asked during the interpretation process were:

- What does the sentence or piece of data mean?
- What did the participants mean?
- What was the context of the response?
- What is the implication of the information?
- What have others written (or what is known) about it?

Representative verbatim quotations from IDIs and FGDs were selected to illustrate key findings.

Ethical Approval

The Kilimanjaro Christian Medical University College Research and Ethics Review Committee (CRERC: No. 566) approved this study and all study activities.

RESULTS

Demographic Characteristics

A total of 41 participants (20 male and 21 female) were selected for the study. In total, we conducted 3 FGDs with 21 participants (7 participants per group) and 20 IDIs. About two-thirds (n=13, 65%) of the IDI participants were male, and the median age of all participants was 45 years (range,

24 to 67 years). The majority were married (n=17, 85%), had gone to school (n=14, 70%), and were Christian (n=14, 70%). The IDI participants were health-care providers (n=4), religious leaders (n=3), traditional healers (n=4), Maasai local leaders (n=4), local government leaders (n=3), and NGO officials (n=2) involved in the provision of mental health-care services in the study setting. Among the FGD participants, most were peasants (n=16, 76.2%), female (n=14, 66.7%), married (n=15, 71.4%), Christian (n=17, 80.1%), and had gone to school (n=13, 61.9%); the median age was 37 years (range, 26 to 60 years).

Definition of Mental Disorders

The participants defined or conceptualised mental illness in different ways. Some provided spontaneous responses, while others were unable to define mental illness, although they did recall having seen someone with mental illness. Some participants equated mental illness with overt psychosis or inability to speak, while others considered mental illness as an inborn, incurable illness.

One participant said:

I do not know what mental disorders are . . . But I have seen patients with mental confusion. (Male, Maasai leader, unknown age, IDI)

Another participant elaborated:

Mental disorders can be associated with a person who cannot speak or is crazy. (Male, local government leader, 53 years old, IDI)

A female participant explained:

Mental disorders are the diseases that if someone is born with, then it's God's work, and it cannot be treated. (Female, local government leader, unknown age, IDI)

Terminology for Mental Disorders

Across interviews, participants used 4 different Maasai terms to refer to mental disorders: *ormaema* ("disabled [or abnormal] person"), *enagiormotonyi* ("disease of falling or fainting"), *ormodai* ("someone who is unable to communicate"), and *orkichaa* ("crazy person").

Causes of Mental Disorders

Participants mentioned several causes of mental disorders. The majority of participants ascribed mental disorders to nonmedical causes. The common nonmedical causes mentioned included supernatural powers, witchcraft, curses, and God's sickness. Other causes reported by participants included excessive alcohol use, drug abuse, and heredity. The majority of Maasai participants believed that most people with mental disorders are cursed because of their failure to observe Maasai traditions and customs, or because they had done something bad to others in the community, as one participant said:

The cause of mental disorders in the Maasai community is believed to be witchcraft, to curses, or possession by demons. (Female, traditional healer, 50 years old, IDI)

Another participant stated:

Mental disorders result from being cursed if they [patients] fail to observe traditions or elders. (Female, local government leader, 45 years old, IDI)

Finally, another participant emphasised the consequences of bad behaviour in the Maasai community:

Bad behaviours, such as stealing or killing someone, can also cause mental disorders when someone is cursed. (Female, local government leader, unknown age, IDI)

Several participants indicated that most mental illness results from witchcraft, as a consequence of jealousy, particularly of individuals who are wealthy and successful in life.

One participant said:

The disease [mental disorders] is caused by someone being bewitched, mostly because of the jealousy of other people." (Female, local government leader, 45 years old, IDI)

Another woman said:

The cause of the disease [mental illness] is someone being bewitched, mostly because someone has many cows, children, or wives. They give explanations like. . . The person that passed through the herd of cows is the one who bewitched this person. (Male, Maasai leader, 59 years old, IDI)

One participant described how some people believe that mental disorders can be transmitted via hostile glares. He stated:

Being looked at by someone with a bad eye is also believed to cause mental disorders. (Male, 40 years old, FGD)

One participant stated that if a bird flies over a person, the shadow could cause a mental disorder:

If someone sleeps facing upwards and a certain bird flew over that person, he or she gets enagiormotonyi. (Male, 32 years old, FGD).

Other causes mentioned by participants included: God's wish or punishment, stressful conditions, lack of sleep, and evil spirits. Proposed biomedical causes included incorrectly administered injections at health facilities. Interestingly, health-care providers had different perspectives on the causes of mental disorders within the Maasai community.

Participants related natural causes of illness, injuries at birth, and family history with the development of mental disorders. One participant explained:

Mental disorders can be caused by diseases like malaria or brain injury. (Male, health-care provider, 45 years old, IDI)

On the other hand, a young female nurse elaborated on the complications associated with unassisted home deliveries:

> *Women still give birth at home, with prolonged labour and other complications without proper care; children get brain damage and may develop mental disorders.* (Female, health-care provider, 26 years old, IDI)

Help-Seeking Behaviours

Substantial discussion revolved around help-seeking behaviours and beliefs related to prevention and treatment of mental disorders.

Beliefs About Prevention

Beliefs about prevention of mental disorders revolved around traditions and customs among the study participants. Participants scarcely mentioned modern prevention strategies, as the major causes of mental disorders were thought to be related to curses, demons, and spiritual matters. The effect of the traditional mindset on beliefs about prevention of mental disorders was well illustrated by this quotation:

> *Maasai believe that mental disorders cannot be prevented through modern treatment.* (Female, NGO representative, 46 years old, IDI)

A more explicit explanation was offered by another participant:

> *According to Maasai belief, in order to prevent mental disorders, people have to stop doing bad things in the community, like stealing, and should obey elders and follow traditions, and they should not engage in witchcraft.* (Female, NGO representative, 50 years old, IDI)

Beliefs About Treatment

Beliefs about treatment for mental disorders within the Maasai community in Monduli District were based on the same traditional mindset. Most participants believed that mental disorders could not be treated by the modern therapeutic modalities found in a hospital. Most participants explained that traditional healers, commonly known as *olaibons,* were more equipped to treat mental disorders in the Maasai community:

> *People with mental disorders in our community are usually taken to* olaibons, *meaning traditional healers or elders in the community. This is done in order to find out what the problem is. After enquiring, traditional healers will find out if the person is cursed or bewitched, and by whom, and from there the plan to help or treat the patient is decided.* (Female, local government leader, unknown age, IDI)

Another participant provided an alternative description of the potential healing process for a Maasai patient with mental illness:

> *If the one who is believed to have cursed the patient is alive, then the elders in the community gather and take a cow and some local brew to the person who has cursed the patient to ask for forgiveness on behalf of the patient. Once the offerings are accepted, the patient will be cured. If the person refuses to forgive, it is a bad thing, then the elders either use power to make that person forgive, or they also curse that person.* (Male, Maasai leader, 63 years old, IDI)

Use of different paraphernalia was also mentioned as part of the alternative healing practices for mentally ill patients in the Maasai community:

> *Also, to cleanse the curse, the elders spit on a rope called* ngopito *and tie the rope on the patient and do special prayers to break the curse. If the person who triggered the curse has died, elders visit the grave and give offerings to ask for forgiveness and recite a special prayer.* (Male, traditional healer, 55 years old, IDI)

Across interviews, participants emphasised the difficulty involved in curing mental disorders caused by supernatural forces. One participant said:

> *For those bewitched, it is hard to treat in the community; it takes time to be healed.* (Male, religious leader, 55 years old, IDI)

Spiritual prayers were another reported treatment option for mental disorders. A male religious priest said:

> *When those kinds of people – with mental disorders – are brought here, first I baptise them, followed by prayers, and the patient is told to affirm that they are cured and turn their beliefs and lives to God. We apply water, olive oil, and a type of juice called* fruto *[a blackcurrant juice], which we pray upon to turn it [the juice] into the blood of Jesus for the patient to drink. Thereafter, the patient is cured, or if not, the Holy Spirit will show me what else to do. Normally, we tell them never to sin again and to fear God.* (Male, religious leader, 24 years old, IDI)

Spiritual leaders reported conflicting beliefs about what should be done after prayers, once the patient is declared healed. The main point of contention was whether the patient should seek help at a hospital after the prayers or not.

Another treatment option believed to cure mental disorders among the Maasai in this community was the use of herbs. Ambiguity was centred on whether herbs alone could treat mental disorders, or if they should be used in conjunction with other treatment options. The uncertainty was well elaborated by a female caregiver:

> *Treating patients with mental disorders is not easy by using herbs, but we try; and when they fail, we refer patients to either traditional healers, spiritual healers for prayers, or the hospital.* (Female, caregiver, unknown age, FGD)

An older female herbalist reported:

> *When a patient of that type [with a mental disorder] is brought to me, I make small cuts [scarifications] on the body and apply herbs*

on the wounds. I examine the patient and provide first aid. I massage the whole body, especially the stomach and hands. When massaging the body, I realise where the problem is and if it can be cured or not. After examining the patient and after first aid, if I discover that I cannot treat the disease, I refer the patient to wherever they can be treated, either by olaibons, *or the hospital, or prayers.* (Female, traditional healer, unknown age, IDI)

Preferred Treatment for Mental Disorders

Participants generally preferred traditional treatment methods. A female herbalist said:

Most patients go to traditional healers because they believe that they are bewitched... and get cured. (Female, traditional healer, 50 years old, IDI)

Some participants indicated a strong aversion to modern therapies for mental disorders:

People prefer traditional healers because they believe them to be more effective than modern medicine; however, after other treatment options fail, then the patient is taken to the hospital as the last option. (Male, 55 years old, FGD)

During IDIs, most participants mentioned that modern therapies are regarded as the last option, once the traditional treatment options fail.

They believe that traditional medicine can cure mental disorders; hospital treatment is the last option. (Male, health-care provider, 55 years old, IDI)

Another perspective took educational status into account:

Educated relatives are more likely to seek treatment from the hospital, while the uneducated will start with herbs or traditional healers. (Female, caregiver, 59 years old, FGD)

DISCUSSION

This study aimed to explore perceptions of mental disorders and help-seeking behaviour related to mental health among the Maasai people in Arusha Region. The study findings demonstrated a range of misconceptions about mental health within this community. The causes of mental disorders were attributed to either sociocultural and spiritual (eg, curses, bewitching, or hostile glaring) or biological (eg, disease or heredity) factors. This Maasai community perceived a pluralistic framework for help-seeking behaviour and preferred traditional health care over modern health-care services.

Having correct knowledge of the causes of and potential treatments for mental illness is important because this can influence positive help-seeking behaviour and appropriate care. In this study, participants explained mental disorders using both social and biomedical models.[14] From the social-model perspective, participants had a number of misconceptions about the causes of mental disorders. They attributed mental disorders to supernatural experiences, such as God's will, curses, witchcraft, and antagonistic stares. These results support previous findings from studies conducted in Tanzania in Kinondoni District in Dar es Salaam[28] and Mbulu District in Manyara Region,[22] as well as studies conducted in Vietnam[21] and Nigeria.[29]

In Maasai society, curses or acts of God are attributed to shameful or harmful behaviour on the part of figures of authority or respect, such as parents or grandparents.[24] In this study, Maasai participants also believed that mental illness can result from bad deeds or crimes leading to the cursing or bewitching of the perpetrator. These beliefs about the causes of mental disorders can lead to poor disease management, leaving many patients untreated and increasing the burden of mental illness in the community.

In this study, some participants attributed mental disorders to biomedical causes, including genetics and perinatal injury. Concerning hereditary factors, some participants rightly stated that family history can predispose individuals to mental illness; however, despite some understanding of the biomedical contribution to mental disease causes, participants often ascribed the hereditary component of mental illness to a "family curse". Studies in Uganda and Sri Lanka have shown that families with a history of mental illness are often stigmatised and discriminated against.[30,31]

Other illnesses, malaria in particular, were reported by participants to be associated with mental disorders, although they could not give a plausible explanation on how malaria can cause mental illness. According to Idro et al, cerebral malaria may predispose children to long-term mental disorders, possibly due to convulsions, impaired consciousness, and coma, leading to brain damage.[32] Furthermore, injuries to neonates during unassisted childbirth were perceived by participants to cause mental illness. Evidence suggests that children with birth injuries often develop mental illness in adulthood.[33]

Generally, the Maasai participants in our study believed that people cannot acquire mental disorders without an identifiable cause and that most cases are due to supernatural causes, often facilitated by human actions or behaviours. These findings are in line with other studies.[22,24,28,29,34] However, key informants were of the opinion that these kinds of beliefs were slowly changing over time in the Maasai community.

According to Jain et al,[35] help-seeking behaviour, particularly in rural communities, is a complex outcome of many factors operating at the individual, family, and community levels, including biosocial factors, an individual's past experiences with health services, and the availability of alternative health care.

In describing help-seeking behaviour, Kleinman's explanatory models help describe what influences patients to

navigate through different therapeutic options. The explanatory models in this context focus on the treatment options that are employed by all those engaged in the clinical process. Kleinman further argues that explanatory models are held by both patients and practitioners, that these models offer explanations of sickness and treatment to guide choices among available therapies and therapists and cast personal and social meanings on the experience of sickness.[14]

Based on this framework, in this study, we found that the Maasai have 3 major treatment options for mental health concerns, namely, modern health-care services, traditional care, and spiritual care. In most instances, patients and relatives will use 1 or more treatment options at a time, depending on the perceived causes of illness and the cost and effectiveness of care. The 3 pathways describe the conceptualisation of help-seeking behaviour for mental disorders within the Maasai community in sequential patterns that are influenced by factors, such as social norms (eg, beliefs about causes of disease) and literacy levels. The first pattern was to first seek assistance from traditional healers, then spiritual healers, and, finally, modern health-care providers. The second pattern was to seek assistance from herbalists, and then, in order, traditional healers, spiritual healers, and modern health-care providers. The third pattern was to first seek help from modern health-care providers, then traditional healers, and, finally, spiritual healers.

Most participants in this study believed that mental disorders can be prevented by observing some cultural traditions and practices, stopping bad behaviours, and preventing or refraining from witchcraft. Several studies on mental disorders and other chronic diseases have reported similar perceptions.[29,36]

Most participants believed that traditional healers should be the main treatment providers for mental disorders and that biomedical personnel either should not be consulted or should be considered as the last option.[8,30,36] This study also revealed that traditional healers perform physical examinations and some forms of massage as part of their mental health assessment and therapeutic procedures. Traditional healers were reported to look beyond physical treatment of illness by trying to deal with perceived causes, such as curses and witchcraft.[37]

Although the majority of participants believed that mental disorders could be treated using alternative medicine, only a few participants had confidence in modern health-care services. Participants who believed in modern health-care services were often those with some formal education or were health-care providers themselves. The study also found that some Maasai community members depend on spiritual prayers. Participants reported that during prayers, holy water, blessed fruit juice, Bible quotations, or self-confessions were used to break curses and to cast out demons. This is in line with a study reported by Atindanbila and Thompson,[37] which demonstrated that spiritual treatment for people with mental disorders is common and that spiritual healers use confession, biblical or Koranic quotations, laying of hands, holy water, and salt when dealing with mental disorders.

An interesting finding was that some religious leaders who held dual beliefs were reported to have advised patients to attend modern health-care services for further treatment, while others reportedly believed that prayers were enough. Furthermore, some religious leaders, mainly Christians, did not allow their followers to go to traditional healers, including the Maasai elders, or *olaibons*.

Limitations

This study had some important limitations. The first limitation was language. Some participants were not conversant with Kiswahili, the language widely used in Tanzania. To rectify the language limitation, a research assistant fluent in the Maasai language translated the interviews and responses from Maasai to Kiswahili. The second limitation was related to the sensitive subject matter. Mental disorders are widely associated with stigma, and this might have prevented participants from freely discussing matters pertaining to mental disorders, particularly during the FGDs. Efforts to overcome this limitation included spending considerable time with participants to build rapport before conducting the interviews. The aim was to make participants feel comfortable and relaxed. In addition, the interviewers used probing and prompting questions or statements during the IDIs and FGDs to reduce any stigma or discomfort associated with discussing mental disorders. The final limitation is an inherent weakness of qualitative study designs, whereby the findings may not be representative of the population in the study setting much less other settings. Because the study participants were recruited from a rural setting, with the majority of participants being from the Maasai community, the study findings may not be relevant to urban settings or non-Maasai communities. Despite these limitations, the study findings do contribute knowledge about perceptions of mental disorders and help-seeking behaviour for mental health among the Maasai in this region. The study findings could form a basis for further mental health studies among Maasai and other pastoral communities.

CONCLUSION

This study explored the perceptions of mental disorders and help-seeking behaviour for mental health care among Maasai in Monduli District, Arusha Region. In several ways, the current study corroborated what has previously been reported and added new knowledge, particularly on how mental illness is conceptualised and the culture-specific and cognitive factors influencing help-seeking behaviour in a Maasai community.

Knowledge about the causes and treatment of mental disorders within this Maasai community were mixed. The Maasai have both naturalistic and personalist views of

mental health, as they associate mental illness with both biology and witchcraft, curses, and punishment from God. Secondly, patients and family members have multiple options for seeking care, with the majority of people using traditional healers and spiritual healers more than modern health-care providers.

These findings have 2 key primary health-care implications on mental health in this community. Firstly, they underline the urgency for advocacy initiatives that may increase mental health literacy and awareness at the individual, family, and community levels. The advocacy initiatives should emphasise the importance of the social cognitive factors reported in this study that influence help-seeking behaviour. Secondly, the findings call for interventions that will empower traditional healers to identify people with mental disorders and participate in the design of mental health prevention programmes in this study setting.

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ORIGINAL ARTICLE

Prevention of Mother-to-Child Transmission and Early Real-Time DNA Polymerase Chain Reaction Results Among HIV-Exposed Infants in Bujumbura, Burundi

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ABSTRACT

Background: Prevention of mother-to-child transmission (PMTCT) programmes aim to both eliminate vertical transmission of HIV and optimise the health and survival of infants born with HIV. Therefore, early infant diagnosis (EID) of HIV infection via DNA polymerase chain reaction (PCR) testing is a key component of PMTCT programming. We assessed the effectiveness of EID and PMTCT interventions at health-care facilities in Bujumbura, Burundi.

Methods: This was a prospective analytical study of infants born to HIV-positive mothers on antiretroviral therapy (ART), who were followed from December 2016 to March 2017 at 3 centres providing PMTCT services in Bujumbura. Babies enrolled in this study received once-daily nevirapine from birth through to 6 weeks of life, after which HIV DNA PCR testing was conducted.

Results: Of 122 HIV-exposed infants, 60 were boys and 62 were girls. The mother-to-child transmission rate at 6 weeks of life was 0.9%. Eighty-three (68%) of the women had commenced ART before pregnancy and 39 (32%) during pregnancy. The mean CD4 lymphocyte count was 653±308 cells/μl. Ninety-two (75.4%) of the pregnancies were planned, and 98 (80%) of the births were via spontaneous vaginal delivery. After birth, 111 (91.0%) infants were exclusively breastfed, and 11 (9.0%) infants received exclusive replacement feeding.

Conclusion: There was a low rate of transmission of HIV from women taking ART to children who were given nevirapine for the first 6 weeks of life. Infants of HIV-positive women can live healthy lives free from HIV infection if their mothers participate in PMTCT programmes.

INTRODUCTION

HIV/AIDS remains a disease of great public health importance, and vertical transmission of HIV – from mother to child – continues to be a common route of transmission, accounting for the vast majority of new infections in children.[1] In 2012, about 330,000 children under 15 years of age worldwide were infected with HIV, according to estimates by the Joint United Nations Programme on HIV and AIDS (UNAIDS), with more than 90% of paediatric HIV infections occurring in sub-Saharan Africa.[1] Most of these infections occurred during pregnancy, delivery, or breastfeeding, thereby making the prevention of mother-to-child transmission (PMTCT) an important public health strategy for reducing HIV transmission.[2]

PMTCT programmes provide antiretroviral therapy (ART) to HIV-positive pregnant women to prevent their infants from acquiring the virus. Effective PMTCT programmes require women and their infants to have access to and make use of a cascade of interventions, including antenatal services and HIV testing during pregnancy, ART for pregnant women living with HIV, safe childbirth and appropriate infant feeding practices, and infant HIV testing and other postnatal health-care services.[3] In the absence of such interventions, the risk of mother-to-child transmission (MTCT) of HIV is 15% to 45%. However, ART

and other effective PMTCT interventions can reduce this risk to below 5%.[4]

Early infant diagnosis (EID) permits the detection of HIV infection in exposed children from 4 to 6 weeks of age via a polymerase chain reaction (PCR) assay. In infants, HIV infection may progress to full-blown AIDS within the first few months of life. The advent of EID has brought about considerable survival benefits for HIV-infected infants who receive early ART.[5] EID also permits the assessment of PMTCT programme effectiveness.

The Burundi PMTCT programme was implemented in 2000. The goal was to achieve virtual elimination of HIV infection in infants and young children. In 2011, the UNAIDS Global Plan was launched to reduce the number of new HIV infections acquired via MTCT by 90% by 2015.[6] The World Health Organization (WHO) identified 22 priority countries, with the top 10 – including Burundi – accounting for 75% of the global PMTCT services need. It was estimated that the effective scale-up of interventions in these countries would prevent over 250,000 new infections annually. The 2010 Burundian Demographic and Health Survey reported a decrease of HIV prevalence in the general population from about 3% in 2007 to 1.4% in 2010 (1% in men and 1.7% in women).[7] New HIV infections, acquired via MTCT, among children under 5 years of age accounted for 25% of all new infections during the same period. In 2016, Burundi had 84,000 people living with HIV, among whom were 4,300 pregnant women who received ART for PMTCT. WHO reporting estimated that fewer than 500 children were newly infected with HIV due to MTCT.[8] Despite sustained PMTCT efforts, infants of HIV-positive women are at risk of becoming infected after birth. One of the major ways of reducing HIV transmission is by ensuring the consistent implementation of EID. The WHO recommends DNA real-time PCR (RT-PCR) HIV testing at 4 to 6 weeks of life for infants of HIV-positive mothers, and commencement of ART for HIV-positive children below 24 months of age.[1,2,9]

This study examined EID with DNA RT-PCR at 3 health facilities in Bujumbura, Burundi, with the aim of assessing the effectiveness of PMTCT interventions towards reducing vertical transmission of HIV.

METHODS

Study Design and Setting

This was a prospective analytical study of pregnant women enrolled in the Burundi PMTCT programme, implemented according to national guidelines. The study was conducted from December 2016 to March 2017 at 3 health facilities providing HIV screening, antenatal care, and PMTCT services in Bujumbura: the Buyenzi Community Medical Centre (CMC); the Society for Women Against AIDS in Africa (SWAA), Burundi; and the Burundian National Association of Support for People Living with HIV and AIDS Patients (ANSS).

The Buyenzi CMC is a public urban antenatal care clinic and was the first centre to implement PMTCT in Burundi in 2000.

The Burundi branch of the SWAA International was built in 1992 thanks to the initiative of a group of women wishing to fight the taboo and stigma attached to HIV/AIDS. It is a nonprofit organisation dedicated to HIV prevention and client support among women, children, families, and communities by providing medical and psychosocial support. At the end of June 2015, the SWAA sites in Burundi were monitoring 5,238 people, including 3,530 taking ART.

Founded in 1993, the Burundian ANSS was the first civil society organisation in Burundi to provide HIV prevention, care, and treatment services aimed at improving the well-being of people living with and affected by HIV. In 2016, 506 women were registered with the ANSS PMTCT programme.

Study Population

This study focused on pregnant women living with HIV-1 infection and taking ART. Eligible women were those who were enrolled in PMTCT programmes at the 3 participating health-care facilities and expected to give birth within 6 weeks before the end of the study period. Babies delivered to enrolled women were included. Exclusion criteria among infants included being a second twin or a third triplet because of the reported lower MTCT risk among second twins and third triplets.[10] CD4 cell counts were done during antenatal care. HIV-exposed infants received 2 mg/kg of once-daily nevirapine from birth for 6 weeks and were thereafter screened for HIV-1 by DNA RT-PCR.

Blood Analysis

Blood analysis was carried out in the Department of Virology at the National Reference Laboratory of the National Institute of Public Health in Bujumbura. Whole blood samples (6 ml) drawn from the expectant mothers were collected in ethylenediaminetetraacetic acid (EDTA) tubes at the laboratories of each PMTCT service and directly transported to the National Institute of Public Health, where plasma was separated from the whole blood after centrifugation at 40,000 g for 10 minutes. The plasma was then stored in 1.5 ml aliquots at −80°C. CD4 T-cells were counted using the BD FACSCount System (Becton Dickinson, San Jose, CA, USA). At 6 weeks of life, all children born to enrolled mothers underwent qualitative DNA RT-PCR HIV testing. Dried blood spots from capillary samples were prepared on Whatman blotting papers and stored at room temperature until being used for DNA RT-PCR analysis with the Abbott RealTi*m*e HIV-1 Qualitative kit (Abbott Laboratories, Abbott Park, IL, USA). According to the manufacturer, the DNA RT-PCR assay has a specificity of 100% and a sensitivity of at least 2,500 copies/ml using the dry blood spot procedure.

Data Collection and Management

Data collection was conducted by a team of trained and supervised nurse data collectors. The principal investigator monitored data collection, and another senior member of the study team frequently conducted random checks to ensure data quality. Error and data consistency checks were conducted during analysis. Data were extracted from structured national data collection tools and entered into Microsoft Excel spreadsheets designed for data entry. The national tools from which the data for analysis were drawn included the PCR request and result forms as well as the EID register, containing information about the baseline characteristics of HIV-exposed babies, type of ART received by the mother, frequency of antenatal care follow-up, mode of delivery, mother's ART start date, infant feeding method, and outcome of the DNA RT-PCR test.

Data Analysis

Data entered into the Microsoft Excel spreadsheet were cleaned and checked for consistency. The cleaned data were exported to Statistical Package for the Social Sciences (SPSS) for Windows, version 12.0 (SPSS Inc., Chicago, IL, USA), for data management and further statistical analysis. Frequency counts were performed to assess the completeness of all variables. The DNA RT-PCR result was the primary outcome variable and was determined for HIV-exposed infants at 6 weeks of life.

Ethical Approval

This study was approved by the Comité d'Éthique et de Recherche en Santé Humaine (Committee of Ethics and Research in Human Health) of the Faculty of Medicine of the University of Burundi in accordance with the code of ethics for biomedical research involving human subjects (reference no. FM/CE/04/2016). Women were included in the study after they received a detailed explanation of the aim of the study and gave their written voluntary consent, when they were able to do so, and verbal consent if they were unable to read or write. The study used routinely collected, aggregated programme data at the 3 health-care facilities, and participant confidentiality was ensured, as personal identifiers – including names and identification numbers – were not recorded with the collected data.

RESULTS

The study population was composed of 122 pregnant women and 122 babies. The mean age of the women was 31±6.6 years (range, 17 to 44 years); over half (n=62, 50.8%) of the women were aged between 30 and 39 years. Ninety-two (75.4%) of the pregnancies were planned, and 30 (24.6%) were unplanned. Eighty-three (68.0%) women commenced ART before pregnancy, and 39 (32.0%) began ART during pregnancy. The mean CD4 cell count for the women was 653±308 cells/μl, and 79 (64.7%) had ≥500 CD4 cells/μl. Only 1 (0.8%) mother gave birth at home, and the rest (n=121, 99.2%) delivered at health facilities (Table 1). Most (n=98, 80.3%) participants delivered via spontaneous vaginal delivery, with 24 (19.7%) delivering through caesarean section (Table 2).

All 122 babies were born at term (≥37 weeks of gestation); 60 (49.2%) of the newborns were boys, and 62 (50.8%) were girls. Most (n=111, 91.0%) of the infants received exclusive breastfeeding during the first 6 weeks of life; the other 11 (9.0%) children received exclusive replacement feeding. At 6 weeks of age, 121 (99.2%) infants tested negative for HIV by DNA RT-PCR, and 1 (0.8%) child tested positive (Table 2).

TABLE 1. Baseline Characteristics of Women Enrolled in the Study (N=122)

Characteristics	n (%)
Age (years)	
<19	2 (1.6)
20–24	29 (23.8)
25–29	18 (14.8)
30–34	31 (25.4)
35–39	31 (25.4)
≥40	11 (9.0)
Prepregnancy plan	
Planned pregnancy	92 (75.4)
Unplanned pregnancy	30 (34.6)
Place of delivery	
Health-care facility	121 (99.1)
Home	1 (0.9)
Timing of mother's antiretroviral therapy commencement	
Before pregnancy	83 (68.0)
During pregnancy	39 (32.0)
CD4 T-lymphocyte count (/μl) during antenatal care	
≤200	2 (1.6)
201–349	17 (13.9)
350–499	24 (19.7)
≥500	79 (64.7)

TABLE 2. Selected Characteristics of HIV-Exposed Infants (N=122)

Characteristics	n (%)
Sex	
Male	60 (49.2)
Female	62 (50.8)
Mode of delivery	
Vaginal	94 (77.0)
Caesarean section	28 (23.0)
Preterm delivery (<37 weeks of gestation)	
No	122 (100)
Yes	0 (0)
Feeding option adopted by mother	
Exclusive breastfeeding	111 (91.0)
Exclusive replacement feeding	11 (9.0)
HIV DNA RT-PCR result at 6 weeks of age	
Positive	1 (0.8)
Negative	121 (99.2)

Abbreviation: RT-PCR, real-time polymerase chain reaction (assay).

DISCUSSION

Nearly all (n=121, 99.2%) of the enrolled infants tested negative by HIV DNA RT-PCR at 6 weeks of age. The 1 child who had a positive test was born at home and immediately transferred to the PMTCT centre, where nevirapine prophylaxis was initiated; however, the treatment did not continue at home. The MTCT rate of 0.8% is consistent with findings from a previous retrospective study conducted at Buyenzi CMC. In that study, Bindariye et al screened 774 children for PMTCT from January 2008 to December 2010, finding an MTCT rate of 1.4%.[11] In another prospective follow-up study of 843 HIV-infected mothers from 2009 to 2011, the MTCT rate was 1.2%.[12] This is also comparable to findings of 0.0% for Option B+ studies conducted in Burkina Faso and Ethiopia.[13,14] Option B+ is a treatment approach that recommends immediate lifelong ART for all pregnant women living with HIV, regardless of CD4 count, and daily nevirapine or zidovudine for HIV-exposed infants from birth until 4 to 6 weeks of age, regardless of infant feeding method.[15]

Burundi, like several African countries, opted for Option B+ in 2014, which is why all expectant mothers enrolled in this study were already on the standard ART regimen, according to national guidelines.[15] This may have contributed to the decline in the rate of HIV MTCT in Burundi. Eighty-three (68%) women were on lifelong ART before the pregnancy investigated in this study, and 39 (32%) women started treatment after testing positive for HIV during the applicable pregnancy. The mean CD4 count was 653±308 cells/µl, and only 2 (1.64%) women had CD4 counts <200 cells/µl. These levels could be due to antiretroviral drugs reducing maternal viral load and thereby reducing the risk of HIV transmission from mother to child by creating good conditions for the pregnancy. ART provides other antenatal and postnatal benefits; for example, in a Nigerian study, the rate of HIV transmission among infants of HIV-positive mothers was higher in babies whose mothers did not receive ART during pregnancy (28.6%) compared with those whose mothers commenced ART during pregnancy (5.4%), and it was lowest among those whose mothers commenced ART before pregnancy (3.4%).[16] Our results are promising in the light of the further rollout of PMTCT interventions in sub-Saharan Africa, especially considering the most recent "test and treat", or "treat all", approach that recommends immediate initiation of treatment for all HIV-infected individuals, including pregnant women.[17] However, high MTCT rates have still been reported relatively recently in Africa, specifically 6.3% at a tertiary hospital in Ado-Ekiti, Nigeria; 6.5% among public health-care facilities in Lusaka, Zambia; and 2.8% among public health-care facilities in South Africa.[16,18,19]

In our study, 98 (80.3%) women underwent vaginal deliveries and 24 (20%) underwent caesarean sections. This was in line with national guidelines that recommend against systematic caesarean deliveries for HIV-infected pregnant women. The frequency of caesarean section was largely determined by maternal and infant complications and not by maternal HIV status, and our caesarean section rate was similar to rates reported by other African studies.[16,20,21]

In our study, all babies were born at term. In a Nigerian study, the authors reported undesirable obstetric and neonatal outcomes in 48.3% of HIV-positive women compared to 30.3% of HIV-negative women. Preterm delivery and miscarriage were among the independent factors associated with HIV.[22] In a Spanish study on the effect of highly active antiretroviral therapy (HAART) on spontaneous and iatrogenic preterm delivery, Lopez et al[23] found that the incidence of prematurity was 19.7% in HIV-positive women and 8.5% in the control group. Prematurity secondary to treatment was significantly associated with the use of HAART during the second half of pregnancy. The incidence of spontaneous preterm birth was also higher among HIV-positive women not on HAART.[23]

WHO recommends antiretroviral prophylaxis for HIV-exposed neonates immediately after birth for 6 to 12 weeks.[9] Nevirapine prophylaxis is recommended for 6 weeks for breastfeeding infants and for 4 to 6 weeks for infants

who are not breastfeeding.[24] In this study, all infants received nevirapine prophylaxis from birth to 6 weeks of life, regardless of whether they received exclusive breastfeeding (n=111, 91.0%) or exclusive replacement feeding (n=11, 9.0%). Exposed-infant antiretroviral prophylaxis serves as pre- and post-exposure prophylaxis and is especially protective against HIV acquisition via breastfeeding.[24–26] A recent meta-analysis showed that HIV-exposed infants who do not receive antiretroviral prophylaxis at or after birth are more than 7 times more likely to become HIV-infected than infants who receive antiretroviral prophylaxis.[27] Several studies have underscored the importance of infant antiretroviral prophylaxis in preventing MTCT of HIV.[24,25]

Despite all of these encouraging results, many studies have identified different maternal, obstetric, and child-level factors that determine antenatal, perinatal, and postnatal MTCT of HIV. Olana et al noted various predictive factors associated with positivity of DNA RT-PCR HIV testing at 6 to 8 weeks of age among children born to HIV-positive mothers: home delivery, maternal CD4 count <100 cells/µl during pregnancy, absence of PMTCT interventions for the mother, absence of prenatal consultations, and non-enrolment in an HIV-management programme during pregnancy.[14] Mixed feeding, which has had reported rates of 5% in Botswana and Cameroon, has also been identified as an important risk factor for MTCT of HIV and infant deaths.[28,29] Lack of participation in mother-to-mother support programmes, low partner involvement, poor ART adherence, positive syphilis test results, maternal malnutrition, and unplanned pregnancy have also been associated with MTCT of HIV.[30]

Limitations

Our study's limitations include the short study period. A longer study period could have allowed for the inclusion of more participants, leading to more consistent results. The study was carried out at 3 centres with broad experience in managing PMTCT interventions. The centres are located in Bujumbura, where accessibility to heath facilities is high compared with the rest of the country. Our results, therefore, are not generalisable to the entire country. Additionally, this study focused only on EID of HIV at 6 weeks of age. Future studies should evaluate the effectiveness of PMTCT programmes until HIV-exposed infants reach 18 months of age.

CONCLUSION

This study highlighted the low rate of MTCT of HIV when HIV-positive pregnant women receive ART and the infants born to these women receive nevirapine for the first 6 weeks of life. Infants born to HIV-positive women can live healthy lives free from HIV infection if their mothers participate in PMTCT programmes. To identify infants with HIV and monitor those at risk of infection, HIV testing and counselling programmes focused on PMTCT interventions should be scaled up in antenatal, labour and delivery, and postnatal settings. Also, institutional and community-based comprehensive health education programmes that emphasise the importance of skilled birth attendance, postpartum care, and PMTCT interventions are essential. This calls for the Ministry of Public Health and other concerned partners to work towards improving the PMTCT programme by making DNA RT-PCR testing available and accessible to all families of exposed infants for early HIV diagnosis.

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ORIGINAL ARTICLE

Assessing Factors Associated With Survival Among Cervical Cancer Patients in Kenya: A Retrospective Follow-up Study

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ABSTRACT

Background: Cervical cancer ranks as the fourth most commonly diagnosed cancer and the fourth leading cause of cancer death in women worldwide. In Kenya, cervical cancer is the second most commonly diagnosed cancer after breast cancer and the leading cause of cancer death in women. It is estimated that by the end of 2018, cervical cancer will be responsible for 5,250 (11%) new cases and 3,286 (11.84%) deaths in Kenya.

Methods: We conducted a retrospective follow-up study to estimate the overall survival of women treated for cervical cancer in Kenya. Medical records were reviewed to extract information for generating a quantitative data set, and the chi-square test was used to test for associations between patient outcomes and various sociodemographic and clinical factors. To estimate overall survival after treatment, we used Kaplan–Meier survival analysis, the logrank test, and Cox proportional hazards regression.

Results: A total of 481 patient records were included in this study. From the bivariate analysis, 4 factors demonstrated a statistically significant association with survival: access to care (P=.049), stage of disease at diagnosis (P<.001), type of treatment received (P<.001), and whether or not treatment was initiated and completed (P<.001). The overall 5-year survival estimate for women with cervical cancer was 59%. However, 396 (82.3%) women were lost to follow-up; with no deaths observed after the first year, the overall survival estimate is only accurate for the first year.

Conclusion: The high rate of loss to follow-up appears to be characteristic of cancer care in Kenya and highlights the difficulties in conducting survival studies in low-resource settings with low coverage of vital registration and a lack of centralised national administrative systems. Despite the study's limitations, the results support evidence whereby late-stage diagnosis, deficiencies in cancer management, and limited cancer care services, in particular, have been found to contribute to poor patient outcomes in sub-Saharan Africa.

INTRODUCTION

The Global Cancer Incidence, Mortality, and Prevalence (GLOBOCAN) database indicates that, in 2018, cervical cancer will be responsible for 570,000 new cases and 311,000 deaths globally.[1] Cervical cancer, therefore, ranks as the fourth most commonly diagnosed cancer and the fourth leading cause of cancer death in women worldwide.[1] Although cervical cancer incidence and mortality rates have been on the decline in many populations worldwide, evidence suggests that these rates are increasing in sub-Saharan Africa.[2,3] This is catastrophic considering the highest regional age-standardised incidence rates (ASIR) and mortality rates (ASMR) for cervical cancer are in Africa, with particularly elevated rates observed in southern (ASIR, 43.1; ASMR, 20.0), eastern (ASIR, 40.1; ASMR, 30.0), and western Africa (ASIR, 29.6; ASMR, 23.0).[1] In Kenya specifically, it is estimated that, in 2018, cervical cancer will be responsible for 5,250 (11%) new cases and 3,286 (11.84%) deaths. This makes cervical cancer the second most commonly diagnosed cancer in Kenya after breast cancer and the leading cause of cancer death in women.[4]

Timely pathology and laboratory services are fundamental for the provision of quality health services for noncommunicable diseases (NCDs).[5] However, few countries have any or enough staff to adequately support the need. For example, only Botswana and South Africa have at least 1 pathologist for every 500,000 people,

while Somalia does not have any active pathologists.[6] Factors driving poor access to care and low survival in sub-Saharan Africa include: few trained health workers, poor health system infrastructure, and high cost of oncological care in the absence of universal health care.[7] In Kenya, breast and cervical cancer treatment services in the private sector were found to be 10 times more expensive compared to the public sector.[8] Without health insurance, even care at a public hospital becomes inaccessible for many.[8]

Cancer is not a rare disease in Africa. However, the overwhelming burden of communicable diseases has restricted investments in appropriate cancer control strategies and management guidelines and has resulted in late-stage diagnosis of cancer with poor outcomes.[9] For example, analysis of population-based cancer survival data found that 5-year age-standardised relative survival did not exceed 22% for any cancer site in The Gambia or 13% for any cancer site except the breast (46%) in Uganda.[10] This translates to a high proportion of terminally ill cancer patients; data suggest that at least 88% of cancer deaths in Africa with moderate to severe pain are untreated.[11] In Kenya, the scaling up of palliative care services faces 3 main challenges: difficulties in forecasting demand for opioid analgesics, administrative bottlenecks that characterise the public-sector procurement process, and a lack of sufficient funding for essential drugs including morphine.[11]

Very little is known about the structure, processes, and outcomes of cancer control activities in sub-Saharan Africa. Development of high-quality health data sources and improved capacity for health services research would promote better understanding of the current situation and identify areas of improvement of oncological health services in low- and middle-income countries (LMICs).[12] This study aimed to use medical records to estimate overall survival among cervical cancer patients interacting with the Kenyan health system, which operates a predominantly centralised oncological health service.

METHODS

This retrospective follow-up study was conducted at Kenyatta National Hospital (KNH), a public teaching and referral hospital with a 1500-bed capacity. The hospital's radiotherapy and obstetrics and gynaecology departments make up the largest cervical cancer management centre in Kenya, receiving patients from all over the country. There was no direct contact between the study team and patients. All information and data presented in this article were solely obtained from the review of clinical notes and laboratory reports contained within study participants' medical records.

Sample Size

No sample size calculation was made for this study. KNH was the only hospital in Kenya offering comprehensive cancer care in 2008. Therefore, we aimed to identify every case of cervical cancer attended to at the hospital. However, a retrospective sample-size calculation indicates that the study's final sample size of 481 patients would have been sufficient to estimate a mortality rate of 20% per year with a precision of 5%.

Data Collection

A review of medical records belonging to all cervical cancer patients who presented with illness for the first time between January and December 2008 at KNH was undertaken. We obtained medical records from the hospital's inpatient record registry at the Health Information Department (HID) and from the outpatient record registry at the Radiotherapy Clinic (RTC).

Both the HID and RTC operated predominantly manual paper-based record registry systems. In the HID, a registry clerk identified and retrieved hard-copy patient records based on each files' assigned International Classification of Diseases (ICD) 10 code of C53/C53.9 for cervical cancer. The HID does not code files using all the 10 digits of the code. Within the RTC, the staff advised our team where to physically locate files for all patients treated in their clinic in 2008.

We defined cervical cancer cases as patients with histologically confirmed cervical cancer, diagnosed via biopsy. Records of patients who met that definition and commenced treatment at KNH between January and December 2008 were included in the study. Patients' records were excluded from the study if the patients were diagnosed with a form of cancer other than cervical cancer, received a histological diagnosis of benign tumour of the cervix or clinical diagnosis of cervical cancer, or if they commenced treatment at KNH prior to January or after December 2008.

We screened approximately 2,367 patient files opened between January and December 2008 to identify those belonging to cervical cancer patients. Through triangulation of patient data and follow-up between the 2 registries of inpatient and outpatient departments, 617 medical records of the initial 2,367 were confirmed as belonging to cervical cancer patients who sought treatment at KNH between January and December 2008. The 617 medical records were thereafter assessed against the study's inclusion and exclusion criteria.

The major limitation with the patient file retrieval process was that unlike the HID, which codes patient files and retains a separate but equally detailed record registry for patients who died during their admission, the RTC does not code their files according to cancer type nor do they keep an organised record or registry for deceased patients. The deceased patient files are stored in cupboards and date back several decades. Consequently, only patients whose files were considered active in the RTC main registry were reviewed. This means that the number of hospital-occurring deaths was likely underestimated and not all cervical cancer patient files were reviewed.

The study was carried out between February and August 2014. We extracted the required patient information from the 481 patient medical records selected for inclusion in the study using a specially designed data entry form in Epi Info 7 (Centers for Disease Control and Prevention, Atlanta, GA, USA). The data collected included information on sociodemographic factors (eg, age, marital status, education, and parity), clinical factors (eg, diagnostic method, stage of disease, and tumor histopathology), and patient outcomes at 5 years (ie, death, alive at 5 years, or lost to follow-up). This ensured uniformity in data extraction and generated a quantitative data set.

Data Analysis

Statistical analysis was conducted using Stata, version 14.2 (StataCorp LLC, College Station, TX, USA) after manually exporting the data from the Epi Info database. We generated descriptive statistics for both sociodemographic and clinical factors. Using Pearson's chi-square (X^2) test, associations between patient outcomes and various sociodemographic and clinical factors considered during this study were assessed.

Overall survival was defined as the length of time a patient was alive from the date of diagnosis to 5 years post diagnosis. Survival analysis was restricted to factors showing strong associations with patient outcomes as determined during bivariate analysis. However, age was included as an additional potential confounder, although it did not demonstrate any statistically significant association with patient outcomes for this study population. Initially, we conducted Kaplan–Meier survival analysis to estimate the mean survival time until death and the median survival time (ie, time at which 50% of subjects had died). The logrank test was thereafter applied to compare the survival distribution between groups. This was followed by mortality hazard ratio analyses. Cox proportional hazards regression was used to generate both univariate and multivariate hazard ratios (ie, rates adjusted for potential confounders). We then compared the univariate and multivariate hazard ratios to establish which factors consistently demonstrated an influence over the overall survival rates of cervical cancer patients treated at KNH. A significance level of .05 and, where appropriate, a 95% confidence interval (CI) were used to interpret the analysis results.

Ethical Approval

Ethical approval for this study was granted by the Kenya Medical Research Institute (KEMRI) Ethical Review Committee (KEMRI/RES/7/3/1 Protocol SSC No. 2486) and the University of Nairobi/Kenyatta National Hospital Ethical Review Committee (KNH-ERC/R&R/546 Protocol No. P404/7/2013).

RESULTS

We reviewed a total of 617 medical records for inclusion in this study; 481 records qualified for inclusion while 136 were excluded. Of the 136 excluded records, 97 (71.3%) belonged to women who had presented with illness for the first time at KNH earlier than January 2008. In 18 (13.2%) cases, patients were treated for clinically diagnosed cervical cancer. The remaining 21 (15.5%) cases belonged to patients whose records were miscoded during filing and were either ailing from noncancerous illnesses or diagnosed with cancers other than cervical cancer.

Sociodemographic and Selected Characteristics

The patients had a mean age of 49 (95% CI, 48.26 to 50.57) years and a median age of 48 years (range, 20 to 86 years). The 40- to 49-year age group was the largest, with 147 (30.6%) patient records. Collectively, 262 women of reproductive age (20 to 49 years) accounted for 54.5% of the study population. Of the 481 patients, 194 (40.3%) women reported being married, while 82 women (17.05%) had only attained primary school-level education. Notably, women with tertiary education accounted for only 1.6% of the records reviewed.

Despite KNH being located in the capital city, Nairobi, 263 patients (54.68%) reported residing in areas that were up to 3 hours from Nairobi by road. For women with documented occupations, 119 (24.7%) were reported as being self-employed, and 117 (24.3%) were housewives. Parity ranged from 0 to 13, with a mean and median number of 5 children. Over half (n=264, 54.9%) of the women reported having 5 or more children.

Of the 225 women of known HIV status, 164 (34.1%) were HIV-negative. Only 43 (8.9%) of the women reported a history of Pap smear testing, while 12 (2.5%) reported never having undergone cervical cancer screening.

Clinical Presentation

The most reported histological types of cervical cancer were squamous cell carcinoma (n=406) and adenocarcinoma (n=30).

In 2008, KNH was using the pre-2009 International Federation of Gynaecology and Obstetrics' classification system to stage cervical tumours.[13] Most women (n=406) were diagnosed at advanced stages – predominantly stages 2B (n=131), 3A (n=55), and 3B (n=140).

Comorbidity with other NCDs was considered, but analyses were restricted to diabetes, heart disease, and hypertension. Of the total study population (N=481), 5 (1.0%) women had diabetes, and 26 (5.4%) had hypertension, while none suffered from heart disease. Out of the 28 women with NCD comorbidity, 3 suffered from both diabetes and hypertension. The prevalence of NCD comorbidity was low at 5.8% in this study population.

Treatment Options

The full spectrum of cancer treatment available at KNH was surgery (both radical and total abdominal hysterectomy), radiotherapy, and adjuvant chemotherapy (mainly with cisplatin and fluorouracil). We confirmed that out of the 481 women, 66 (13.7%) underwent surgery as part of their treatment plan. A total of 298 (62.0%) women received radiotherapy, with (n=36) or without (n=263) surgery; and, of these, 185 (62.1%) women completed treatment.

In contrast, 66 (13.7%) women received both chemotherapy and radiotherapy, either with (n=9) or without (n=57) surgery. Only 40 (60.6%) women completed the chemoradiation treatment plan. Women who either underwent surgery only (n=12) or had surgery and chemotherapy (n=9) were grouped together as "other" treatment and represented only 4.4% of the study population. Of the 21 "other treatment" women, 20 (95.2%) completed treatment.

A fifth (n=96, 20.0%) of the medical records provided no evidence of any treatment received.

Bivariate Analysis

A total of 396 (82.3%) patients were lost to follow-up. There were 50 deaths (10.4%) and only 35 women (7.3%) were reported to be alive 5 years after the initiation of treatment. Based on bivariate analysis, none of the sociodemographic variables directly influenced patient outcomes at KNH, as all *P* values were >.05 (Table 1).

For clinical variables, no statistically significant associations between either histological type (X^2=1.1, 4 degrees of freedom [df]; *P*=.90) or NCD comorbidity (X^2=7.7, 6 df; *P*=.26) and patient outcomes were found. However, strong statistical associations of *P*<.001 were detected between stage of disease (X^2=30.1, 6 df), treatment received (X^2=52.7, 6 df), and treatment status (ie, whether or not treatment was initiated and completed) (X^2=53.4, 4 df), and patient outcomes.

Kaplan–Meier Survival Analysis

Five variables – age, access to care, stage of disease, treatment received, and treatment status – were included in the Kaplan–Meier survival analysis. Following the application of the logrank test, age remained statistically non-significant (*P*=.70). Access to care was statistically significant (*P*=.012) while stage of disease, treatment received, and treatment status were all highly significant (*P*<.001).

The Kaplan–Meier survival curves for stage of disease and treatment received are provided in the Figure.

Mortality Hazard Ratio Analyses

There were 50 known deaths among women followed up for a total of 494 person years. The average period of follow-up was slightly over 1 year – approximately 13 months – ranging from a minimum follow-up of 1 day to a maximum of 5 years. The overall 5-year survival was estimated as 59.0%.

For age, we observed increments in multivariate hazard ratios across the age groups compared to univariate values. The *P* values associated with the multivariate hazard ratios were all less than .05; therefore, observed differences in survival were not statistically significant. However, from the multivariate hazard ratios, the 60 years and above age group was at the greatest risk of dying.

Based on multivariate hazard ratios, deaths among patients residing outside of Nairobi appeared less likely to be reported to KNH. Both univariate and multivariate hazard ratios for stage of disease consistently demonstrate that the risk of dying increased with disease stage.

Concerning treatment received, women who received chemoradiation had the lowest risk of dying, although this did not achieve statistical significance. Women who either had surgery or surgery with chemotherapy – the "other" group – were more than 8 times more likely to die compared with those who had radiotherapy as part of their treatment plan. Also, women who completed their recommended treatment plans were least likely to die while those who never started treatment were at the greatest risk of dying.

Analyses suggest that the major determinants of survival among patients with cervical cancer were stage of disease at diagnosis, type of treatment given to the patient, and whether or not a patient initiates and completes treatment (Table 2).

DISCUSSION

Sociodemographic and Selected Patient Factors

None of the sociodemographic factors considered showed a significant association with patient outcomes; however, evidence suggests most are associated with late-stage diagnosis and patient outcomes. Older age, in particular, has been linked to late-stage diagnosis[14,15] and poor survival outcomes[16–18] and has been shown to be a factor in treatment defaults leading to poor survival outcomes.[19]

Low education levels have been linked to poor uptake of screening services, increased cervical cancer incidence, and late-stage diagnosis.[14,20–24] In previous studies, poor education has been closely associated with low socioeconomic status and residence in a medically underserved area. Understandably, a woman's residence in a medically underserved area has also been found to contribute to late-stage diagnosis resulting in poor patient outcomes.[25,26] In 2008, KNH was the only health facility in the country offering radiotherapy and hosting a comprehensive cancer treatment centre in the country. This explains why a majority of patients reported residing outside Nairobi and travelling long distances to seek care.

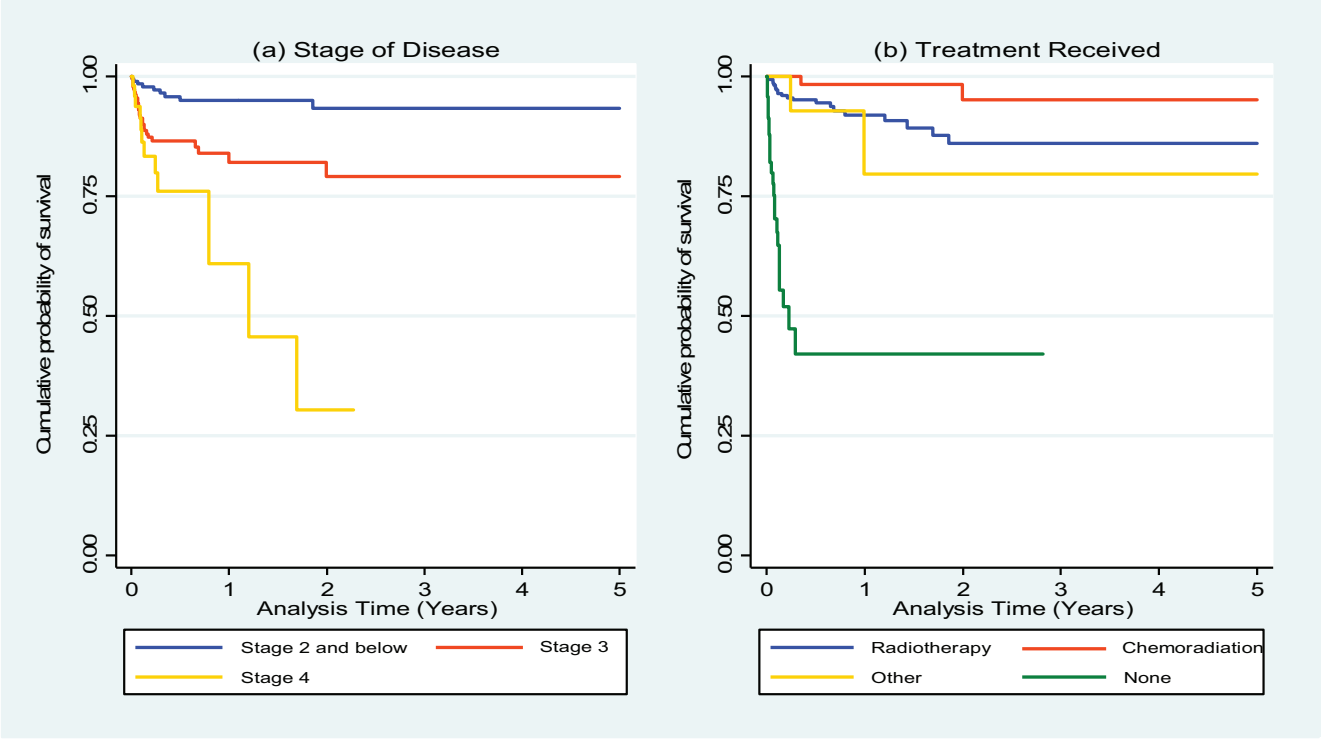
Socioeconomic status likely influenced patient outcomes in this study as reported in other studies.[14,25,27] In Kenya, similar to other LMICs, patients incur significant out-of-pocket expenditure to access medical services[27–29] due to low per capita expenditures on health by

TABLE 1. Cross-tabulation of Patient Outcomes vs Sociodemographic and Selected Characteristics

Variables	Cases[a] n	Deaths n (%)	LTFU n (%)	Alive at 5 Years n (%)	X^2 *P* Value
Overall	481	50 (10.4)	396 (82.3)	35 (7.3)	
Age, years					
20–39	115	14 (12.2)	96 (83.5)	5 (4.4)	.83
40–49	147	13 (8.8)	123 (83.7)	11 (7.5)	
50–59	111	12 (10.8)	89 (80.2)	10 (9.0)	
60+	108	11 (10.2)	88 (81.5)	9 (8.3)	
Marital status					
Never married/Single	35	6 (17.1)	29 (82.9)	0 (0.0)	.36
Married	194	27 (13.9)	155 (79.9)	12 (6.2)	
Divorced/Widowed	76	15 (19.7)	55 (72.4)	6 (7.9)	
Education					
None	29	12 (41.4)	17 (58.6)	0 (0.0)	.16
Primary	82	26 (31.7)	55 (67.1)	1 (1.2)	
Secondary	37	6 (16.2)	29 (78.4)	2 (5.4)	
Tertiary	8	1 (12.5)	7 (87.5)	0 (0.0)	
Access to care					
Residing in Nairobi	71	13 (18.3)	52 (73.2)	6 (8.5)	.05[b]
≤3 hours from Nairobi by road	263	27 (10.3)	214 (81.4)	22 (8.4)	
>3 hours from Nairobi by road	141	9 (6.4)	125 (88.7)	7 (5.0)	
Occupation					
Casual/Retired/Unemployed	52	10 (19.2)	42 (80.8)	0 (0.0)	.20
Housewife	117	16 (13.7)	94 (80.3)	7 (6.0)	
Professional	18	0 (0.0)	17 (94.4)	1 (5.6)	
Self-employed	119	21 (17.7)	89 (74.8)	9 (7.6)	
Parity					
0	4	1 (25.0)	2 (50.0)	1 (25.0)	.39
1	21	2 (9.5)	19 (90.5)	0 (0.0)	
2–4	165	15 (9.1)	141 (85.4)	9 (5.5)	
5+	264	28 (10.6)	215 (81.4)	21 (8.0)	
HIV status					
Positive	61	10 (16.4)	49 (80.3)	2 (3.3)	.22
Negative	164	20 (12.2)	131 (78.9)	13 (7.9)	
Pap smear screening					
Yes	43	3 (7.0)	36 (83.7)	4 (9.3)	.14
No	12	3 (25.0)	9 (75.0)	0 (0.0)	

[a] The number of cases for each characteristic is variable across different categories, because data recording in medical records varied, and analysis was confined to the data available.
[b] Borderline statistical significance relative to a *P*=.05 significance level.
Abbreviations: X^2, chi-square test; LTFU, lost to follow-up.

FIGURE. Cumulative Probability of Survival in Women with Cervical Cancer, by Stage of Disease and Treatment Received (N=481)



governments.[30] Despite financial inability being the main reason behind delayed, prolonged, or interrupted treatment, no statistically significant association could be detected between occupation and patient outcomes. It is, therefore, likely that occupation, as recorded in patient files and categorised for our analysis, was not a good measure of socioeconomic status.

In India, having many children at home created a burden to cervical cancer patients resulting in treatment defaults.[19] This shows that high parity can indirectly contribute to poor patient outcomes in LMICs through increased competition for limited household resources. However, this was not reflected in our study.

Cervical cancer has been classified as an AIDS-defining illness in women with HIV infection, which is a recognised prognostic indicator of poor treatment outcomes for cervical cancer.[31] Our study findings appear to contradict previous studies whereby HIV-positive cervical cancer patients were more likely to be diagnosed at a later stage, have poorer responses to treatment, exhibit higher rates of recurrence and undergo rapid disease progression compared to HIV-negative women.[31–33]

For this study population, few women had their screening history documented, which contributed to difficulties in accurately establishing the statistical significance of the relationship between screening history and patient outcomes. It would have been expected that regular or previous screening would be associated with positive patient outcomes resulting from early diagnosis.

From the above, it is evident that in low-resource settings, such as Kenya, 2 key factors specifically limit the effectiveness of retrospective cancer survival studies. First, inconsistent documentation of patient histories, sociodemographic, and contact information within primarily manual and paper-based systems. Second, the lack of centralised vital registration and national health sector systems makes it difficult to follow up with patients once they leave a specific health facility. As a result, a number of statistically significant relationships were likely undetected during data analysis.

Clinical Factors

Most women were diagnosed at advanced stages of disease. This is similar to several studies that have collectively

TABLE 2. Univariate and Multivariate Estimates Using Cox Regression of Mortality Hazard Ratios and 95% Confidence Intervals

	Univariate				Multivariate		
		95% CI				95% CI	
Factors	Hazard Ratio	Lower Limit	Lower Limit	*P* Value[a]	Hazard Ratio[b]	Lower Limit	Upper Limit
Age, years							
20–39	1.00	—	—	—	—	—	—
40–49	0.64	0.30	1.36	.36	0.68	0.29	1.55
50–59	0.76	0.34	1.67	.61	1.25	0.53	2.93
60+	0.78	0.35	1.72	.40	1.46	0.61	3.50
Access to care							
Residing in Nairobi	1.00	—	—	—	—	—	—
≤3 hours from Nairobi by road	0.53	0.27	1.03	.15	0.58	0.27	1.22
>3 hours from Nairobi by road	0.28	0.12	0.68	.04	0.39	0.15	0.97
Stage of disease							
Stage 2 or below	1.00	—	—	—	—	—	—
Stage 3	3.74	1.75	8.00	.01	3.12	1.37	7.07
Stage 4	8.22	3.42	19.76	<.001	5.50	2.18	13.89
Treatment received							
Radiotherapy	1.00	—	—	—	—	—	—
Chemoradiation	0.29	0.07	1.24	.21	0.39	0.09	1.72
Other	1.50	0.35	6.38	.01	8.89	0.61	49.04
None	13.09	7.07	24.25	.70	1.44	0.22	9.52
Treatment status							
Completed	1.00	—	—	—	—	—	—
Incomplete	5.11	2.12	12.31	<.001	7.60	2.79	20.66
Never started	42.26	17.71	100.81	<.001	28.25	3.75	212.94

[a] *P* values for multivariate hazard ratios;
[b] Hazard ratios adjusted for age, access to care, stage of disease, treatment status, and treatment received.
Abbreviation: CI, confidence interval.

established that more than 80% to 90% of women across sub-Saharan Africa present with late-stage cervical cancer.[24,27,34]

In their 2002 systematic review, Grossman et al[35] found an association between hypertension and increased mortality among cancer patients. Other studies that have shown that type 2 diabetes resulted in poor oncological outcomes in patients with early stage cervical cancer.[36,37] These proposed associations were not reflected in this study, which could be the result of both low overall prevalence of NCD comorbidity in the study population and a small number of patients undergoing or completing chemoradiation.

With regards to treatment options, chemoradiation with cisplatin is the accepted standard treatment for locally advanced disease.[38] Despite this, the critical component of

treatment plans for the women in this study was radiotherapy, with or without surgery, depending on disease stage.

The strong statistical associations between patient outcomes versus stage of disease, treatment received, and treatment status at KNH suggests that while the loss to follow-up was exceedingly high, the few deaths reported followed a distinct pattern allowing for these relationships to be detected. Furthermore, compared to patient history and sociodemographic information, clinical data were relatively well documented, as they are the primary focus of medical records.

Overall Survival

The overall survival rate of 59% (12 deaths per 100 person years) in our study population was likely an underestimation owing to the high proportion of women lost to follow-up. As almost all reported deaths occurred within the first year of follow-up, the actual survival rate over 5 years is likely to be less than 25%, as has been observed in the Gambia and Uganda.[10] This suggests that a review of medical records can yield more accurate survival estimates for a 1-year period or less, but inaccuracies will increase as the period of follow-up increases if additional measures to ascertain patients' vital status are not taken. Notwithstanding the study's limitations, the results suggest that stage of disease at diagnosis, treatment received, and whether or not treatment was completed were major predictors of survival among women treated for cervical cancer in Kenya.

Patients diagnosed with stage 4 cervical cancer demonstrated the greatest risk of dying. Globally, stage 4 cervical cancer has been shown to have a poor prognosis and an extremely low survival rate of 15% to 16%.[39] In many LMICs, late-stage diagnosis coupled with incomplete treatment for advanced cancer contributes to mortality, as 80% of patients already have incurable disease when first diagnosed.[40] Maranga et al[26] additionally raises concerns over the possibility of "under-staging" – wherein women had more advanced disease than was diagnosed – impacting negatively on patient outcomes.[27] Similar to their study at KNH, we noted during our study that initial staging and tumor response were primarily assessed using digital vaginal examination because few patients could afford imaging tests, such as ultrasound, x-ray, computed tomography, or magnetic resonance imaging. Consistency of these results with international studies is yet another reminder of the importance of scaling up cervical cancer screening and diagnostics in LMICs.[41]

There was no statistically significant difference in the risk of dying between patients receiving chemoradiation compared with those receiving radiotherapy. Chemoradiation has been demonstrated to increase the chances of survival among cervical cancer patients.[42,43] One hypothesis to explain this phenomenon is the prohibitive cost of treatment.[40,44] While the cost of chemotherapy plus radiotherapy is significantly higher than other treatments, it is plausible that many patients recommended for either radiotherapy or chemoradiation are equally unlikely to either start or complete treatment due to limited finances. Furthermore, a significant number of women were rendered ineligible for chemotherapy owing to complications from advanced disease (severe anemia or hydronephrosis) or advanced age (60 years and above). These reasons may explain why the difference in risk of dying was not statistically significant between the 2 groups despite expectations that patients recommended for chemoradiation would have reduced risk.

From reviewing the records, we noted that the period from diagnosis to commencement of treatment took an average of 2 to 3 months for most patients. This phenomenon was also reported by Maranga et al,[26] citing the main reasons for delay as financial constraints, difficulties with travelling, inability to gain admission to crowded hospital oncology wards, and queues of patients awaiting treatment with the single radiotherapy machine at KNH.[27] To that end, it is evident that organisational delays in accessing diagnostic and treatment services additionally contribute to poor patient outcomes.

Since 2008, multiple initiatives aimed at improving cancer management in Kenya have been launched. The Ministry of Health – in partnership with reproductive health partners – are rapidly expanding access to visual inspection screening methods and ensuring that basic treatment with cryotherapy for precancerous lesions is widely accessible. The hospital has acquired new radiotherapy machines and, in 2017, officially launched its cancer treatment centre. In January 2016, Kenya's national hospital insurance fund launched revised benefit packages that have enabled more patients to access cancer care. Moreover, between 2010 and 2012, 4 comprehensive private health sector cancer treatment centres have been established. Cancer survival studies are urgently needed to examine the impact of these strategies on access to care and overall survival.

Ascertaining Patients' Vital Status in Future Studies

Four methods of study participant follow-up are recommended: provision of incentives, use of mailing addresses, telephone follow-ups, and home visits.[45] Owing to the lack of resources available to existing oncology programmes in sub-Saharan Africa, incentives, use of mailing addresses, and home visits may not be practical. However, the use of mobile phones in Africa has grown exponentially in the last decade and may provide an effective way for conducting active surveillance of cancer patients.[46] Follow-up by telephone could go beyond ascertaining the patients' vital status by providing advice on medications, clarification of missing or unclear information from medical records, psychosocial support through training callers to handle difficult topics – such as coming to terms with medical illness – and referrals to any organisations and foundations offering supportive services to cancer patients and their families.

Additionally, there needs to be a greater emphasis on prospective cancer survival studies, because the rapport and trust built during recruitment of study participants would facilitate long-term follow-up in a context where cancer patients exhibit high mobility by seeking care in multiple facilities.

Additionally, cancer survival studies should be conducted within a national cancer research network, which would harmonise data collection tools and set up a vital registration database for cancer patients. Using data-sharing agreements, this database could then be used for subsequent studies and help improve data quality.

Limitations

Patient medical records may have been missed for various reasons: reviews of deceased patient files at the RTC were not done, patients died on arrival to the hospital before diagnostic confirmation, and the facilities may have misplaced files. Furthermore, the women who registered for treatment at KNH were a select subset of women with cervical cancer, as more seriously ill women and women with fewer resources may not have had access to KNH.

Lack of a centralised national database for vital registration prevented determination of how many patients may have died outside KNH. Also, lack of a centralised national health system database prevented effective follow-up of patients who may be continuing care in alternative health facilities across the country.

CONCLUSION

Late-stage diagnosis, treatment defaults, and constrained oncological health services undoubtedly contribute to the high mortality rates from cervical cancer in Kenya. Reviewing medical records is an integral component of cancer survival studies that needs to be coupled with innovative strategies to ascertain patients' vital status in regions where vital registration systems are limited in coverage, and national health system databases are either nonexistent or limited in scope.

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ORIGINAL ARTICLE

Factors Associated With Contraceptive Use Among Antenatal Care Clients With 3 or More Children at a Central Hospital in Burundi: A Cross-Sectional Study

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ABSTRACT

Background: The fertility rate in Burundi has remained consistently high since the 1980s, while the prevalence of contraceptive use in the country (22%) has been among the lowest in Africa. Reasons for low contraception uptake in Burundi have not been adequately clarified.

This study aimed to identify factors associated with contraceptive use among pregnant women who had at least 3 healthy children and sought antenatal care services at an urban tertiary hospital in Burundi.

Methods: Data were collected from antenatal clients with 3 or more children at Kamenge University Hospital. Data analysis included univariate and multivariate methods as well as multiple logistic regression analysis using SPSS, version 16.0.

Results: We enrolled 255 women with a mean age of 32±4.5 years. The majority (n=232, 91.0%) of participants were urban residents with low incomes, and most (n=227, 89.0%) were educated to the primary school level or lower. The mean parity was 4.2±1.4, and most women had either 3 (n=120, 47.1%), 4 (n=66, 25.9%), or 5 (n=43, 16.9%) children; 26 (10%) participants had at least 6 children. Most (n=166, 65.1%) participants were part of couples who desired to have a final number of 4 to 6 children. About half (n=129, 50.6%) of the participants were able to name 1 or 2 benefits of contraception, and 105 (41.2%) participants mentioned 3 or 4 benefits of contraception. The most commonly reported benefit of contraceptive use was that it allows for improved maternal and child health. Low rates of contraceptive use were reported by participants with partners who worked as farmers, those citing fewer benefits of contraception, and those who relied on neighbours as their main source of information about contraception.

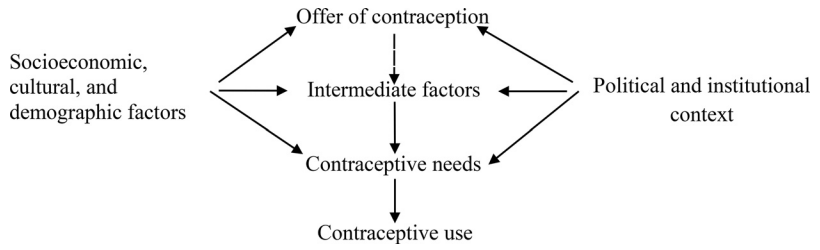
Conclusion: Knowledge of the benefits of contraception was among the strongest determinants of contraceptive use in this population. Farmers and traders were less likely to use contraceptives than participants who were engaged in other types of work. Medical personnel were the most relied upon source of information about contraception, and the strongest predictor of contraceptive use was the personal opinion that contraception is acceptable.

INTRODUCTION

Sustainable societal development is closely linked to the right balance between available resources and population size. In many low-income countries, particularly in sub-Saharan Africa, this balance continues to be elusive.[1] High birth and fertility rates perpetuate the cycle of resource limitations and poverty.[2] Strategies promoting widespread adoption of family planning and contraception methods have effectively decreased fertility rates and some of the associated negative consequences.[3–5] Despite the implementation of health policies favouring and promoting birth control, the synthetic fertility rate in Burundi was still 5.5 children per woman in 2016, marginally down from 6.8 in the 1980s and 6.4 in 2010.[6,7] High fertility is strongly associated with high maternal morbidity and mortality rates.[3,4,8] Burundi's high fertility rate certainly contributes to the high maternal mortality rate (392 deaths per 100,000 live births), and it has been linked to the country's high neonatal mortality rate (23 per 1,000 live births) as well as the high rate of obstetrical complications.[6,9]

The contraceptive use rate in Burundi among women in union is 29%, which is the lowest in the East African Community.[6] According to the United Nations

FIGURE. Conceptual Model of Determinants of Contraceptive Use[12]



Development Programme's Vision Burundi 2025 project estimates, to achieve control of the country's current population growth rate, couples should not exceed having 3 living children.[10] However, 32% of Burundian women with 3 children still desire more children in the near future.[6] This could be a major obstacle towards achieving the Vision Burundi 2025's objectives related to population control.

To guide policies supporting Vision Burundi 2025, we attempted to identify factors associated with contraceptive use among pregnant women with at least 3 children.

METHODS

Study Design and Variables

This cross-sectional study was carried out between 8 December 2014 and 6 February 2015 to identify the factors influencing contraceptive use among Burundian women with 3 or more living children.

Data collection included participant sociodemographic characteristics and perceptions about contraceptive use and contextual factors, such as Burundi's political and institutional climate. The dependent variable was contraceptive use.

Study Site, Population, and Participants

The study was conducted within the confines of the antenatal care service of Kamenge University Hospital, which is a 421-bed tertiary referral facility in Bujumbura, Burundi. The antenatal service, in the obstetrics and gynaecology department, manages about 9,950 women per year.

The study population consisted of consenting pregnant antenatal clients who had at least 3 children reported to be in good health. This population was targeted because of the likely substantial contribution to the country's high fertility rate by women who desire bearing additional children despite already having given birth to at least 3 healthy children. Any strategy aiming to slow down population growth should consider this segment of the population.

The sample size was calculated using Fisher's formula for cross-sectional studies,[11] as follows:

$$N = \frac{z^2 pq}{d^2}$$

where z=1.96 for the 95% confidence level; p=proportion of pregnant women utilising antenatal services at Kamenge University Hospital who have at least 3 children; q=(1−p); d=study precision (set at 0.05 for the 95% confidence level).

The proportion of antenatal care clients who had 3 or more living children was calculated using figures found in hospital registers. Owing to limitations in our medical record keeping capacity, this proportion was calculated only for 8 months, between 3 November 2012 and 8 July 2013. During that period, out of 809 pregnant women who utilised antenatal services at Kamenge University Hospital, 169 (20.9%) had at least 3 living children.

The sample size calculation determined that we needed to enrol 255 pregnant women with at least 3 children. The first participant was randomly selected using a random number generator. Subsequently, we attempted to enrol every third antenatal client (based on the total population divided by the sample size, 809/255) seeking care at our centre until we reached the desired sample size.

Conceptual Model

The study drew from the model of contraceptive use proposed by Akam et al[12] in their study about contraceptive use in Cameroon (Figure). This model depicts factors that potentially determine the use of contraceptives within a given population and the links between these factors. We also assessed the influence of knowledge among participants regarding the benefits of contraception using a tool developed by Singh.[8] Topics addressed by the tool include maternal and child health improvement, increasing household wealth, prevention of obstetrical complications, and children's educational opportunities. A score was calculated for every participant according to their knowledge about the benefits of contraception.

Data Collection and Analysis

Data were collected, using a structured questionnaire, by a female medical assistant trained in quantitative research

TABLE 1. Number of Living Biological Children Among Participants

Number of Children	n (%)
3	120 (47.1)
4	66 (25.9)
5	43 (16.9)
6	13 (10.2)
7	7 (2.7)
8	4 (1.6)
9	2 (0.8)
Total	**255 (100)**

TABLE 2. Number of Benefits of Contraception Reported by Participants

Score	Interpretation	n (%)
0	No benefits reported	11 (4.3)
1	1–2 benefits reported	129 (50.6)
2	3–4 benefits reported	105 (41.2)
3	5–6 benefits reported	10 (3.9)

methods. The questionnaire was pretested before its formal use, and adjustments were made to ensure its reliability and validity. Data analysis included descriptive statistics using frequencies, percentages, and means. Thereafter, univariate analysis was done between each potential determinant and the dependent variable, and statistical significance was determined using the chi-square test.

Multivariate analysis based on adjusted odds ratios and multiple logistic regression were used to assess the strength of the relationships between variables in the final best fit model with 95% confidence intervals (CIs). Data analysis was carried out using SPSS, version 16.0 (SPSS Inc., Chicago, IL, USA).

Ethical Considerations

The study was officially approved by the National Ethical Committee in October 2014. Codes were assigned to client files to ensure anonymity.

TABLE 3. Factors Significantly Associated With Contraceptive Use

	Reported Contraceptive Use Before Current Pregnancy		
Variables	No n (%)	Yes n (%)	*P* Value
Age (years)			
20–24	5 (55.6)	4 (44.4)	.020
25–29	28 (52.8)	25 (47.2)	
30–34	30 (28.3)	76 (71.7)	
35–39	33 (41.8)	46 (58.2)	
40–44	2 (25.0)	6 (75.0)	
Parity			
3	34 (35.8)	61 (64.2)	.025
4–5	41 (34.2)	79 (65.8)	
≥6	23 (57.5)	17 (42.5)	
Desired final number of children			
1–3	5 (35.7)	9 (64.3)	.026
4–6	53 (32.1)	112 (67.9)	
≥7	8 (53.3)	7 (46.7)	
Undetermined	32 (52.5)	29 (47.5)	
Knowledge of benefits of contraception			
No benefits reported	9 (81.2)	2 (18.2)	.025
1–2 benefits reported	45 (34.9)	84 (65.1)	
3–4 benefits reported	40 (38.1)	65 (61.9)	
5–6 benefits reported	4 (40.0)	6 (60.0)	
Main source of information			
Medical personnel	58 (27.4)	154 (72.6)	<.001
Church	4 (80.0)	1 (20.0)	
Neighbours	31 (96.9)	1 (3.1)	
Radio/television	5 (83.3)	1 (16.7)	
Opinion on contraception			
Not acceptable	34 (91.9)	3 (8.1)	<.001
Acceptable	64 (29.4)	154 (70.6)	

TABLE 4. Factors Not Significantly Associated With Contraceptive Use

Variables	Reported Contraceptive Use Before Current Pregnancy: No n (%)	Reported Contraceptive Use Before Current Pregnancy: Yes n (%)	*P* Value
Occupation			
Farmer	47 (40.2)	70 (59.8)	.211
Employed	9 (42.9)	12 (57.1)	
Traders	26 (44.8)	32 (55.2)	
Other	16 (27.1)	43 (72.9)	
Partner's occupation			
Farmer	33 (49.3)	34 (50.7)	.074
Employed	17 (41.5)	24 (58.5)	
Trader	19 (43.2)	25 (56.8)	
Driver	13 (27.1)	35 (72.9)	
Other	16 (29.1)	39 (70.9)	
Level of education			
Less than primary	42 (38.2)	68 (61.8)	.552
Primary	44 (37.6)	73 (62.4)	
Secondary	8 (36.4)	14 (63.6)	
Tertiary	4 (66.7)	2 (33.3)	
Partner's level of education			
Less than primary	29 (39.7)	44 (60.3)	.118
Primary	50 (35.5)	91 (64.5)	
Secondary	10 (35.7)	18 (64.3)	
Tertiary	9 (69.2)	4 (30.8)	
Marital status			
Married	71 (39.4)	109 (60.6)	.806
Separated	1 (50.0)	1 (50.0)	
Widow	0 (0.0)	1 (100)	
Free union	26 (36.1)	46 (63.9)	
Religion			
Catholic	30 (35.7)	54 (64.3)	.764
Christian, non-Catholic	61 (40.4)	90 (59.6)	
Muslim	7 (36.8)	12 (63.2)	
Other	98 (38.4)	157 (61.6)	

RESULTS

Participant Characteristics

Sociodemographic Characteristics

The mean age of the participants was 32±4.5 years (range, 21–44 years). Most participants were urban residents (n=232, 91.0%) with low incomes and primary-level education or less (n=227, 89.0%).

Parity and Number of Children

The mean parity was 4.2±1.4 (range, 3–10 deliveries). Most women had either 3 (n=120, 47.1%), 4 (n=66, 25.9%), or 5 (n=43, 16.9%) children; 26 (10%) participants had at least 6 children (Table 1).

Participants' Knowledge of the Benefits of Contraception

Participants were asked to mention some benefits of contraceptive use, and the following were the expected responses: contraception leads to (1) improvement of the national economy, (2) better educational opportunities for children, (3) prevention of obstetrical complications, (4) improvement of family finances, (5) improvement of maternal health, (6) and improvement of children's health. Each participant was assigned a score based on the number of benefits she was able to list (Table 2). Regarding knowledge of the benefits of contraception, most women achieved a score of 1 (1 or 2 benefits mentioned; n=129, 50.6%) or 2 (3 or 4 benefits mentioned; n=105, 41.2%).

Contraceptive Use Among Study Participants

Ninety-eight (38.4%) participants reported having never used contraception, 157 (61.6%) had interrupted contraception before the current pregnancy, and 37 (14.5%) were opposed to contraception.

Rates of reported contraceptive use were highest among women aged 30 to 34 years (76 of 106, 71.7%) and those aged 40 to 44 years (6 of 8, 75.0%), and contraceptive use

TABLE 5. Logistic Regression Results for Determinants of Contraceptive Use (N=255)

Variables	n (%)	AOR (95% CI)	*P* Value
Partner's occupation			
Farmer	67 (26.2)	6.82 (2.15–21.5)	.001
Employed	41 (16.1)	3.57 (1.05–12.0)	.041
Trader	44 (17.2)	5.85 (1.62–21.1)	.007
Mechanic agent	48 (18.8)	2.59 (0.71–9.39)	.147
Other	55 (21.5)	1	
Knowledge of benefits of contraception			
No benefits reported	11 (4.3)	8.55 (0.96–75.8)	.054
1–2 benefits reported	129 (50.6)	0.44 (0.10–1.91)	.277
3–4 benefits reported	105 (41.2)	0.69 (0.16–2.85)	.611
5–6 benefits reported	10 (3.9)	1	
Main source of information			
Medical personnel	212 (83.1)	0.10 (0.02–0.45)	.003
Church	5 (2.0)	0.35 (0.01–7.84)	.512
Neighbours	32 (12.5)	14.6 (1.23–173)	.033
Radio/television	6 (2.4)	1	
Opinion on contraception			
Not acceptable	37 (14.5)	43.5 (10.7–177)	<.001
Acceptable	218 (85.5)	1	

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval

was reportedly lowest among participants aged 20 to 24 years (4 of 9, 44.4%) (Table 3). Reported contraceptive use was relatively high among women with a parity of 4 or 5 (79 of 120, 65.8%) and low among participants wishing to have 7 or more children (7 of 15, 46.7%).

Participants with less knowledge of the benefits of contraception were less likely to report contraceptive use (Table 3 and Table 5). Additionally, participants who reported personal acceptance of contraception reported contraceptive use significantly more often than those who were opposed to contraceptive use (adjusted odds ratio 43.5; 95% CI, 10.7 to 177; $P<.001$).

Four variables were significantly associated with the use of contraceptives in the final logistic regression model: partner's occupation, knowledge score regarding the benefits of contraception, the main source of information on contraception, and contraception acceptance (Table 5).

DISCUSSION

Contraception remains the most effective strategy to reduce maternal and neonatal mortality in developing countries, particularly in sub-Saharan Africa.[4] It is also 1 of the 4 pillars of the Safe Motherhood initiative. Most of the determinants of contraceptive use investigated in this study have also been investigated in other developing countries.[12–15]

Knowledge of the advantages of contraception is among the main factors leading to its use,[8] but as the majority of our participants were educated to the primary school level or lower, the lack of knowledge about the benefits of contraceptive use might not be surprising. Similar observations were made in a study investigating high fertility and low contraceptive use among young people in Uganda.[16]

Participants who worked as farmers and traders were less likely to use contraception in our study, compared with the other employment categories. Additionally, women whose

partners were farmers or traders were, respectively, 7 and 6 times less likely to use contraceptives than women with partners in other occupations. Other studies carried out in low- and middle-income countries have established that women with lower levels of formal education and those in the lower and middle social classes are less likely to use contraception than those from high-income households or backgrounds.[17–21] Low literacy rates, poor access to information, and poor health infrastructure are particularly widespread in sub-Saharan Africa. Moreover, it has been reported that traditional African society is structured in such a way that high fertility and large surviving families are often considered economically and socially rewarding, in contrast with modern societies elsewhere.[1,20]

Information sources also play a role in contraception uptake.[22–24] In our study, medical personnel were the most frequently reported source of information about contraception, over neighbours, radio or television, and the Church. In rural Malawi, it has been shown that the media can play a significant role in improving maternal health outcomes when it is community-led and locally driven.[22]

Acceptance of the practice of contraception was the strongest predictor of contraceptive use in our analysis. Approval or disapproval of contraception has previously been reported to be strongly influenced by religion in Burundi; we, therefore, recommend that political authorities and healthcare leaders consider prioritising reproductive health issues, including contraception, in their correspondence and interactions with Burundian religious leaders.[25]

Limitations

This study did not assess participants' knowledge about contraceptive methods, which could have enriched our findings. However, the identified factors provide sufficient scientific value and can be used to inform policy discussions and awareness campaign planning, for example. Moreover, we did not assess men's opinions on contraception or the influence of side effects on contraceptive use in our study population, as we thought that these issues would be better investigated using qualitative methods.

CONCLUSION

This study has contributed to a better understanding of contraceptive use among multiparous women in the study area. Knowledge of the benefits of contraception was among the main factors leading to contraceptive use. Farmers and traders were less likely to use contraception compared with individuals earning a living through other types of work. Medical personnel were the most commonly sought source of information on contraception. Personal acceptance of the practice of contraception was the strongest predictor of contraceptive use. Health policy managers could use these findings to guide interventions promoting contraceptive use.

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ORIGINAL ARTICLE

"Should We Take Them or Leave Them?" A Qualitative Study to Understand the Social, Cultural, and Ethical Issues Associated With the Lifecycle Management of Insecticide-Treated Nets in Tanzania

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ABSTRACT

Background: Insecticide-treated nets (ITNs) are highly effective in reducing morbidity and mortality from malaria. However, it is widely accepted that ITNs – if not re-treated – lose their effectiveness with time and eventually need to be replaced. This study sought to determine the social, ethical, and cultural issues related to the lifecycle of ITNs, which includes net ownership, usage, maintenance, reuse, recycling, disposal, and replacement.

Methods: In this qualitative study, conducted in the districts of Mtwara Rural, Kilombero, and Muheza, Tanzania, we collected information about bed nets, including usage habits, types, treatment status, materials used, brands, acquisition sources, and perceptions thereof. We conducted 23 key informant interviews and 20 focus group discussions with village leaders, other influential people in the community, and district health-care personnel.

Results: ITNs were deemed acceptable and used by most community members in the participating communities. Alternative uses and disposal practices of used bed nets were also common among community members; however, participants had limited knowledge regarding the health and environmental risks associated with these practices. Most participants did not perceive bed net recycling as a sustainable option. Recycling was considered feasible, however, if effective infrastructure for collection and disposal could be established. Poverty was identified as a major driving force towards alternative uses of bed nets. Financial constraints also meant that not all household members were able to sleep under bed nets; pregnant mothers, children under 5 years old, and the elderly were prioritised.

Conclusion: Our findings may inform the National Malaria Control Programme and other stakeholders as they develop country-specific and environmentally friendly bed net replacement strategies. Appropriate strategies will help ensure sustained protection of vulnerable populations against malaria, while considering local social, ethical, and cultural issues related to the recovery of bed nets.

INTRODUCTION

Globally, about 500,000 deaths result from the over 210 million cases of malaria that occur every year, with 90% of both cases and deaths occurring in sub-Saharan Africa.[1,2] While malaria control measures include chemotherapy, chemoprophylaxis, and vector control, insecticide-treated nets (ITNs) are a cost-effective preventative measure that can significantly reduce the incidence of malaria and its associated morbidity and mortality. Bed net use is, therefore, a priority for malaria control in sub-Saharan Africa. In Tanzania, where 77.9% of households have at least 1 bed net, an estimated 7.3% of children aged 6 to 59 months have malaria parasitaemia at any given time.[3]

ITNs approved by the World Health Organization Pesticide Evaluation Scheme are considered effective for 3 to 5 years and should be replaced in a timely manner to maximise their efficacy and contribution to malaria prevention. There is a growing awareness of the potential environmental impact of the increasing number of used and discarded ITNs.[4,5]

As it is widely recognised that ITNs lose their effectiveness with time,[4–10] ITN durability assessments and evaluations must be conducted under various conditions and settings. To address these issues, the World Health Organization released its *Guidelines for Laboratory and Field Testing of Long-Lasting Insecticidal Nets* in November 2005[6] and *Guidelines for Monitoring the Durability of Long-Lasting Insecticidal Mosquito Nets* in 2010.[7] These guidelines can be used by country programmes to assess the durability of distributed ITNs to make informed decisions about which ITNs the programmes ought to procure and how often the ITNs should be distributed. At present, however, the general consensus is that ITNs should be replaced every 3 to 5 years.[5–8]

There is emerging evidence that ITNs are often misused,[5,11–14] although the type and extent of the misuse has not yet been clearly established. Still, documented and anecdotal evidence from monitoring and evaluation activities following ITN distribution campaigns have shown ITNs being used for a range of purposes, including fishing and drying fish in Kenya[12]; protecting a "nursery" (a small crop) in the Solomon Islands[13]; and as ceiling covers, bed covers, room dividers, curtains, tablecloths, and cattle ties in Ethiopia.[14]

While many studies have shown that the most vulnerable household members – particularly, children under 5 years old and pregnant women – are given priority use of available bed nets,[11,14–20] other studies have reported otherwise in some regions.[11] Other programme monitoring activities investigating general knowledge about malaria have shown that heads of household often do not know the treatment status of their nets, do not understand why using a treated net is important, and, therefore, they may not know how to prioritise who gets the "best" net.[13,14,17]

Key factors associated with non-use or incorrect use of ITNs include lack of knowledge and misconceptions about the cause of malaria, educational level, type of net, shape of net (ie, conical vs rectangular), perceived efficacy of the net, perceived danger of malaria, perceived discomfort (increased heat), perceived risk, fear of the insecticide, and "saving the net" for future use.[13–16,18,21–23] The last of these is especially troubling if old nets are no longer effective.

ITNs have been delivered to households through a variety of distribution systems, including the public sector (routine delivery through health facilities, distribution combined with vaccination campaigns, community house-to-house distribution), the private sector (formal and informal markets, social marketing campaigns), and mixed public and private systems. The method through which nets are distributed may affect the success of the campaign, not only in terms of coverage but also in terms of use.[19,20] Effective and efficient delivery mechanisms – coupled with effective information, education, and communication (IEC) and behaviour change communication (BCC) campaigns – are crucial for ensuring population coverage, appropriate use, and proper maintenance of bed nets.[1,14,17,19,23] Increasing net usage by vulnerable persons among net-owning households has been a predominant focus of many IEC/BCC activities. The most successful programmes have been "hang-up, keep-up" campaigns, in which volunteers or health-care workers visit households and demonstrate or assist with hanging up bed nets.[19] If a country was to decide to recollect and recycle used nets, a seamless integration of this activity into existing distribution systems and IEC/BCC campaigns would be paramount.[5] Any decision made to either encourage or discourage a particular use of a net will need to align with IEC/BCC strategies and new directives to ensure they will not jeopardise existing initiatives.

METHODS

Study Design and Data Collection

In this qualitative cross-sectional study, focus group discussions (FGDs) and key informant interviews (KIIs) were used to explore community practices regarding the use or misuse of bed nets; perceptions about net expiry, disposal, and environmental and health risks; and community acceptability of alternative disposal strategies.

Study Setting

The study was conducted in the 3 districts of Mtwara Rural, Kilombero, and Muheza in Tanzania. The districts were selected based on their high bed net coverage and malaria rates.[3,25–28]

Mtwara Rural (Latitude: 10°16' S, Longitude: 40°10'6'' E) is among the 5 districts of the Mtwara Region of Tanzania. It is bordered to the south by Mozambique, to the west by the Tandahimba District, to the north by the Lindi Region, and to the east by the Mtwara Urban District and the Indian Ocean. According to the 2012 Tanzania National Census, the population of the Mtwara Rural District was 228,003.[24] Most of the residents are from the Makonde and Makua tribes. The area of the Mtwara Rural District is 3,597 km^2, and the district is administratively divided into 6 divisions, 17 wards, and 101 villages.[26] It has no hospital, but there are 28 dispensaries and 4 health centres. Villages involved in the study included Msijute, Imekuwa, and Naumbu. An estimated 78.8% of the households in Mtwara Rural have at least 1 ITN, and about two-thirds of the population sleeps under mosquito nets.[3]

Kilombero (Latitude: 8°31' S, Longitude: 37°22' E) is the name of a river and a district in Morogoro Region, southwestern Tanzania. The district is situated in a vast floodplain between the Kilombero River to the southeast and the Udzungwa Mountains to the northwest. Across the southeast side of the Kilombero River, the floodplain is part of Ulanga District. The population of Kilombero District in 2012 was 407,880.[24] The main ethnic groups are the Wapogoro, Wandamba, Wabena, and Wambunga. The area is predominantly rural, with the semiurban district headquarters in Ifakara. The majority of villagers are subsistence

farmers of maize and rice. Villages visited for the study were Michenga, Mahutanga, Idete, and Ihanga. Mean bed net coverage in Kilombero District was recently estimated to be 44%.[27]

Muheza (Latitude: 5°10' S, Longitude: 38°46' E) is among the 8 districts of Tanga Region. It is bordered to the north by Kenya, to the east by the Tanga District and the Indian Ocean, to the south by the Pangani District, and to the west by the Lushoto and Korogwe Districts. In 2012, the population of the Muheza District was 204,461.[24] Muheza has 1 hospital, 4 health centres, and 44 dispensaries.[28] The malaria prevalence in the district is about 17%, and the mean bed net coverage is about 39%.[28] We surveyed the villages of Magila, Ubembe, and Kilulu.

Participant Recruitment

We conducted 23 KIIs, with village leaders, influential people, opinion leaders, and district health personnel. We purposively selected key informants according to their strategic positions in policy and decision-making processes for malaria prevention and control interventions. In each district, we purposively selected 6 key informants: (1) district malaria control programme coordinator, (2) district medical officer, (3) district executive director, (4) Health Management Information System focal person, (5) Expanded Programme on Immunization focal person, and (6) district health secretary.

We conducted 23 FGDs with separate groups for adult men and women. Eight groups were from Kilombero, 8 were from Mtwara Rural, and 7 were from Muheza. This was done to facilitate more freedom and flexibility during the discussions. Each FGD session consisted of between 5 and 12 participants aged 18 years and older.

Data Collection

Social scientists from the National Institute for Medical Research facilitated the KIIs and FGDs. The FGDs lasted between 50 and 72 minutes, and the mean duration of the KIIs was 34 minutes. All interviews and FGD sessions were tape-recorded. Unless otherwise stated, all KIIs and FGDs were conducted in Kiswahili, which is Tanzania's official language and is spoken by over 80% of the population. The research team was flexible, however, and allowed participants to express their views using other languages, such as English, if they preferred.

All participants provided oral or written informed consent after receiving an explanation of the study rationale and procedures, including their right to withdraw from the study at any time.

Data Analysis

The data collected from the FGDs and KIIs were transcribed verbatim by social scientists who were not involved in any of the study's prior activities. We used thematic content analysis, whereby we combined and inductively coded the transcribed notes with handwritten notes composed during KIIs and FGDs. We then used the codes to map out the relationships between themes to produce a thorough synthesis of the data.

To a certain extent, data analysis was an iterative process whereby some initial analysis was conducted concurrently with data collection. When an issue emerged that was not addressed by the interview guide, we added this emerging content to the interview guide and followed it up in the subsequent interviews. The central themes that finally emerged and were included in our analysis were: mechanisms for net distribution, community practices regarding net use and misuse, alternative uses, and disposal practises after net expiry. We did not use computer software for data analysis.

Ethical Approval

This study received clearance from the National Institution for Medical Research and approval from district executive officers in the participating districts.

RESULTS

Net Distribution and Coverage

The majority of participants received their bed nets during bed net distribution activities conducted by the National Malaria Control Programme (NMCP) in 2011. Children under 5 and pregnant women were given first priority during the mass distribution campaigns. In a few instances, elderly villagers were also prioritised. A few participants reported that they bought their bed nets, and a few others stated that they received nets from relatives or friends. Most of the freely distributed nets were of the Olyset and DawaPlus brands. All surveyed districts reported similar varieties of net distribution mechanisms. These included existing supply infrastructures, such as the Expanded Programme on Immunization.

> *We have a known structure of distributing nets. . . and I think it is all uniform in the country because campaigns are always top down. It is the responsibility of the DMOs [district medical officers] to organise which best suit the time and plan of distributing nets in the household. After that, village leaders are mobilised, and they are the ones to organise distribution points, as they well know their administrative boundaries.* (Female, district health official, 46 years old, Kilombero District, KII)

In all villages, participants considered bed net coverage to be high because each household was reported to have at least 1 bed net. The number of bed nets in each household varied with the number of beds or other sleeping points and family sizes.

> *Currently, everyone uses bed nets, unlike old times.* (Male peasant, 38 years old, Mahutanga Village, Kilombero District, FGD)

People are now aware: if you don't use a bed net you and your family are in danger. We use the nets. (Female, 42 years old, Naumbu Village, Mtwara Rural District, FGD)

According to some participants, for the bed nets that were distributed via a government scheme, whether mass or universal, priority was given to children under 5, pregnant women, and sometimes the elderly:

First priority... pregnant women then children... especially when bed nets were insufficient... the rest later... but remember that even older persons were sometimes given free nets. (Male, district health official, 52 years old, Muheza District, KII)

Bed Net Preferences

Preferences for specific bed net types and brands depended on their perceived effectiveness. The main issue that was singled out by many interviewees and FGD participants was the nets' ability to prevent mosquito bites and malaria, which was considered a major cause of morbidity and mortality in many households. Many participants had a common perception that Olyset bed nets have larger mesh spaces, which allow mosquitoes to penetrate. Bed net quality, associated by participants mainly with how easily a net can be torn, was also a critical factor influencing preference. The majority of key informants and FGD participants reported that some net brands were undesirable because they could easily be torn to create holes for easy penetration by mosquitoes.

Participants reported that bed net colour preferences, particularly blue and green, were greatly influenced by availability in their villages. Suppliers, especially those distributing free or subsidised bed nets, often provided blue and green bed nets. Some participants preferred coloured nets because they are not easily soiled or stained with dirt and dust and, therefore, do not need to be washed as frequently as white bed nets.

People prefer green nets... they do not like white nets because of the issue of cleanliness... hence you find most nets here are blue and green. (Male, 40 years old, Magila Village, Muheza District, FGD)

When do People Stop Using Nets?

During FGDs, varied opinions were expressed regarding when to stop using nets. Some participants stated that people should stop using nets when they are worn out and during seasons when mosquito numbers are low.

From August until this December, if you walk to all households, nets are hanged – no nets are used. (Male, 49 years old, Msijue Village, Mtwara Rural District, FGD)

Alternative Uses of Bed Nets

Participants reported several alternative uses of bed nets seen in their villages, including making fences, protecting chickens from predators, and fishing activities. Very few bed nets were regarded as waste in the participating communities. Participants from Mtwara reported particularly diverse uses; old nets were used as shades for vegetable gardens and others fitted as latrine walls.

Most FGD participants from Muheza District agreed that totally worn-out nets should be thrown away or burned because they were useless.

Those nets you see in the garbage [pointing to discarded nets] cannot serve any useful purpose. You can neither use them for sleeping under nor for any beneficial alternative. (Male, district health official, 41 years old, Muheza District, KII)

Participants believed in other personal protection measures as the best strategies to prevent malaria. Among these were using treated damaged nets as curtains.

Normally, damaged nets have bigger holes and are ineffective for preventing entry by mosquitoes; they, however, can function better when used as curtains. (Male, 33 years old, Magila Village, Muheza District, FGD)

Common Practices for Bed Net Disposal

Several net disposal practices existed in the participating communities. The most commonly reported practices were disposing of or burning worn-out bed nets along with other household waste. In villages participating in free net distribution campaigns, residents reported being advised to pack expired nets into bags before returning them to collection teams.

Bed Net Collection

In view of the perceived environmental and health risks associated with bed net disposal, participants described alternative, organised bed net removal strategies. As long as the removal was accompanied by provision of new or better bed nets, participants reported that communities were ready to hand over even relatively intact nets.

Community preferences for net collection included designating a specific drop-off location within the community and assigning an organisation to facilitate the optimal collection and replacement strategies based on community members' input and needs. FGD participants and key informants unanimously agreed that – according to how the administrative system is organised – wherever bed nets must be collected, health facilities and village offices are appropriate collecting venues, and health facility management and village leaders should supervise the process.

We have agreed here that waste nets that are no longer in use should be collected, how?... We have health centres, dispensaries, and village offices – these are the best places where nets not in use may be collected. Leaders of these institutions should lead the exercise, but for those living far away from these centres, we have leaders within their localities who may help with collecting and bringing waste nets

to the proposed collection centres. (Male, district health official, 52 years old, Kilombero District, KII)

Community Acceptability of Bed Net Removal and Recycling

Although community members were willing to surrender their bed nets for recycling, incentives – either in the form of monetary compensation at the price of a new net or a net replacement – were mentioned as expectations or necessities. Some participants contended that a lack of compensation or failure to replace old nets could lead to reduced bed net usage. Moreover, it was stated that collectors encounter difficulties and resistance when bed net collection is arranged without the intention of replacement or compensation.

People won't be happy... it will affect the net usage negatively, as not all people will be able to buy their own nets, and it will be bad, as people will have started to protect themselves and suddenly nets are taken away ... there will be nothing to motivate them. (Female, 36 years old, Idete Village, Kilombero District, FGD)

Bed Net Recycling and its Association With "Good" Alternative Uses

Due to low levels of knowledge among community members about the best alternative uses and disposal methods for bed nets, as well as limited alternative use options for worn-out nets, many participants did not associate net recycling with "good" alternative uses. They insisted that nets are properly used when they are new and capable of protecting people from mosquito bites and nuisance; only after bed nets are used for protection against mosquitoes should they then be relegated to an alternative use. However, nets that were too worn out to protect users from mosquitoes were often considered too worn out for alternative uses.

A net is assigned another use, for example fishing or protecting chicks from predators, only when users convince themselves that it can no longer protect them from mosquito bites. (Male, district health official, 43 years old, Muheza District, KII)

There was general agreement among participants that it is abnormal for new bed nets to first be used for purposes other than mosquito protection and malaria prevention, only to later fulfil their intended function.

A new net cannot be assigned alternative uses because somehow people are aware of the importance of using nets for protecting household members from mosquito bites and malaria. In addition, many people cannot afford to buy a new net every time they need one – because of poverty... so they rely on those nets which are distributed for free or those obtained through a subsidised voucher system [Hati Punguzo]*... In this regard, it is very unlikely to expect a new net to first be used for alternative purposes and later be used as a bed net proper.* (Male, 44 years old, Kilulu Village, Muheza District, FGD)

Risks and Benefits of Alternative Uses of Old Bed Nets

The participants reported a diverse set of perceptions about the environmental and health-related risks and benefits associated with alternative uses of old nets, with consensus among participants predominating over disagreement. Most key informants and FGD participants reported that the perceived lack of risk was associated with a lack of adequate knowledge among community members about health and environmental hazards associated with alternative uses of bed nets.

What most people know, and especially what they hear from the radios, is that nets will protect them from mosquito bites and, thus, malaria.... Even in health facilities, we have not seen anything educating us on how to keep nets after they are no longer used as mosquito protectors... we have not gotten any information regarding the relationships between net use, health, and the environment... So it is difficult for community members to stop doing "business as usual." They will keep disposing of old nets conventionally in garbage pits or burn them, as they do with other household waste. (Female, district health official, 37 years old, Mtwara Rural District, KII)

Alternatively, many participants asserted that community members might be aware of the potential environmental and health risks but are not informed of the best ways to deal with old nets as special waste. Participants reported that most community members believed that discarding nets in garbage pits or burning them like any other type of waste are the normal and preferred disposal methods.

A few key informants claimed that some community members were aware of the health and environmental risks associated with alternative uses and improper disposal of used nets and emphasised the community's perception that:

Materials used to manufacture most of the ITNs can hardly be decomposed and thus pose an environmental threat to the soil ecology. (Male, district health official, 54 years old, Muheza District, KII)

Community Perceptions of the Presence of Insecticides in Bed Nets

Participants expressed worries about the presence of insecticides in bed nets and their carrier bags. Most commonly, FGD participants across all sites wondered if the insecticides that impregnated the nets can kill mosquitoes and others insects, what were their effects on humans, especially if people inhale these chemicals? Such worries and potential hazards of ITN use led participants to call for authorities to conduct effective community sensitisation and health education campaigns to address these issues.

These bed nets have chemicals that kill mosquitoes and other insects, and we are told that they can last for about 5 years. Our worry is that sometimes the bed nets' plastic bags have further domestic reuse. What will now happen to the users of these bags if they are not properly disposed of? (Male, 49 years old, Ihanga Village, Kilombero District, FGD)

DISCUSSION

Malaria still poses a threat to public health and socioeconomic well-being among populations in endemic countries. Over time, ITNs gradually become less effective and worn, and must be regularly re-treated or replaced. This study sought to investigate ITN use and misuse among residents of 3 districts in Tanzania, which were selected because of their high rates of ITN coverage. We also explored perceptions related to net expiry and disposal, the associated environmental and health impacts, and community acceptability of alternative disposal strategies.

Net Coverage and Usage

Bed net coverage and usage rates were high in the participating communities, especially among pregnant women and children under 5. This was partly attributable to the general bed net distribution that is organised by the NMCP that had taken place just prior to the study period. Additionally, the NMCP, through the National Voucher Scheme that was initiated in Tanzania in 2004, has targeted pregnant women and their infants for subsidised ITN allocations via voucher distribution at antenatal clinics.

Our study findings suggest that appropriate net usage and coverage may be enhanced by the presence of effective collection and waste disposal mechanisms. The majority of our study participants emphasised that organised incentive-based systems for the removal or collection of old nets would be used if people were assured that they would receive new nets; they would have no reason to continue hanging worn-out and tattered ITNs.

Community Misconceptions Regarding ITN Use

Several studies have reported fears and misconceptions associated with ITN use, particularly related to potential harm caused by the chemicals used to treat the nets.[29–31] Many participants expressed worry about the consequences of using ITNs in extreme heat, and some participants were concerned about a possible link between ITN use and impotence or infertility. Participants also reported mild side effects, such as skin rashes, among people who might have been allergic to the insecticide. Studies elsewhere have demonstrated that sociocultural beliefs among community members have important bearings on peoples' decisions to use or not use bed nets.[23,29,30] To dispel these fears and misconceptions, it should be made clear to all bed net users and recipients that the chemicals used for ITNs kill and repel mosquitoes but are safe for humans when used correctly.

Bed Net Preferences

A key policy implication suggested by these findings is that authorities should design and implement strong and effective quality control and monitoring strategies to make sure that manufacturers produce nets of the required standard, which appeal to not only those who pay for production and distribution but also to end users.

Our findings revealed that individual households may have had up to 3 or more new and unused nets, which did not match bed sizes or were considered incompatible with household sleeping arrangements.

Bed Net Disposal

International and national malaria control stakeholders have emphasised increasing bed net coverage and usage among populations at risk of malaria infection.[4,18] However, there is limited empirical evidence on net disposal practices in communities that benefit from malaria control interventions, such as bed net distribution. Furthermore, there are no comprehensive international or national policy guidelines regarding what community members are supposed to do with worn-out ITNs. The majority of community members in our study were not aware of how to properly dispose of used nets, leading them to improper disposal practices associated with environmental and health risks through pollution.

Bed Net Recycling and Its Association With "Good" Alternative Uses

Bed net recycling has been demonstrated as a feasible and needed option for sustainable management of long-lasting insecticidal nets, especially when they have lost their efficacy in protecting humans from mosquito bites and malaria infection.[4,5] This study demonstrated that community members are willing to participate in efforts to maximise appropriate alternative uses of old ITNs, and the findings have called attention to the fact that ongoing mosquito net campaigns have not seriously considered packaging information about the proper management of used nets. Participants reported a low level of knowledge about the best ways to dispose of nets or reuse them for other purposes.

Moreover, there were reportedly limited options regarding what nets should be used for after they are declared waste. Because of this shortcoming, the majority of participants did not associate net recycling with "good" alternative uses, especially after nets were declared as waste. Like many countries in sub-Saharan Africa, Tanzania lacks adequate waste disposal infrastructure, and the existing waste management laws are either weak or lack adequate enforcement mechanisms. It is, therefore, difficult to institutionalise incentives to motivate widespread sensitisation about health and environmental issues related to proper management of waste, including used bed nets.

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ORIGINAL ARTICLE

Prevalence of Sickle Cell Disease Among Anaemic Children Attending Mbeya Referral Hospital in Southern Tanzania

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ABSTRACT

Background: Sickle cell disease (SCD) is a common genetic haematological disorder present in most countries in sub-Saharan Africa. In Tanzania, between 50% and 75% of the children born with SCD die before reaching the age of 5 years. The objective of this study was to determine the prevalence of SCD in children under 5 years of age attending Mbeya Referral Hospital between March and April 2014.

Methods: We conducted a hospital-based, cross-sectional, descriptive study in which 50 children under 5 were included at Mbeya Referral Hospital in southern Tanzania. Full blood counts were conducted using SYSMEX KX 21 and SYSMEX XT 2000i haematology analysers. The presence of haemoglobin S was determined using the sodium metabisulfite sickling test on blood samples with haemoglobin levels less than 10 g/dl.

Results: Blood samples from 50 infants and children under 5 were tested for sickle cell anaemia. Of these, 9 (18%) participants were found to be sickling test positive, 5 (55.6%) of whom were male and 4 (44.4%) were female. Almost half (n=4, 44.4%) of the SCD-positive children were between 25 and 36 months old, while the rest were between 13 and 24 months (n=2, 22.2%), 37 and 48 months (n=1, 11.1%), and 49 and 60 months (n=2, 22.2%) of age.

Conclusion: At our facility, among children under 5 with serum haemoglobin levels <10 g/dl, the prevalence of SCD was 18%. This might pose a substantial public health challenge in the region. More and larger studies are needed to help map out the sickle cell burden throughout the country to guide policy and management strategies.

INTRODUCTION

Sickle cell disease (SCD) is the most common hereditary condition that affects the structure of haemoglobin. The abnormal sickle-shaped structure that is characteristic of SCD occurs as a result of a person inheriting either 1 (heterozygous AS) or 2 (homozygous SS) sickle cells genes from their parents. Haemoglobin SS (HbSS) homozygosity, the most severe form of sickle cell anaemia, leads to a structural variation of the haemoglobin globin chains, particularly beta (β)-globin chains, making them polymerise upon deoxygenation, which can lead to vaso-occlusion in the microcirculation and subsequent ischaemia, pain, and tissue damage.[1]

SCD poses considerable public health challenges,[2,3] particularly in sub-Saharan Africa – a region also characterised by a high burden of malaria.[4,5] Worldwide, over 300,000 children are born with a sickled haemoglobin (HbS) disorder each year.[6] Sub-Saharan Africa has the greatest burden of SCD, with more than 70% of the 300,000 global cases occurring in the region.[7–9] Projected estimates indicate that the number of newborns with SCD will exceed 400,000 by 2050.[5]

In HbS, the structural β-globin polypeptide gene experiences a substitution mutation on the codon for the sixth amino acid (GAG to GTG), which leads to an amino acid substitution of valine for glutamic acid at position 6 of the 146-amino-acid polypeptide chain.[3] This causes crystallisation and polymerisation of the abnormal HbS as a result of deoxygenation during normal oxygen transport processes.[10] The red blood cells carrying this abnormal haemoglobin gradually become sickle-shaped and are thus unable to pass through microcapillaries. The trapped cells cause vaso-occlusion, which in turn leads to a repeated cycle of ischaemia and reperfusion.[11] Sickle cells are also susceptible to mechanical damage, which can lead to chronic haemolytic anaemia, and recurrent crises can cause end-organ damage.[12]

Distribution of SCD in Africa

The sickle cell trait and malaria exhibit a similar geographic distribution, owing to the evolutionary link between the 2 entities. Sickle cell trait is known to protect against the development of severe *Plasmodium falciparum* malaria, which explains the high frequency of the sickle cell gene in African regions most affected by *P. falciparum* malaria.[8] The protective benefits of the sickle cell trait are most consequential during early childhood, because this is a crucial development period, and it is when humans are most at risk of mortality from severe malaria. Sickle cell carriers are more likely to escape childhood mortality from malaria and, therefore, subsequently pass the abnormal haemoglobin gene to their offspring. Although a single abnormal gene is protective against *P. falciparum* malaria, the inheritance of 2 abnormal genes leads to SCD and does not confer such protection.[4,8] Additionally, many of the complications of SCD are severe and life-threatening, and many individuals with the disease die before reaching reproductive age.[9]

Public Health Impact of Sickle Cell Disease in Children

SCD accounts for about 5% of deaths among African children under 5, including more than 9% of under-5 deaths in West Africa and up to 16% in individual West African countries.[9]

Makani and colleagues, in 2011, reported 5.7% mortality among children with SCD in Dar es Salaam, Tanzania. The factors that were strongly associated with death among these children included low haemoglobin levels and high total and conjugated bilirubin levels, with the highest incidence of death being reported among children under 5.[7]

Treating SCD involves therapy with hydroxyurea, a ribonucleotide reductase inhibitor, which is given as a daily oral dose to prevent the acute or chronic complications of the disease.[14] Despite this, SCD remains difficult to treat, with the only potential cure being haematopoietic stem cell transplantation, the use of which is limited by its high cost and difficulties with human leukocyte antigen compatibility.[15]

Administration of prophylactic antibiotics to all infants diagnosed with SCD is recommended, as these children are more likely to suffer from bacterial infections, especially those caused by *Streptococcus pneumoniae*.[16]

Weatherall reported that individuals carrying the HbAS genotype are protected against malaria and that severe malaria is more likely to occur in homozygous (HbSS) individuals as well as in normal healthy people (HbAA).[17] Malaria infection increases the risk of ischaemic crises and childhood morbidity and mortality.[18,19] In the deoxygenated condition, HbS has poor solubility, forming polymers in red cells leading to changes in the red cell membrane and metabolism, causing the cells to become rigid and distorted with a sickle shape. The sickled cells haemolyse easily, adhere to vascular endothelium and one another, block small blood vessels, and become sequestered in the spleen.[20]

Regionally, in 2010, an estimated 79% of newborns with SCD were in sub-Saharan Africa, and this proportion is expected to increase to 88% by 2050.[5] Muoneke et al reported that SCD and malaria were significantly associated with severe anaemia among children under 5 in South East Nigeria.[21]

In Tanzania, the frequency of HbAS is estimated to be around 13%, and there are about 8,000 annual births of homozygous HbSS children, compared to 302 in Jamaica and 1,500 in the United States, for example.[7] It is also estimated that between 50% and 75% of the 8,000 Tanzanian children born with SCD die before the age of 5 years. In 2013, Simbauranga et al reported a 21% SCD prevalence among paediatric patients with anaemia in Mwanza, Tanzania. Severe paediatric anaemia was associated with SCD in this study, wherein 34 (11%) of 309 patients showed homozygous inheritance (HbSS) of SCD, while 31 (10%) patients were heterozygous (HbAS).[22]

Therefore, in this study, we sought to investigate the prevalence of SCD among children below 5 attending Mbeya Referral Hospital (MRH) in the Southern Highlands Zone of Tanzania.

METHODS

Study Design and Setting

We conducted a hospital-based, cross-sectional study at MRH, which is a 477-bed tertiary health-care facility that has been operating as the referral centre for the southern part of Tanzania since 1985. MRH serves a catchment population of over 6 million, and it has extensive infectious disease medical clinics, inpatient services, training facilities, and a referral clinical laboratory. MRH covers the regions of Ruvuma, Rukwa, Iringa, Njombe, Katavi, and Mbeya.

Participant Criteria

Children under 5 who presented with haemoglobin levels less than 10 g/dl were eligible and screened for SCD.

Data Collection

We collected data for this study over 2 months, starting in March 2014 and targeted children whose physician-requested laboratory investigations included a full blood count or haemoglobin determination. We did not inspect the clinical data because we only aimed to estimate the prevalence of SCD among children with low haemoglobin levels. Once the full blood count was done, we looked at children with low haemoglobin levels (less than 10.0 g/dl) and classified them, based on local population-validated reference ranges, as having moderate (7 to 9.99 g/dl) or severe (<7 g/dl) anaemia.

We obtained parental written informed consent before collecting venous blood specimens, by standard venepuncture procedures, into a 2 ml K_3 or K_2 EDTA tubes, which were sent to the MRH clinical laboratory. Thin blood films were prepared from EDTA-anticoagulated venous blood and stained with 5% Giemsa for morphological examination. For patients found to be anaemic or showing a red cell distribution width greater than 20%, a peripheral smear evaluation was done followed by a sickle cell test. Full blood counts were determined using the SYSMEX KX 21 and SYSMEX XT 2000i haematology analysers (Sysmex Corporation, Japan). Sickling tests were performed using the 2% sodium metabisulphite-based haemoglobin deoxygenation method. EDTA-anticoagulated blood was placed on a slide and mixed with 2% sodium metabisulphite, covered with a cover glass, and then incubated at room temperature for 20 minutes and examined for sickling. All positive results were reported at the first examination, and the negative samples were re-examined once per hour for 3 hours then incubated overnight and examined the following day if still negative.

Quality Control and Quality Assurance

All laboratory investigations were done at the MRH laboratory, which is accredited by the Southern African Development Community Accreditation System. The hospital operates under high quality control standards. All reagents were checked for expiry dates and reconstituted according to the manufacturer's instructions. Daily maintenance checks were conducted to ensure proper functioning of the instruments. Quality control runs for haematological analysers were done daily before running patient samples using tri-level control (low, normal, and high). Known sickle cell-positive and negative samples were used as controls for the sickling tests.

Ethical Consideration

We obtained permission to conduct this study from the MRH administration and the regional medical officer, through Tumaini University, Makumira Kilimanjaro Christian Medical University College, Office of the Dean, in the Faculty of Medicine. The guardian or caretaker of each participant provided informed consent. Participation was voluntary and did not affect the care provided to the patients.

Data Analysis

A single data collector entered the data, which were checked for accuracy by another individual. The analysis was done using Statistical Software for Social Sciences (SPSS), version 20 (IBM Corp., Armonk, NY, USA). Descriptive statistics (means, medians, standard deviations, and proportions) were estimated.

TABLE 1. Age Categories and Sex Distribution of Study Participants (N=50)

Age (Months)	Males n (%)	Females n (%)	Total n (%)
1–12	9 (18)	11 (22)	20 (40)
13–24	7 (14)	5 (10)	12 (24)
25–36	5 (10)	3 (6)	8 (16)
37–48	3 (6)	2 (4)	5 (10)
49–60	1 (2)	4 (8)	5 (10)
Total	**25 (50)**	**25 (50)**	**50 (100)**

RESULTS

Sociodemographic Characteristics

We enrolled 50 children, 25 females and 25 males, with ages ranging from 1 to 60 months and a mean age (± standard deviation [SD]) of 22.82 ± 18 months (Table 1).

Prevalence of Sickle-Cell Anaemia by Age and Sex

We tested 50 blood samples for SCD, among which 9 (18%) were positive for SCD. Of the 9 children found to be sickle cell-positive, 5 (55.6%) were males and 4 (44.4%) were females. The age and gender distributions of the children with SCD are displayed in Table 2.

Haemoglobin Levels

Forty-two (84%) children had haemoglobin levels between 6.0 and 9.9 g/dl; the rest had haemoglobin levels below 6.0 g/dl (Table 3). Four (44.4%) of the 9 children with SCD had haemoglobin levels between 6.0 and 9.9 g/dl, and 5 (55.6%) had haemoglobin levels below 6.0 g/dl. The mean haemoglobin level for children with SCD was 6.4 g/dl, compared with 8.1 g/dl among children who had a negative sickle cell test result.

DISCUSSION

This cross-sectional study aimed to estimate the prevalence of SCD in southern Tanzania. We report a high prevalence (18%) of SCD among anaemic children under 5 in this population, which is similar to prevalence reports from eastern Uganda and Qatif, Saudi Arabia, of 17.5% and 17.9%, respectively.[23,24] However, the prevalence observed in our study was higher than the 3% reported for sub-Saharan Africa.[25] The prevalence reported in this study may have been higher because of the small sample size and the selection of only children with low haemoglobin values. However, this prevalence may not deviate substantially from reality, based on the

TABLE 2. Sickle Cell Test Results by Age and sex Categories of the Study Participants (N=50)

	Sickling Test		
Age (Months)	**Positive n (%)**	**Negative n (%)**	**Total n (%)**
1–12	Male: 0 (0) Female: 0 (0)	12 (24) 8 (16)	20 (40)
13–24	Male: 2 (4) Female: 0 (0)	6 (12) 4 (8)	12 (24)
25–36	Male: 2 (4) Female: 2 (4)	2 (4) 2 (4)	8 (16)
37–48	Male: 0 (0) Female: 1 (2)	3 (6) 1 (2)	5 (10)
49–60	Male: 1 (2) Female: 1 (2)	2 (4) 1(2)	5 (10)
Total	**Male: 5 (10) Female: 4 (8)**	**25 (50) 16 (32)**	**50 (100)**

TABLE 3. Haemoglobin Levels by Age Category (N=50)

	Haemoglobin Level		
Age (Months)	**0-5.9 g/dl n (%)**	**6.0-9.9 g/dl n (%)**	**Total n (%)**
1–12	4 (8)	16 (32)	20 (40)
13–24	2 (4)	10 (20)	12 (24)
25–36	0 (0)	8 (16)	8 (16)
37–48	0 (0)	5 (10)	5 (10)
49–60	2 (4)	3 (6)	5 (10)
Total	**8 (16)**	**42 (84)**	**50 (100)**

occurrence of sickle cells recorded in routine patient care laboratory tests.

SCD positivity was most frequently detected among children aged between 25 and 36 months in this study. Haemoglobin levels below 5 g/dl were most frequently encountered in children between 1 and 12 months of age; surprisingly, none of these children tested positive for SCD. Many of the severely anaemic children may have had iron-deficiency anaemia, malaria, or other causes of haemolysis common among children. This would imply that low haemoglobin should not necessarily be associated with sickle cell anaemia in this population. We also might have missed some children with SCD as a result of our choice to target low haemoglobin levels as the starting point of our SCD screening.

In this study, the prevalence of SCD among males was slightly higher than the prevalence among females, with a ratio of 1.25:1. Similarly, a study conducted in a rural hospital in central India reported a slightly higher prevalence among males (1.07:1),[26] compared to findings in Saudi Arabia, where SCD was reported to occur at a ratio of 1:1 between males and females.[27] The preselection of low haemoglobin levels could have been the cause of this slight variation.

The mean haemoglobin level among sickle cell-positive children was 6.5 g/dl, which was similar to what was reported from a cohort of children with SCD at the Red Cross Children's Hospital in Cape Town, South Africa.[28] In our study, 34% of children were severely anaemic (haemoglobin <7 g/dl), which is a slightly lower prevalence of severe anaemia than the 39% reported from a community-based study conducted in southeastern Tanzania.[29] This difference might be because children in southeastern Tanzania are more at risk of acute malaria and, therefore, have higher rates of severe anaemia. The risk of mortality is high with low haemoglobin levels, as previously reported by a surveillance study in Tanzania.[7]

Limitations

The study period was short, limiting the study to the few patients who visited the hospital during the study period. Likewise, resource limitations, particularly those related to funding the student who carried out this study as part of his bachelor's degree in health laboratory sciences, may have affected our sample size. It is possible that we failed to detect SCD in some patients because we did not use haemoglobin electrophoresis in this study. Despite these limitations, we managed to recruit children with SCD, which was a target of the study.

CONCLUSION

Our study found that the prevalence of SCD in children under 5 in the southern highlands of Tanzania was high at 18%. Larger studies may help to map out the sickle-cell burden among the various regions of the country, which, in turn, will help better inform the planning of management and control strategies. Future studies are needed to determine if newborn screening and early identification may complement early preventive measures to improve quality of life.

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ORIGINAL ARTICLE

Prevalence of *Plasmodium falciparum* and *Salmonella typhi* Infection and Coinfection and Their Association With Fever in Northern Tanzania

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ABSTRACT

Background: *Plasmodium falciparum* and *Salmonella typhi* are major causes of fever in the tropics. Although these infections are caused by different organisms and are transmitted via different mechanisms, they have similar epidemiologic and clinical features. This study aimed to determine the prevalence of *S. typhi* and *P. falciparum* infections and their associations with fever at 2 sites in Northern Tanzania.

Methods: This was a community-based, cross-sectional study, conducted from February to June 2016, involving 128 randomly selected individuals, aged between 1 and 70 years. Sixty-three (49.2%) participants were recruited from Bondo Ward, Tanga Region, and 65 (50.8%) were recruited from Magugu Ward, Manyara Region. Blood samples were collected by venepuncture into sterile microtubes. Detection of pathogen DNA was achieved via a multiplex real-time polymerase chain reaction assay. Data analysis was done using Stata, version 14. Prevalence data were presented as numbers and percentages, and chi-square analysis was used to assess associations. *P* values of .05 or less were considered statistically significant.

Results: Of 128 participants, 31 (24.2%) and 17 (13.3%) tested positive for *P. falciparum* and *S. typhi* infection, respectively. Of the 63 participants from Bondo, 31 (49.2%) had *P. falciparum* parasitaemia. None of the participants from Magugu tested positive for *Plasmodium* parasitaemia. *S. typhi* bacteraemia was detected in 11 (17.5%) of 63 and 6 (9.2%) of 65 participants in Bondo and Magugu, respectively. *P. falciparum–S. typhi* coinfection was only detected in Bondo (n=6, 9.5%). Age was the only variable that showed a significant association with both *P. falciparum and S. typhi* infection; falling within the 5- to 9-year or 10- to 15-year age groups was associated with both infections (X^2=2.1; *P*=.045). Among the 30 patients with *Plasmodium* parasitaemia, 7 (23.3%) had fever, whereas 2 (12.5%) of 16 patients infected by *S. typhi* had fever. *P. falciparum* infection (X^2=12.4, *P*<.001) and *P. falciparum–S. typhi* coinfection (X^2=5.5, *P*=.019) were significantly associated with fever, while *S. typhi* infection alone was not.

Conclusion: *S. typhi* and *P. falciparum* were considerably prevalent in the area. One-third of the *P. falciparum–S. typhi* coinfected individuals in Bondo had fever. *P. falciparum* infection was an important contributor to febrile illness in Bondo. In the presence of coinfections with *P. falciparum* and *S. typhi*, the use of malaria rapid diagnostic tests should be emphasised to reduce irrational use of medications.

INTRODUCTION

In the investigation of fever in the tropics, 2 important diagnoses to be ruled out are typhoid fever and malaria. Both cause significant morbidity, mortality, and economic loss. Despite the progress in controlling salmonellosis globally, typhoid fever remains a public health problem in several parts of the world. Despite a reported decline in incidence in many countries, the disease is still widespread, particularly in South Asia and sub-Saharan Africa, as a source of significant morbidity, mortality, and economic losses.[1,2] The World Health Organization (WHO) estimates the global typhoid fever disease burden at 11 to 20 million cases annually, resulting in about 128,000 to 161,000 deaths per year.[3] Malaria affects

about 1 billion people each year, out of which 1 to 3 million die. In the tropics, *S. typhi* and *Plasmodium falciparum* are the most endemic pathogens,[1,4] causing typhoid fever and malaria, respectively. The 2 diseases are associated with poverty and underdevelopment, making them more prevalent in underdeveloped countries.[5,6] Although these diseases are caused by vastly different organisms transmitted via different routes of infection – 1 is a gram-negative bacillus transmitted via the faecal–oral route, and the other is a protozoan transmitted via the bite of an insect vector – typhoid and malaria share similar clinical and epidemiologic features.

Typhoid fever control efforts have included the establishment of the Typhoid Fever Surveillance in Africa Program (TSAP) in 2009 – a network of 13 sentinel sites in 10 sub-Saharan African countries – created to generate high-quality, contemporary, and standardised data on the incidences of typhoid fever and invasive nontyphoidal salmonellosis in sub-Saharan Africa.[7] The overarching aim was to produce the evidence required to support policy makers in introducing prevention efforts against invasive *S. typhi* infections – in particular, the introduction of safe and effective typhoid fever vaccines into routine immunisation programmes. TSAP has achieved this ambitious target, finding high incidences of typhoid fever in both rural and urban populations in several countries in sub-Saharan Africa. The results of TSAP will dictate the direction of future typhoid fever research and control endeavours in Africa, and at last provide a key piece of the disease burden jigsaw puzzle.[7]

Malaria control in Tanzania has been significantly scaled up in the past decade. The Tanzanian National Voucher Scheme (TNVS) has expanded the availability and accessibility of insecticide-treated nets (ITNs), particularly for children and pregnant women, by subsidising costs of bed nets for about a decade now.[8] Parallel to this are other similar programmes aimed at strategically controlling malaria, such as the National Insecticide Treated Nets (NATNETS) Tanzania "Under-five Catch-up Campaign" and "Universal Coverage Campaign", which have contributed to an effective integrated malaria control environment through increased ITN use, subsidised tests, artemisinin-based medicines, and massive community sensitisation initiatives.[9] The net result of these strategies has been a reduction in malaria incidence and child mortality rates in Tanzania.[8]

In malaria-endemic areas, the clinical presentation of patients in the early stages of typhoid fever is challenging because it is similar to numerous other causes of febrile illness, such as malaria. Of all symptoms, persistent fever is a prominent source of difficulty when narrowing down the differential diagnosis list.[10] In most resource-limited tropical settings, definitive laboratory diagnosis of concurrent malaria and typhoid fever is based on blood smear microscopy for malaria and the Widal test or bacterial culture for salmonellosis.

Although the introduction of malaria rapid diagnostic testing (mRDT) has reduced the diagnostic dilemma of patients presenting with fever, challenges exist that limit the use of mRDT, including the logistical challenges involved in increasing coverage to areas not accessible by road. Nonetheless, many endemic countries in sub-Saharan Africa have adopted mRDT to expand parasitological-based malaria diagnosis capacity.[10,11] The WHO recommends that malaria treatment be based on diagnostic test results, but this directive has yet to gain universal acceptance. This recommendation will become particularly important as the incidence of malaria decreases, as it will become more important to distinguish cases of malaria from other febrile illnesses.[12]

Despite efforts invested in the diagnosis of malaria and typhoid fever coinfections, it is concerning that diagnostic challenges continue to hinder effective malaria and typhoid control in the tropics. This is due to a combination of factors, including the nonspecific clinical presentations of the diseases, the high prevalence of asymptomatic infections in many areas, the lack of resources and insufficient access to trained health-care providers and facilities, and the widespread practice of self-treatment for clinically suspected malaria or typhoid fever.[13–15] Unfortunately, there is a paucity of epidemiologic data regarding the extent of coinfection with *P. falciparum* and *S. typhi* in many parts of Africa, including Tanzania. Such data could assist clinicians to make more informed decisions when patients present with symptoms that pose a diagnostic dilemma.

We designed this study to provide baseline epidemiologic data on the prevalence of *P. falciparum*–*S. typhi* coinfections in 2 areas of Northern Tanzania for which *S. typhi* prevalence has not previously been determined. These data will provide useful baseline information that will clarify the magnitude of *P. falciparum*–*S. typhi* coinfection and facilitate reasonable diagnostic and prescribing decisions.

METHODS

Study Design

This community-based, cross-sectional study, which aimed to determine the prevalences of *P. falciparum* and *S. typhi* infection and coinfection and their associations with fever, was conducted from February to June 2016, in Bondo Ward, Tanga Region, and Magugu Ward, Manyara Region, in Northern Tanzania.

Study Sites

The 2 sites are located about 600 km apart and were selected based on their differing locations, climatic conditions, malaria transmission intensities, and the absence of data on prevalence of *S. typhi* infections in these areas. Magugu is located at 4°12' S and 35°45' E and is about 1,392 m above sea level. Bondo is about 309 m above sea level at 5°22'60" N and 38°34'60" E. The natives of both areas are agropastoralists with moderate human–animal interaction. Both areas have 2 rainy seasons per year, with a long rainy season between February and May and short rainy season between

October and December. The long rainy seasons are usually followed by high numbers of reported fever cases.[11,16,17]

Study Population

Study participants consisted of children and adults, aged 1 year and above, who were residents of the study sites, Bondo and Magugu, for at least 6 months and consented to participate in the study.

Sample Size

The minimum sample size for prevalence determination was estimated using the Epi Tools online sample size calculator and the following formula: $[Z^2p(1-p)]/c^2$, where Z=1.96 for the 95% confidence level, p=the expected true proportion of (9.0%) and c=the minimal tolerable error at the 95% confidence level (0.05). This formula yielded a minimum sample size of 126. We enrolled 128 participants. Following community sensitisation activities, community members were invited to participate, and those who met the enrolment criteria were consecutively recruited into the study until the desired sample size was attained.

Data Collection and Diagnostic Procedures

A short questionnaire was used to obtain demographic information. Fever was defined as an axillary body temperature ≥37.5°C. Thick and thin blood smears for malaria microscopy were prepared as described elsewhere.[18,19] Briefly, blood samples of 0.5 to 1 ml were collected into sterile tubes by venepuncture from all consenting participants, and about 10 µl of whole blood was used for mRDT (SD BIOLINE® Malaria Ag P. f/Pan, Suwon City, South Korea) and microscopy. These procedures were carried out by a trained laboratory technician. For each consenting participant, 1 ml of whole blood was aseptically collected into ethylenediaminetetraacetic acid (EDTA) vacutainer tubes. The tubes were shipped to the local laboratory in dry ice and later sent to the Kilimanjaro Christian Research Institute's biotechnology laboratory and stored at –20°C for laboratory analyses. For the purposes of this study, malaria parasitaemia (*P. falciparum* infection) was defined by detection of *P. falciparum* using a real-time polymerase chain reaction (RT-PCR) assay, regardless of the presence of fever or other clinical symptoms. mRDT and microscopy were done to aid clinical decision making and management.

Children under 5 years of age who were found to be malaria-positive by mRDT were treated with antimalarials according to national and WHO guidelines. Adults with fever and positive mRDT results were treated with artemether-lumefantrine, the first-line antimalarial drug in Tanzania. Severe paediatric cases were referred to the nearby district hospital in Korogwe District. Participants who were found to have salmonellosis were appropriately managed with ciprofloxacin according to national guidelines.

DNA Extraction

DNA extraction and purification were done using QIAamp DNA Mini Kits (Qiagen, Valencia, CA, USA) according to the manufacturer's instructions. A 200 µl aliquot of blood was lysed by QIAGEN protease and bound to a QIAamp membrane by centrifugation according to the manufacturer's instructions. The wash buffers, AW1 and AW2, were sequentially used to remove residual contaminants to improve the purity of the DNA. The purified DNA was then eluted from the QIAamp membrane using buffer AE (Qiagen, Valencia, CA, USA) and stored at –20°C ready for the RT-PCR assay.

Detection of *P. falciparum* and *S. typhi* by RT-PCR

The RT-PCR assay was carried out in an Applied Biosystems ViiA™ 7 Real-Time PCR system (Thermo Fisher Scientific, Waltham, MA, USA). The Master Mix kit for Tropical Fever Core (Fast Track Diagnostics, Luxembourg) was used to prepare the reaction mix. For a single reaction, 12.5 µl of FTD buffer, 1.5 µl of tropical fever primers and probe mix, and 1µl of enzyme mix were placed into single MicroAmp Optical 8-Tube Strips (Thermo Fisher Scientific, Waltham, MA, USA), compatible with the ViiA™ 7 Real-Time PCR system, followed by 10 µl of sample. The same was done for all samples, the positive control, and the extracted negative control. The detection of pathogens was done at wavelengths of 520 nm for *P. falciparum* Tropical Fever 1 Primers and Probes and 620 for *S. typhi* Tropical Fever 2 Primers and Probes in the Master Mix of the Tropical Fever Core kit (Fast Track Diagnostics, Luxembourg). The positive, negative, and internal controls used in this assay were commercially prepared by Fast Track Diagnostics. The positive control contained plasmids for the detection of *P. falciparum* and *S. typhi*. The negative control contained lysis buffer, and the internal control contained *Streptococcus equi*, which was also used as an extraction control. At the end of the run, amplification plots were reviewed in order to adjust the threshold line above all the background noise, as per the manufacturer's instructions.

Data Processing and Statistical Analysis

Data were analysed using Stata, version 14 (StataCorp, College Station, TX, USA) and categorised into demographic (age, sex, residence) and clinical (body temperature and prevalence of *P. falciparum* and *S. typhi* infections) variables. The participant age groups for analysis were: <5 years, 5 to 9 years, 10 to 15 years, and above 15 years. Descriptive statistics were used to summarise the demographic and clinical characteristics of study participants. The chi-square (X^2) test was used to determine associations between categorical data. Fisher's exact test was used in cases when expected counts were less than 5. A 2-tailed *P* value of .05 or less was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Kilimanjaro Christian Medical University College Research Ethical Review Committee (certificate of clearance #2030). Permission was also obtained from community and local authorities. Written informed consent was obtained from each participant before enrolment, and legal guardians consented for minors. Access to the data – which were anonymised – was restricted to the research team.

RESULTS

Demographic and Clinical Characteristics

Demographic data are presented in Table 1. A total of 128 participants were enrolled, with almost equal enrolment from each site: 63 (49.2%) participants from Bondo and 65 (50.8%) from Magugu. About two-thirds (n=85, 66.4%) were females, and a similar proportion (n=83, 64.8%) were above 15 years old. There were 21 (16.4%) children younger than 5 years of age. Few participants (n=10, 8.1%) were found to have fever at the time of the survey.

TABLE 1. Demographic and Clinical Characteristics (N=128)

Variable	n (%)
Sex	
Male	43 (33.6)
Female	85 (66.4)
Site	
Bondo	63 (49.2)
Magugu	65 (50.8)
Age, years	
<5	21 (16.4)
5–9	17 (13.3)
10–15	3 (5.5)
>15	83 (64.8)
Fever status[a]	
No	114 (91.9)
Yes	10 (8.1)

[a] There were 4 missing entries for fever status (n=124).

Prevalence of *P. falciparum* and *S. typhi* Infection and Coinfection

Table 2 shows both the overall and site-specific prevalences of *P. falciparum* and *S. typhi* infection. Sixty-three participants were screened for *P. falciparum* infection in Bondo, of whom 31 (49.2%) had malaria parasitaemia, in contrast with the absence of *P. falciparum* parasitaemia in Magugu. The prevalences of *S. typhi* infection in Bondo and Magugu were 17.5% and 9.2%, respectively. The prevalence of *P. falciparum–S. typhi* coinfection was 9.5% in Bondo, and – with no cases of coinfection in Magugu – the overall coninfection prevalence was 4.7%.

Association of *P. falciparum* and *S. typhi* Infection With Demographic Characteristics

Table 3 shows findings related to the associations between *P. falciparum* and *S. typhi* infection and participant demographic variables. When data from both sites were combined, only age was significantly associated with *S. typhi* infection (X^2=2.1; *P*=.045), with 17.6% and 28.6% of the participants in the 5- to 9-year and 10- to 15-year age groups testing positive for *S. typhi* infection, respectively. Children younger than 5 years had the lowest prevalence of *S. typhi* infection. There was no association between *S. typhi* infection with either participant sex or study site.

Similarly, there was a strong association between *Plasmodium* infection and age (X^2=18.2; *P*<.001), with the 5- to 9-year and 10- to 15-year age groups having parasitaemia prevalences of 57.9% and 57.1%, respectively. The participants aged >15 years had the lowest prevalence of *P. falciparum* infection. We did not find any association between *P. falciparum* infection and sex.

Factors Associated With *P. falciparum–S. typhi* Coinfection and Fever

Table 4 shows that the associations between *P. falciparum–S. typhi* coinfection and sex, age, and study site were all not statistically significant.

Table 5 shows the analysis findings related to the associations between various factors and fever. Seven (23.3%) of 30 participants with *P. falciparum* parasitaemia had fever, compared with only 2 (12.5%) who had fever among the 16 participants who tested positive for *S. typhi* infection. *P. falciparum* infection was associated with fever (X^2=12.4; *P*<.001), and no association was found between *S. typhi* infection and fever. Among the 6 participants with *P. falciparum–S. typhi* coinfection, 2 (33.3%) had fever (X^2=5.5; *P*=.019). Fever was most prevalent among 5- to 15-year-olds (X^2=17.44, *P*<.001). There was no association between sex and fever.

DISCUSSION

The high prevalence of pathogens that cause overlapping clinical signs and symptoms, particularly fever, poses a serious challenge in diagnosing and managing febrile illness. This is particularly true in resource-poor countries, such as

TABLE 2. Prevalences of *Plasmodium falciparum* infection, *Salmonella typhi* infection, and *P. falciparum–S. typhi* Coinfection

Variable	Prevalence		
	Bondo (n=63) n (%)	Magugu (n=65) n (%)	Overall (N=128) n (%)
***P. falciparum–S. typhi* coinfection**			
Negative	57 (90.5)	65 (100)	122 (95.3)
Positive	6 (9.5)	0 (0.0)	6 (4.7)
***S. typhi* infection**			
Negative	52 (82.5)	59 (90.8)	111 (86.7)
Positive	11(17.5)	6 (9.2)	17 (13.3)
***P. falciparum* infection**			
Negative	32 (50.8)	65 (100)	97 (75.8)
Positive	31 (49.2)	0 (0.0)	31 (24.2)

Tanzania, where the diagnostic infrastructure is constrained. Diagnoses are frequently provisional in the absence of adequate confirmatory tests, and it is, therefore, a common practice that antimicrobials are irrationally prescribed, leading to serious consequences, including the development of antimicrobial resistance.[20,21] This scenario justifies the application of high-throughput and highly sensitive molecular tools to determine the causes of diseases with overlapping clinical signs and for proper management of febrile illness.

About half of the participants in Bondo had *P. falciparum* parasitaemia. This finding represents an increase in malaria parasitaemia prevalence compared with what has been observed in the past decade, during which time significant shifts have been reported. In 2009, the *P. falciparum* parasitaemia prevalence was 32.8% in the rainy season[22]; the prevalence dropped to 12% in 2011,[12] with a further drop to 8.6% in 2013.[23] However, a recent survey conducted in Bondo in 2016 reported a prevalence of 20.5%.[18] In the absence of studies to explain the observed fluctuations in malaria prevalence in the study area, a number of explanations can be proposed regarding the outcomes of malaria control efforts implemented in the studied areas, including seasonal differences at the times when data were collected for the respective studies.

In the past decade, the TNVS, implemented by the Tanzanian government, has contributed to a significant reduction in malaria through increasing the availability and accessibility of ITNs mainly targeting children and pregnant women.[8] Other initiatives, such as the NATNETS Tanzania "Under-five Catch-up Campaign" and "Universal Coverage Campaign", have complemented the TNVS.[9] These initiatives have contributed to a substantial reduction in the incidence and prevalence of malaria in Tanzania, as reported by recent studies.[8,9] However, a substantial impact on the disease burden has not been sustained. Challenging obstacles preventing optimal malaria control persist, including poor access to health care, poor performance of health service delivery, poor availability of proper diagnosis and treatment services, increased drug resistance, and high costs of health-care services.[15] The increased malaria prevalence in Bondo suggests the possibility of a breakdown of malaria control strategies in the area. Support for malaria control at both the national and district levels has increased considerably over the past few years. The low prevalence of *P. falciparum* infection in Magugu has been reported for about a decade,[11,20,24] likely because Magugu serves as an experimental study site for a national pesticide research institute.[25]

The prevalence of *S. typhi* infection in Bondo was high, with about one-fifth of the population testing positive for *S. typhi*, while in Magugu, about one-tenth of individuals were found to be infected with *S. typhi*. Previous studies have reported a similar uneven distribution of *Salmonella* infection, with the occurrence of invasive nontyphoidal salmonellosis more common in areas with high malaria transmission rates, while *S. typhi* is reportedly common in areas with low rates of malaria transmission.[26] Wide variations in the prevalence of *S. typhi* infection have been reported in different parts of Tanzania and elsewhere in sub-Saharan Africa.[19,27,28]

Participants between 5 and 15 years of age had the highest *S. typhi* infection prevalence in this study – an observation that was statistically significant. *S. typhi* infection was not associated with sex or study site. It has been reported that the most common dietary protein sources in Tanzania include milk,

TABLE 3. Association Between *Plasmodium falciparum* and *Salmonella typhi* Infection With Age, Sex, and Study Site

Infection Type	Variable	*S. typhi* Test Result: Negative n (%)	*S. typhi* Test Result: Positive n (%)	Total n	X^2 (*P* Value)
S. typhi infection	**All subjects**	111 (86.7)	17 (13.3)	N=128	
	Age, years				
	<5	19 (90.5)	2 (9.5)	21	2.1 (.045)
	5–9	14 (71.4)	3 (17.6)	17	
	10–15	5 (71.4)	2 (28.6)	7	
	>15	73 (88.0)	10 (12.0)	83	
	Sex				
	Female	73 (85.9)	12 (14.1)	85	0.2 (.70)
	Male	38 (88.4)	5 (11.6)	43	
	Site				
	Bondo	52 (82.5)	11 (17.5)	63	1.9 (.17)
	Magugu	59 (90.8)	6 (9.2)	65	
		***P. falciparum* Test Result: Negative n (%)**	***P. falciparum* Test Result: Positive n (%)**		
P. falciparum infection	**All subjects**	97 (75.8)	31 (24.2)	128	
	Age, years[a]				
	<5	14 (66.7)	7 (33.3)	21	18.2 (<.001)
	5–9	8 (47.1)	9 (57.9)	17	
	10–14	3 (42.9)	4 (57.1)	7	
	>15	72 (86.8)	11 (13.3)	83	
	Sex				
	Female	64 (75.3)	21 (24.7)	85	0.03 (.86)
	Male	33 (76.7)	10 (23.3)	43	
	Site				
	Bondo	32 (50.8)	31 (49.2)	63	[b]
	Magugu	65 (100)	0 (0.0)	65	

[a] Fisher's exact test performed.
[b] Statistical analysis not performed because 1 of the sites had a prevalence of 0 (0.0%).

TABLE 4. Factors Associated With *Plasmodium falciparum* and *Salmonella typhi* Coinfection

Variable	*Plasmodium–Salmonella* Coinfection		Total n	X^2 (*P* Value)
	Negative n (%)	Positive n (%)		
All subjects	122 (95.3)	6 (4.7)	N=128	
Age, years[a]				
<5	20 (95.2)	1 (4.8)	21	4.3 (.10)
5–9	15 (88.2)	2 (11.8)	17.0	
10–14	6 (85.7)	1 (14.3)	7	
>15	81 (97.6)	2 (2.4)	83	
Sex[a]				
Female	81 (95.3)	4 (4.7)	85	0.0 (1.0)
Male	41 (95.4)	2 (4.6)	43	
Site				
Bondo	57 (90.5)	6 (9.5)	63	[b]
Magugu	65 (100)	0 (0.0)	65	

[a] Fisher's exact test performed.
[b] Association test not performed because 1 of the sites had no cases of coinfection.

eggs, and meat, with urban dwellers consuming more of these products than rural inhabitants.[29] These types of food are known important risk factors for human salmonellosis worldwide.[30] Although the consumption of these foods is generally low in Tanzania, efforts have been made to ensure that school-aged children consume milk countrywide.[31] Whether sanitary precautions are strictly observed or not, this could serve as a possible source of *S. typhi* infection in this age group, especially in periurban sites like Bondo. We found that malaria parasitaemia was most prevalent among participants between 5 and 15 years of age. A shift in burden of infection from being more prevalent among children under 5 to being more prevalent among school-aged children has recently been reported.[18] In the absence of objective data to explain this shift, we speculate that because most malaria interventions over the past decade have targeted children under 5 and pregnant mothers,[8,9] our findings reflect a reduction of immunity to malaria among older children, who were previously targeted by rigorous malaria control interventions when they were below 5 years of age. For both *S. typhi* and *P. falciparum*, individuals older than 15 years had the lowest infection rates, most likely explained by the build-up of specific immunity to these infections.

The prevalence of *P. falciparum–S. typhi* coinfection was low (4.7%), and coinfection occurred only in Bondo, where the malaria parasitaemia prevalence was high. Despite the low coinfection rate, there are important implications for the coinfected individuals. There is accumulating epidemiologic and preclinical evidence supporting a causal association between malaria and nontyphoidal salmonellosis.[32] However, the clinical characteristics and consequences of *P. falciparum–S. typhi* coinfection are not well documented, although mortality associated with coinfection has been reported to be higher than that associated with malaria alone.[32]

We found that nearly a quarter of individuals with *P. falciparum* infection in Bondo had fever, implying a significant contribution of *P. falciparum* infection to the development of fever. Besides that, 12.5% of participants with *S. typhi* infection had fever, reflecting an important contribution of *S. typhi* to the burden of febrile illness in the area. One-third of individuals coinfected with *P. falciparum* and *S. typhi* had fever.

We presume that the remaining three-quarters of afebrile participants with *P. falciparum* infection were asymptomatic carriers. However, our findings do not rule out infection with other causes of fever that we did not test for. This possibility is supported by the findings of a previous study conducted in Magugu, where more than two-fifths of patients were clinically misdiagnosed as having malaria even though only less than 1% of blood films were confirmed *P. falciparum*-positive.[11] Testing for a wider range of fever-causing pathogens would yield more specific findings to inform diagnostic and management guidelines for febrile illnesses. Our findings underscore the urgency of developing appropriate guidelines for the diagnosis and treatment of *P. falciparum–*

TABLE 5. Association of Fever With Demographic Characteristics and Infection *With Plasmodium falciparum, Salmonella typhi*, or Both (N=124)

Variable	Fever Status[a]		X^2 (*P* Value)
	Fever[b] n(%)	No Fever n (%)	
***P. falciparum* infection**			
Positive	7 (23.3)	23 (76.7)	12.4 (<.001)
Negative	3 (3.2)	91 (96.8)	
***S. typhi* infection**			
Positive	2 (12.5)	14 (87.5)	0.5 (.48)
Negative	8 (7.3)	101 (92.7)	
***P. falciparum–S. typhi* Coinfection**			
Positive	2 (33.3)	4 (66.7)	5.5 (.019)
Negative	8 (6.7)	111 (93.3)	
Residence			
Bondo	10 (16.1)	52 (83.9)	[c]
Magugu	0 (0.0)	62 (100.0)	
Age[d]			
<5	3 (15.8)	16 (84.2)	17.4 (<.001)
5–9	5 (29.4)	12 (70.6)	
10–15	1 (14.3)	6 (85.7)	
>15	1 (1.2)	80 (98.8)	
Gender			
Male	5 (12.8)	34 (87.2)	1.7 (.19)
Female	5 (5.9)	80 (94.1)	

[a] There were 4 missing entries for fever status (n=124).
[b] Fever was defined by axillary temperatures ≥37.5°C.
[c] Association test not performed because 1 of the sites had no cases of coinfection.
[d] Fisher's exact test performed.

S. typhi coinfection, as clinicians commonly dismiss the possibility of multiple infections during an initial patient visit. In attempts to implement an intensive malaria control programme in Tanzania, the Ministry of Health has launched a widely advertised Kiswahili slogan: "*Siyo kila homa ni malaria*", literally translated as, "Not every fever is malaria". This slogan not only reminds patients to avoid self-medication, it also reminds clinicians to carefully consider mixed infections when patients present with generic symptoms, such as fever and headache.

RECOMMENDATIONS AND CONCLUSION

We report a prevalence of *P. falciparum–S. typhi* coinfection of 9.5% in Bondo, and we detected no coinfection in Magugu. One-third of the coinfected individuals in Bondo had fever. *P. falciparum* infection was an important contributor to the febrile illness burden in Bondo. Magugu was free from *P. falciparum* infection during the study period. Considering the presence of coinfections with *P. falciparum* and *S. typhi*, we recommend emphasising and enforcing the use of mRDT to reduce irrational use of medications. We also recommend the scale-up of typhoid fever diagnostic tools to underserved areas of Tanzania to help distinguish between malaria and typhoid fever.

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ORIGINAL ARTICLE

Demographic Factors Driving Schistosomiasis and Soil-Transmitted Helminthiases in Milola Ward, Lindi District, Tanzania: A Useful Guide for Launching Intervention Programmes

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ABSTRACT

Background: Current information on the distribution of and risk factors for schistosomiasis and soil-transmitted helminthiases is scarce for most areas of southern Tanzania, including Milola Ward in Lindi District. This study was initiated to establish the status of these infections in Milola Ward and to assess how they vary with demographic factors.

Methods: From September to October 2014, 2 sets of stool and urine samples were collected from residents of Milola Ward. The Kato–Katz technique was used to examine stool samples for faecal-borne parasites, and the filtration technique was used to examine urine for urinary schistosomes. A total of 195 individuals aged 5 to 90 years were enrolled in the study; 190 (97%) participants submitted adequate urine samples, of whom 107 (56%) were female and 83 (43%) were male. Of the 195 participants who took part in the initial sampling exercise, 158 (81%) provided adequate stool samples; 121 (77%) of these were adults, and the rest (n=37, 23%) were children. Only 53 urine and 26 faecal samples were obtained in the second round of sampling, and due to marked inconsistencies, these have been excluded from the analysis. Mean parasite abundance was analysed for its association with demographic factors, such as age and sex.

Results: Three varieties of parasite were detected, namely, *Schistosoma haematobium* in 44 (23%) of 190 urine samples, hookworms in 12 (8%) of 158 stool samples, and *Trichuris trichiura* in 6 (4%) of 158 stool samples. The difference in *S. haematobium* prevalence between male and female participants (27 of 107 females, 25% vs 17 of 83 males, 20%) was not statistically significant (Kruskal–Wallis test, $P=.47$). Linear regression analysis of *S. haematobium* infection with age showed a significant association, with children having higher infection intensities than adults ($P<.001$). *S. haematobium* prevalence and intensity did not vary significantly between villages (intensity [Kruskal–Wallis test], $P=.95$; prevalence, $P=.88$).

Discussion: These data confirm that in this setting, the mean age of peak helminthiasis prevalence decreases as transmission pressure increases, with non-school children below 18 years old being most at risk of acquiring parasitic infections. This was the first baseline survey of parasitic infections in Milola Ward, so the results will be crucial for guiding control efforts against parasitic diseases in the area.

INTRODUCTION

Schistosomiasis and soil-transmitted helminthiases are among the major neglected tropical diseases.[1] Schistosomiasis, caused by parasitic worms of the genus *Schistosoma,* is endemic in 78 countries, most of which are in sub-Saharan Africa.[2] About 200 million people are estimated to have schistosomiasis, while 800 million are at risk of acquiring the disease.[3,4] On the other hand, recent estimates indicate that soil-transmitted helminths (STHs) infect even more people, with over 800 million being infected with *Ascaris lumbricoides,* 465 million with *Trichuris trichiura,* and around 400 million with hookworms (*Necator americanus* and *Ancylostoma duodenale*).[5] Schistosomiasis and soil-transmitted helminthiases occur mostly in the poorest parts of the world,

where they have profound negative effects on the welfare and productivity of the affected people. Infection with STHs impairs growth and cognitive development, particularly among children, resulting in poor educational achievements and reduced productivity.[6]

There are 2 forms of schistosomiasis. One of them is urinary schistosomiasis (caused by *S. haematobium),* which initially leads to haematuria and can have severe effects on the organs of the urogenital system, including the bladder, urethra, uterus, and vagina.[7] The other form is intestinal schistosomiasis, which can be caused by any of the other 4 major schistosome species that infect humans, namely, *S. mansoni*, *S. japonicum*, *S. menkongi,* and *S. intercalatum.* Intestinal schistosomiasis can cause abdominal pain, diarrhoea, stunted growth, and impaired cognitive abilities in children.[1,2,8,9] Chronic infections can also damage internal organs, such as the liver, spleen, and gallbladder.[2]

Both *S. mansoni* and *S. haematobium* exist in Tanzania, with marked focal variations in endemic areas.[10–14] Recent estimates indicate that *S. mansoni* infection is most prevalent around the Lake Victoria basin, while *S. haematobium* infection is distributed along the coast of the Indian Ocean as well as the inland areas and hinterland of Lake Victoria.[14,15] While *S. mansoni* is more focal and virtually absent in the coastal regions and on the Unguja and Pemba islands, *S. haematobium* is widespread in the country, including on the isles.[15,16] Estimates in 1977 indicated that 19% of the people in Tanzania were at risk of acquiring schistosomiasis,[11] while recent reports suggest that by 2010, about 23 million Tanzanians were infected with schistosomiasis, representing an overall prevalence of 53.3%.[17] Even higher schistosomiasis prevalence rates have been reported in recent years in some areas.[14,18] Despite that, current and adequate information on the distribution of schistosomiasis and soil-transmitted helminthiases is not available for most of Tanzania, particularly in Lindi District in the south of the country.[15,18] As a result, information on the burden of schistosomiasis for most areas, including Milola Ward in Lindi District, has been based mainly on hospital reports.[11,15] Such information is liable to inaccuracy and unreliability due to poor recording and lack of random sampling,[19] and the data may not be useful for designing effective disease control programmes.[20] Brooker and colleagues[15] conducted a countrywide survey on the distribution of schistosomiasis in Tanzania from 1980 to 2009 and indicated that schistosomiasis was most likely endemic to Lindi Region, although no field assessment was made on the local distribution of the disease in the region. Building on that situation, this study applied standard field epidemiological techniques to investigate the current status of schistosomiasis and produce up-to-date data on schistosomiasis at the focal level in Milola Ward, southeastern Tanzania. Information on the health status of Milola Ward, particularly of children and other at-risk sections of the population would help guide development programmes, including educational, community welfare, and livelihood support programmes in the area. The results obtained will enhance the understanding of schistosomiasis and soil-transmitted helminthiases in these areas and contribute useful information for controlling the diseases. Furthermore, for control and prevention of morbidity due to schistosomiasis, the World Health Organization (WHO) recommends regular treatment for at-risk groups with praziquantel.[21] Since identifying the high-risk populations and establishing treatment frequency both depend on the prevalence of infection,[21,22] such data are important for guiding treatment and control priorities. This study is also in line with the Tanzanian government's current programme to improve the health and welfare of its people through the control and elimination of infectious diseases, particularly neglected tropical diseases, such as schistosomiasis and soil-transmitted helminthiases.[23] This was the first baseline survey of parasitic infections in Milola Ward. Thus, the results will be crucial for guiding control efforts for parasitic diseases in the area. The transmission of schistosomiasis and soil-transmitted helminthiases is largely determined by host characteristics, such as sex, age, immunity, and economic status as well as the environmental factors, which include temperature, rainfall, humidity, landscape, and land use patterns.[24] This study investigated the possible influence of both the host (age and sex) and the environment factors (village location) to obtain a true picture of the patterns of schistosomiasis and soil-transmitted helminthiasis in the study area.

Objectives

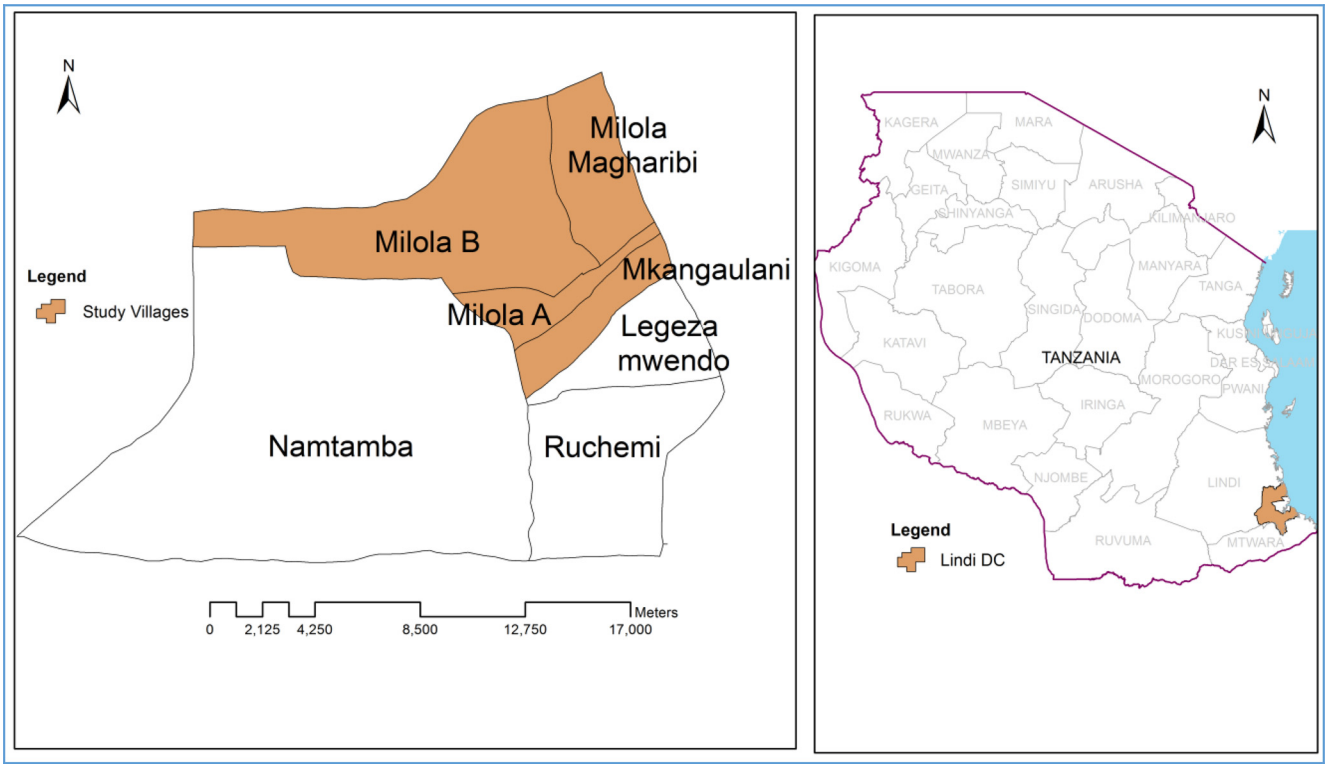
The study's main objective was to produce baseline information about infections caused by schistosomes and STHs (geohelminths) in Milola Ward. The specific objectives were (1) to determine the infection prevalence and intensity of *S. mansoni, S. haematobium,* and STHs among 250 residents of Milola Ward by the end of the study period; (2) to establish the influence of locality on schistosome transmission in Milola Ward by the third quarter of the study period; and (3) to determine the variation of schistosome infection between children and adults, and between males and females in Milola Ward by the third quarter of the study period.

METHODS

Study Area

This study was conducted in Milola Ward located in Lindi Rural District in Lindi Region, southeastern Tanzania (Figure 1). Milola Ward is a rural area inhabited mostly by farmers. The ward was selected for this study because it is among the areas in Tanzania lacking current information on the levels of schistosomiasis and other helminth infections.[14,15,18] At the time of study initiation, the only control and preventive measures against schistosomiasis and soil-transmitted helminthiases in the study area were the school-based annual mass drug administration (MDA) programmes and the occasional

FIGURE 1. Maps of Tanzania Indicating the 4 Milola Ward Study Villages and the Location of Lindi District in Southeastern Tanzania



distribution of antihelminthics to adults during government-organised neglected tropical disease campaigns, which this study aimed to promote. Milola Ward is also a focal site for the Michigan State University–Tanzania Partnership Program,[25] which funded the study. The ward is administratively divided into 7 villages. However, only 4 of them – Milola A, Milola B, Milola West (Magharibi), and Mkanga Ulani – were covered in the present study, while the 3 villages of Namtamba, Legezamwendo, and Ruchemi were left out due to inaccessibility (Figure 1). For each included village, all subvillages (*Vitongoji* in Kiswahili) were included in the sampling. A summary of the estimated population sizes for each village, based on the 2012 National Census report, is shown in Table 1.

Study Design

A sample size of 250 participants was taken for the study. This was based on the WHO recommendation that 250 participants are considered sufficient for studies seeking to establish baseline data on the prevalence and intensity of schistosomiasis and soil-transmitted helminthiasis in a homogeneous geographical area.[24] A homogeneous area in this context is defined as an area with similar climate, humidity, ecology, and soil conditions[24] (Figure 1). This sample size allows for comparison of results with other studies, which would be useful for assessing the success of control programmes.[24] Although about 63 participants would be sampled from each village to make the recommended sample size of 250, we enrolled a higher number of participants (n=85) from each village, assuming around a 30% to 40% dropout rate due to attrition or non-compliance.[26] Systematic sampling was applied by selecting every third household in each studied village. A set of 2 stool samples and 2 urine samples was requested from each participant. This study was only conducted during the dry season due to limited resources. Participants testing positive for schistosomiasis or a soil-transmitted helminthiasis were referred to Milola Health Centre for treatment.

Inclusion and Exclusion Criteria

Participants were included and excluded based on criteria published elsewhere.[27,28] All residents of each selected household were sampled except school children, who were excluded because they had just been treated with praziquantel and antihelminthic drugs as part of the Tanzanian

TABLE 1. Number of Residents and Study Participants in Milola Ward, as per 2012 Population and Housing Census

Village	Total Residents n	Male Participants n	Female Participants n	Total Participants n
Namtamba[a]	798	–	–	–
Milola A	3,347	19	32	51
Milola B	1,508	14	11	25
Milola West (Magharibi)	976	25	45	70
Mkanga Ulani	1,647	27	22	49
Legezamwendo[a]	729	–	–	–
Ruchemi[a]	612	–	–	–
Total	**9,617**[b]	**85**	**110**	**195**

[a] Not sampled due to inacessibility.
[b] 9,616 in 2012 census report.

government's programme against schistosomiasis and soil-transmitted helminthiases in primary schools. Only people aged between 5 and 90 years who were presumed to be active enough to be at a reasonable risk of acquiring parasites were eligible to be included in the study. Children aged less than 5 years were deemed to be at lower risk of contracting schistosomiasis and geohelminthiases and were excluded from the study, although infant infections have been documented.[29] Adults over 90 years and seriously ill people who would not be physically able to participate in the study were also excluded. Other excluded groups included pregnant women and new residents of the study area to avoid infections imported from elsewhere. Moreover, to avoid reporting false prevalence data, adults and non-school children treated with praziquantel or albendazole within the previous month were also excluded from the study. Participants were asked about this information during the enrolment exercise and responses were entered into a questionnaire.

Only participants granting informed consent (oral or written) were enrolled in the study. On the sampling day, participants were counselled on the goals of the study and the implications of their participation. Full information was provided to the participants on the study's benefits and risks in Kiswahili, the language widely spoken in the area. It was explained to them clearly that they were free not to participate in the study and that they could withdraw from it at any time without seeking permission. Full consent was sought, and those agreeing to participate were asked to sign a consent form or indicate consent orally. For minors (children), consent was sought from their parent or guardians, and in situations where a child refused participation, he or she was excluded from the study.

Sample Collection and Examination

Sample collection and examination was conducted from September to October 2014. Sampling materials were distributed to each participant, and instructions about stool and urine collection procedures were provided (Photo 1). The materials included a wooden spatula for picking up stool, 2 plastic vials (120 ml) for depositing stool and urine, respectively, and a polythene bag for storing the vials. The vials for depositing stool and urine samples were labelled with the participant's name, sex, village, and subvillage, as well as the collection date. The materials were distributed on the morning of the first day and collected by members of the study team on the morning of the following day. Two sets of sampling materials were distributed to each participant on 2 days separated by a 7-day interval. Participants were instructed to collect urine between 10:00 and 14:00, as these are peak times for *S. haematobium* excretion.[30] The processing and examination of stool and urine samples were conducted at Milola Health Centre in Milola A village (Photo 2). Stool was examined for *S. mansoni* and STHs using the Kato–Katz technique, and urine was examined for *S. haematobium* using the filtration technique; these 2 methods are widely recommended for this kind of study.[30] All observed parasites were identified and counted using standard guidelines and procedures for parasite recovery and identification based on morphology, size, and shape of eggs and larvae.[28,31] We did not specify egg counts above 50 eggs per 10 ml of urine during examination because we were mostly interested in the

A

B

PHOTO 1. Sampling materials were distributed to each participant at their home (A & B) at Milola Ward in southeastern Tanzania, and instructions were given on the protocols for stool and urine collection

categorical identification of infection intensities (low, medium, and high), and so intensities were capped at 50 eggs per 10 ml of urine. Participants with more than 50 *S. haematobium* eggs per 10 ml of urine were categorised as heavily infected, as per WHO guidelines.[32]

Data Analysis

The terms "prevalence", "intensity" (egg count), and "mean intensity" were used as indicators of parasitic infection, and we applied appropriate analyses recommended for studies on parasite ecology.[24,30] Infection prevalence was calculated as the percentage of infected individuals out of all examined individuals, and intensity was the number of *S. haematobium* eggs per 10 ml of urine. Although we targeted a set of 2 stool and urine samples, most participants did not bring the second sample. The analysis was thus based on a single urine and single faecal sample from each participant. To obtain the number of eggs per gram (epg), which is the standard measurement of the intensity of infection at the individual level, the number of faecal helminth eggs (counted on the slide using the Kato–Katz technique) was multiplied by an appropriate number (multiplication factor), which depends on the size of the template hole used.[30,32] The template hole used in the present study could hold 41.7 mg of faeces, so the number of faecal eggs per slide was multiplied by 24. The mean epg was then used as a proxy of worm burden.[32] Worm burden for *S. haematobium* infection for each participant was estimated as the number of eggs per 10 ml of urine.[33] Levels of STH and *S. haematobium* infection (intensity) were categorised as "heavy", "moderate", and "light" infections, respectively, as per WHO guidelines.[32] Normality testing of the samples indicated that parasite egg counts (intensity) strongly deviated from the normal distribution, as variance was larger than the mean. Non-parametric tests were therefore applied, with the Mann–Whitney U-test used to analyse the variation of parasite intensity between male and female participants and between age groups (children and adults).[34] Linear regression analysis was used to measure the association of age with parasite intensity, and the Kruskal–Wallis test was applied to determine the variation of parasite intensity among villages and test whether the proportion of infected individuals varied significantly among localities.[35] The Pearson chi-square (X^2) test of independence was used to analyse for variation of *S. haematobium* prevalence between the strata of categorical variables. Analyses were performed using Stata, version 11 (StataCorp LLC, College Station, TX, USA), and the statistical significance level was $P<.05$.

Ethical Considerations

Ethical approval for this study (Ref. No. NIMR/HQ/R.8a/Vol. IX/1798) was provided by the National Institute for Medical Research, Tanzania.

RESULTS

A total of 195 participants returned faecal and urine samples (Table 1). However, only 190 (97%) participants submitted viable and analysable urine samples, including 107 (56%) females and 83 (44%) males (Table 2). On the other hand, only 158 (81%) of 195 participants supplied faecal samples in sufficient condition for parasite detection, 37 (23%) of whom were children (Table 2). The types of parasites observed were *S. haematobium,* which was diagnosed from urine samples, as well as *T. trichiura* and hookworms obtained from stool. *S. haematobium* was found in 44 (23%) of 190 urine samples, followed by hookworms diagnosed in 12 (8%) of 158 examined stool samples, and *T. trichiura* observed in 6 (4%) of 158 stool samples (Table 3).

PHOTO 2. Kato–Katz slides smeared with faecal samples (A) and plastic vials containing urine samples (B) being processed and analysed in the laboratory at Milola Health Centre, Lindi District, in southeastern Tanzania. Members of the research team in action in the laboratory (C & D), including the author (standing between chairs in C)

The prevalence and intensity of *S. haematobium* did not vary significantly between villages (intensity, X^2=0.4 with 3 degrees of freedom [df], *P*=.95; prevalence, X^2=0.7; *P*=.88) (Table 2 and Table 4). There were 6 participants, 2 each from the villages of Mkanga Ulani, Milola B, and Milola West, who had heavy *S. haematobium* infections. As shown in Table 2, the prevalence of *S. haematobium* infection was higher among the 107 female participants (n=27, 25%) than among the 83 males (n=17, 20%). However, this variation was not statistically significant (X^2=0.5; *P*=.47) (Table 2). Similarly, variation of the intensity of *S. haematobium* in females (5.21 epg) and males (5.11 epg) was not statistically significant (X^2=0.2 with 1 df; *P*=.66), as also shown in the odds ratio analysis results in Table 4.

Thirty-seven children were sampled during the study, ranging from 5 to 15 years of age, with the majority aged 6 to 8 years (Table 5). The 121 adults sampled for stool were between 18 and 90 years of age, without a clear predominance of any particular age group (Table 5). The prevalence of *S. haematobium* was higher among the 37 children (n=18, 49%) than the 153 adults (n=26, 17%), and the difference was statistically significant (X^2=16.6; *P*<.001) (Table 2). The linearity of the relationship between the intensity of *S. haematobium* infection and human age is demonstrated in Figure 2 (with egg counts capped at 50 eggs per 10 ml of urine). Linear regression analysis of *S. haematobium* egg intensity (dependent variable) with participants' age intervals revealed that mean egg counts were higher in children (15.86 epg) compared to adults (2.56 epg) (Figure 3), and this difference was statistically significant (*P*<.001) (Table 4).

Availability of Data and Materials

The datasets supporting the conclusions of this article are available. Contact the corresponding author for permission and access to the datasets.

DISCUSSION

Observed Levels of Parasitic Infection

The parasite burden observed among study participants in Milola Ward in southeastern Tanzania has significant public health implications for this area. For instance, hookworms and whipworms (*T. Trichiura*) are major STHs that cause significant health impairments, including iron-deficiency anaemia, malnutrition, and growth retardation.[24] Another parasite diagnosed was *S. haematobium,* which is a blood fluke that causes urinary schistosomiasis, a potentially debilitating disease, the chronic form of which can lead to kidney failure and bladder cancer if untreated.[36] The drugs used for these infections – albendazole for hookworm disease and trichuriasis and praziquantel for schistosomiasis – should, therefore, be made available regularly at Milola Ward Health Centre. The drugs should be offered free of charge or highly subsidised because, otherwise, most people in the villages would not be able to afford them.

TABLE 2. Prevalence of Urinary Schistosomiasis by Village, Sex, and Age Group Among Milola Ward Residents

Variable or Category	Participants Examined n	Participants Positive n	Prevalence %	*P* Value
Village				
Milola A	51	10	20	
Milola B	23	6	26	
Milola West	69	17	25	.88
Mkanga Ulani	47	11	23	
Total	190	44	23	
Sex				
Female	107	27	25	
Male	83	17	20	.47
Total	190	44	23	
Age				
Child	37	18	49	
Adult	153	26	17	<.001
Total	190	44	23	

TABLE 3. Overall Prevalence and Intensity of Parasite Types Identified from Study Participants

Parasite Species	Sample Type	Participants Examined n	Participants Infected n	Prevalence %	Intensity
Hookworms	stool	158	12	8	21.4 eggs/Kato–Katz slide
Trichuris trichiura	stool	158	6	4	0.72 eggs/Kato–Katz slide
Schistosoma haematobium	urine	190	44	23	5.2 eggs/10 ml urine

Despite being relatively small in both scope and duration, our study demonstrated prevalence levels, particularly for *S. haematobium*, that the Tanzanian government could use in planning control programmes according to WHO guidelines, which specify prevalence-based treatment frequency.[37,38] We observed that although most infected participants (97%) had a mean prevalence of *S. haematobium* within the light or low infection level (1 to 49 eggs per 10 ml of urine), 3% of them (not included in the analysis) had more than 50 eggs per 10 ml of urine, which is categorised by WHO as heavy infection.[32] The government could, therefore, consider adjusting the frequency of treatment in these areas. According to available records, the current school-based MDA programmes are conducted once each year, which does not match our observed prevalence levels. Over 20% prevalence of *S. haematobium* was found in some areas (Table 2). We recommend that the frequency of treatment be increased to twice per year, in accordance with the WHO recommended frequency when prevalence is above 20%.[38]

TABLE 4. Odds Ratio Analysis Results Showing Significantly Higher Intensity of *S. haematobium* in Children Compared to Adults ($P<.001$)

	Crude OR		Adjusted OR	
Variable	**OR (95% CI)**	***P* Value**	**OR (95% CI)**	***P* Value**
Village				
Mololа A	1.0	–	1.0	–
Mololа B	1.25 (0.48–3.29)	.65	1.33 (0.48–3.71)	.59
Mkanga Ulani	1.34 (0.55–3.24)	.52	1.34 (0.53–3.38)	.54
Milola West	1.54 (0.48–4.93)	.47	1.63 (0.47–5.68)	.44
Sex				
Male	1.0	–	1.0	–
Female	1.29 (0.65–2.57)	.47	1.72 (0.80–3.70)	.17
Age				
Adult	1.0	–	–	–
Child	4.59 (2.12–9.92)	<.001	5.09 (2.29–11.32)	<.001

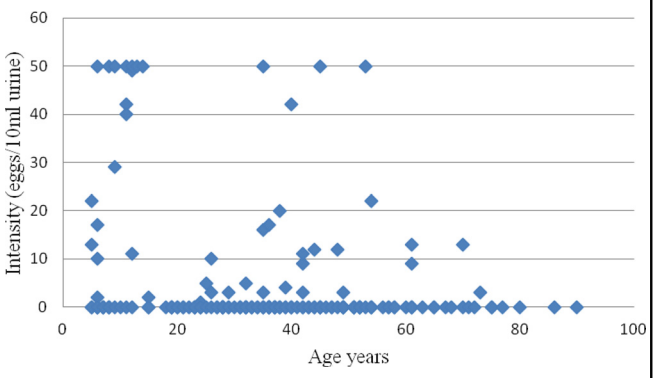
Abbreviations: CI, confidence interval; OR, odds ratio.

The Influence of Age on Parasite Infections in Milola Ward

Although non-school children sampled in the present study were far fewer than adults, the former had heavier parasite burdens. Overall, more children were infected with hookworms and *S. haematobium* parasites than adults, and peak parasite intensities and prevalence rates were found in children aged between 5 and 15 years (Figure 2). These findings confirm the widely known relationship between prevalence and age, wherein the mean age of peak prevalence in a population decreases as transmission pressure increases (Figure 2 and Figure 3).[39,40] The present results are consistent with reports by other researchers who have also reported a slow rise in schistosomiasis prevalence and intensity in children followed by an equally gradual decline in adults.[36,41] Children are more susceptible to infections compared to adults largely because they lack acquired immunity and engage in behaviours and activities that bring them in contact with infested water or soil.[41–43] Most children in Milola Ward were seen walking and playing barefoot at the time of the study, and it is possible that they got infected with STHs, such as hookworms and whipworms (*Trichuris*), through contact with the soil. In the local context, however, the results affirm that age influences parasite transmission in Milola Ward, where children below 18 years old are at higher risk of acquiring the infections compared to adults. Other studies, in similar and different settings, have demonstrated the association between participant age and schistosomiasis, with a gradual increase in both prevalence and intensity in children, followed by a slow decline in adults.[41,42,44]

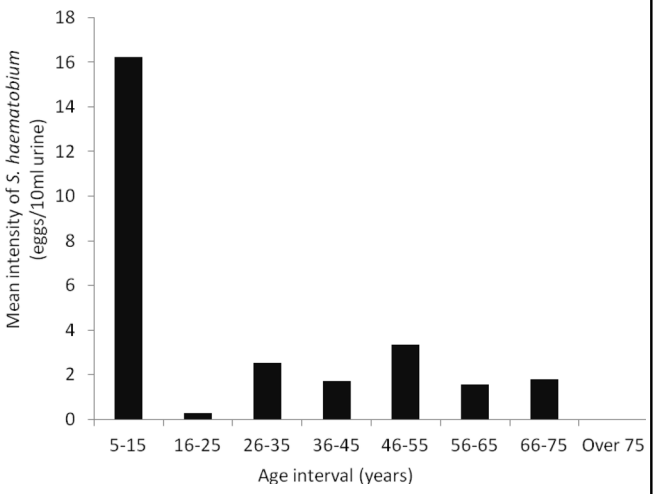
Just before the start of the present study, the Tanzanian government was conducting its regular school-based distribution of antihelminthic drugs to children in the study area. Thus, to avoid reporting false prevalence, and in cognizance of the suggestion that post-MDA sampling for schistosomiasis should be conducted at least 6 months after drug

FIGURE 2. Relationship Between *Schistosoma haematobium* Direct Egg Counts and Participant Age as a Continuous Variable



The intensity of *S. haematobium* egg production was significantly higher in children than adults. Children aged 5 to 15 years had the heaviest infection intensities. Counting of *S. haematobium* eggs was capped at 50 eggs per 10 ml urine, and therefore counts above 50 eggs per 10 ml of urine were not included on the data records and the bar plot because the goal was to categorise infection intensities as low, medium, or high (≥50 eggs/10 ml of urine), as per WHO classification.

FIGURE 3. Variation in *Schistosoma haematobium* Mean Intensity With Participant Age, indicated by the Arithmetic Mean Intensities for Given Age Intervals.



The arithmetic mean intensities of *S. haematobium* for each given age group indicated lower mean intensity of 2.56 epg in adults and a higher mean intensity of 15.86 epg in children, and hence the limit or cut-off of 18 epg on the y-axis.

delivery,[42] school children were excluded from this study. The studied groups (adults and non-school children) had not been involved in the government-sponsored MDA programmes. Most (25 of 37) of the non-school children included in this study were 7 years of age or older (Table 5), which is the school age in Tanzania. For unknown reasons, these children were not attending school at the time of the study. In school, they would likely have received praziquantel and albendazole during the MDA campaigns. The disproportionately higher prevalence of schistosome and hookworm infection among non-school children in Milola Ward could, therefore, be due to missed opportunities for school-aged children to benefit from the government's National Schistosomiasis Control Programme. The current school-based treatment programme, which targets school children only, should also include non-school children, as they were heavily infected with schistosomiasis but did not have regular access to drugs. Further investigations should also be conducted on the strengths and weaknesses of school- and community-based treatment approaches to determine which is better for specific areas. These findings could also form a useful basis for the planning and implementation of control measures against parasitic diseases in these areas. Future studies comparing the levels of parasitic infection between school and non-school children in the area and other similar settings would

TABLE 5. Age Distribution of Non-School Children and Adults Who Participated in the Present Study at Milola Ward in Lindi District, Tanzania (N=195)

Age (Years)	n
Children	
5	4
6	8
7	4
8	4
9	3
10	1
11	4
12	4
13	1
14	1
15	3
Total	37
Adults	
18–22	10
23–27	15
28–32	23
33–37	27
38–42	17
43–47	13
48–52	18
53–57	9
58–62	8
63–67	4
68–72	5
73–77	4
Over 77	5
Unknown	1[a]
Total	158

[a] Unknown age: excluded in data analysis.

enable us to better understand the factors influencing the levels of schistosomiasis and STHs between the 2 groups and take appropriate actions. Furthermore, the causes of differences in the acquisition and progression of these infections in children and adults in Milola Ward can be fully understood if comprehensive surveillance is conducted that encompasses the wet and dry seasons, as well as a broader range of environmental and socioeconomic factors.

Limitations

Compliance to sampling in the present study was not consistent among participants. For instance, in the initial sampling exercise, 158 participants brought back faecal samples but, for whatever reasons, only 26 participants provided the second stool sample. Similarly, for urine sampling, 190 participants provided a first urine sample, but only 53 provided a second specimen. It is also possible that some adults consciously decided not to provide samples. As such, our analysis and discussion have focused only on data from the initial sampling, which may have reduced the chances of a broader interpretation of the findings. As noted elsewhere,[24] epidemiological sampling of adults can be challenging and difficult. Thus, school children are an ideal target group for sampling, especially in resource-constrained settings, to allow for more representative and reliable results.

RECOMMENDATIONS

The present study has not established the transmission points or foci for schistosome infection in the sampled villages. To that end, the sources of schistosome infection remain unknown. Future studies should, therefore, aim to establish the risk areas, such as specific water bodies and farms, and determine how human movements to and away from these areas expose them to the risk of infection. Since snails are critical for the lifecycle and transmission of schistosomes, a comprehensive survey of snails in Milola River and other local water bodies is essential for a full understanding of the transmission patterns and dynamics of urinary schistosomiasis in the area. Although there are already some studies, at least at the national level in Tanzania, that have used geographic information system (GIS) mapping to model the transmission risk levels for soil-transmitted helminthiases and schistosomiasis across the country, based on known climatic, soil, and other environmental variables,[15,45] such studies are lacking at the district and community levels. As such, the use of GIS for mapping and identifying risk areas (transmission hotspots) would help to resolve the questions of how and where the people at Milola Ward acquire urinary schistosomiasis and soil-transmitted helminthiases. Land usage patterns in Lindi District and their impact on schistosomiasis and soil-transmitted helminthiasis distribution should also be analysed to identify priority areas for interventions, to estimate intervention needs and to assess the progress of control programmes against these infections.

CONCLUSION

This study focused on the demographic factors driving schistosomiasis and soil-transmitted helminthiases at Milola Ward in Lindi District, Tanzania. The major parasites present in the population were *S. haematobium*, *T. trichiura*, and hookworms. Across the studied villages, age was the most important factor influencing parasite transmission. The chances of acquiring schistosomiasis and hookworm disease in the area were higher among non-school children than among adults, most likely due to the former's susceptibility to parasitic infections. It is possible that non-school children involved in the present study had infection levels that were higher than expected because they did not receive the school-based treatment. At the time of the study, adults were also not receiving regular treatment and were not covered by an MDA programme. The present study provides baseline information on the distribution of schistosomiasis and soil-transmitted helminthiases in the area, which can be used as guidance for rolling out control and intervention efforts. Because the study was conducted only during the dry season, it is possible that the levels of parasitic infections were underestimated, as the rainy season is more conducive for schistosome and STH transmission. More comprehensive future epidemiological studies in Milola Ward may provide more insights on the patterns and dynamics of parasitic infections in the area.

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EAHRC
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ORIGINAL ARTICLE

Food Safety, Health Management, and Biosecurity Characteristics of Poultry Farms in Arusha City, Northern Tanzania, Along a Gradient of Intensification

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ABSTRACT

Background: With the growth, urbanisation, and changing consumption patterns of Tanzania's human population, new livestock production systems are emerging. Intensification of poultry production may result in opportunities and threats for food safety, such as improved awareness of biosecurity or increasing prevalence of foodborne pathogens including nontyphoidal *Salmonella* or *Campylobacter* spp. We conducted a semiquantitative analysis of poultry production systems in northern Tanzania, with emphasis on biosecurity, health management practices, and prevalence of foodborne pathogens, to gain insight into potential associations between intensification and food safety.

Methods: Interviews were conducted with managers of 40 poultry farms, with equal representation of 4 production systems (extensive, semi-intensive, or intensive production with indigenous chickens, and broiler farming). Per farm, up to 10 birds (total, 386) were tested for cloacal shedding of nontyphoidal *Salmonella*, with a subset of farms tested for *Campylobacter*. Data were analysed using univariate statistics, and results were discussed during feedback workshops with participating farmers and extension officers.

Results: Clear differences existed between farm types with regard to implementation of biosecurity and health management practices and use of extension services. By contrast, prevalence of foodborne pathogens (6 of 40 farms or 15% for nontyphoidal *Salmonella* and 13 of 26 farms or 50% for *Campylobacter* spp.) was not farm-type specific, indicating that it is driven by other factors. Across farming systems, knowledge and awareness of the presence of antimicrobials in poultry feed and the need to abide by post-treatment withdrawal times were limited, as was access to impartial professional advice regarding treatment.

Conclusion: Different control measures may be needed to protect poultry health compared to public health, and improvements in information provision may be needed for both.

INTRODUCTION

Urbanisation in Tanzania increased from 5.7% in 1967 to 29.1% in 2012, and urban areas absorbed 12 million people out of a total growth of 31.6 million over that period.[1] Urbanisation is associated with a growth in mean wealth – the value of assets owned – per capita, which increased from US $250 in 2004 to US $480 in 2012.[2] Urbanisation and wealth drive chicken meat consumption, which is skewed towards medium- to high-income populations in urban areas.[3] Tanzania has an estimated population of more than 43 million chickens.[4] Considering demographic developments in the human population, an increase in poultry production can be anticipated. Indeed, in urban areas, such as Arusha Urban District, traditional extensive backyard poultry farming for home consumption is increasingly complemented by semi-intensive and intensive farming systems, with sales of poultry meat to individual customers, retailers, and caterers. While the majority of chickens – estimated at 96% of the population – belong to indigenous breeds, intensive

production of exotic broilers is increasingly widespread, as evidenced by the presence of farms with such breeds in most wards of Arusha District.[4] Poultry make a significant contribution to human nutrition and provide a source of income for farmers to support their livelihoods.[5,6] Poultry also have important social roles in ceremonies and rituals or as gifts.[6]

While poultry make major contributions to the economy and social life in Tanzania, they may also expose farmers, consumers, and the environment to causative agents of zoonotic infections and foodborne diseases, notably through direct contact with birds or their excreta, or through handling or consumption of poultry meat or eggs contaminated with bacteria, such as *Campylobacter* spp. or *Salmonella* spp. Both genera can be carried asymptomatically by healthy birds, so it may not be obvious that a microbiological hazard is present.[7,8] Globally, *Campylobacter* spp. and nontyphoidal *Salmonella* spp. are among the most important foodborne zoonotic pathogens. *Campylobacter* is the most common bacterial cause of foodborne illness, and *Salmonella enterica* is a major bacterial cause of mortality, associated with an estimated 230,000 deaths per year.[9] The burden of *Salmonella* is particularly high in sub-Saharan Africa, and it is an important cause of febrile illness among hospitalised children in rural and urban Tanzania.[9–12] Healthy poultry and poultry products are considered potential sources of both *Campylobacter* and *Salmonella*. A high prevalence of the bacteria in live birds increases the risk of contamination of chicken carcasses.[13–15] Specific risk factors for *Salmonella* prevalence in poultry flocks have been studied in production systems in high-income countries, but information on risk factors in traditional or emerging African production systems is scarce.[16] The risk of *Salmonella* contamination can be high in intensive poultry production, particularly if biosecurity is poor.[17] However, intensification does not necessarily increase the prevalence of *Salmonella* or *Campylobacter*. For example, both the rise and subsequent fall of *Salmonella enterica* serovar Enteritidis were associated with intensive poultry production in the United Kingdom (UK), and *Campylobacter* prevalence was higher in extensively managed indigenous chickens than in intensively managed broilers in the Morogoro Region and Eastern Zone of Tanzania.[8,15,18] Thus, the emergence of new poultry production systems may bring new risks of foodborne disease as well as new opportunities for human or animal disease prevention.

Our aim was to gain insights into the association between emerging poultry production systems and health risks and opportunities, and to explore suitable routes for dissemination of extension information to promote poultry health and public health. To this end, we conducted a semi-quantitative analysis of poultry production systems at different levels of intensification, with emphasis on the prevalence of foodborne pathogens, biosecurity, health management practices, and sources of medicines and health information.

METHODS

Study Area and Study Farms

The study was conducted in Arusha Urban District, which is among the 7 districts of Arusha Region in northern Tanzania. The district is a hub for tourism and is undergoing rapid economic expansion and urbanisation. It is located between longitudes 34.5° E and 38° E and latitudes 2° S and 6° S and is divided into administrative units called wards. Over the course of the study, the number of wards changed from 25 to 19 as a result of amalgamation. Farming systems for poultry in this area include intensive broiler production, intensive indigenous chicken production, semi-intensive indigenous chicken production, and extensive or free-range indigenous chicken production. The major difference between the various indigenous poultry management systems is in the housing system, which can be described as permanently housed, partly housed, or not housed (Figure 1). Furthermore, the indigenous farming systems differ in their use of commercial feed, mixed commercial and home-made feed, and scavenging for poultry nutrition, respectively. Broilers differ from indigenous chickens in that they are bred and raised specifically for meat production. Broiler production is more intensive than production of meat or eggs with indigenous chickens.

Because the aim of the study was to obtain information on poultry management and prevalence of foodborne pathogens across poultry production studies, only wards with all 4 systems were eligible for inclusion in the study. After permission for research in the district had been granted by the Arusha District executive director, poultry subject matter specialists within the district's agricultural extension service identified 20 of 25 wards as having all production systems. Out of 20 wards, 10 were selected at random by drawing names from a box: Elerai, Engutoto, Kimandolu, Lemara, Moshono, Muriet, Sinon, Sombetini, Terat, and Themi. For every selected ward, extension officers were asked to produce a list of poultry farmers, stratified by poultry farming system. From this sampling frame, 1 farmer was randomly selected per production system per ward by drawing names, written on pieces of paper, from a box.

Data and Sample Collection

To collect information on farming households and poultry management, including husbandry and animal health-related practices, a semi-structured questionnaire was developed in English. During use, the investigator translated the questions into Kiswahili. Pilot testing of the questionnaire was conducted with 1 household per farming system in Sokon Ward to ascertain clarity of the questions and the amount of time needed for completion of all questions. Farmers were contacted by telephone to arrange a time for interview, and the questionnaire was administered to 40 farmers in person by the first author after obtaining the farmer's verbal consent in front of a witness. Questionnaires

FIGURE 1. Examples of Poultry Production Systems at Different Levels of Intensification

(A) Extensive indigenous poultry production; (B) semi-intensive indigenous poultry production; (C) intensive indigenous poultry production; (D) broiler production

Photos: E. Sindiyo (A) and R. Maganga (B, C, D)

were completed before sample collection for 2 reasons: to explain in advance to the farmer how the sampling would take place and to allow for sampling of all farms within a ward (1 each for extensive, semi-intensive, intensive, and broiler production systems) in a single day. The latter was deemed important to avoid temporal bias in culture results from different production systems and would not have been possible if questionnaires also had to be conducted on the same day. Geographical positioning system data were collected for each household using an eTrex 10 device (Garmin, Southampton, UK).

Sampling of chickens and their environment was conducted once a week to allow sufficient time for sample processing between sample collection days. Chickens were handled gently to avoid injury, in compliance with the United Republic of Tanzania's Animal Welfare Act no. 19, part V, section 40-48, 2008.[19] Cloacal swabs were collected by inserting the entire tip of a swab into the cloaca of a chicken and applying gentle pressure against the mucosal surface while swabbing in a circular motion. Each chicken was swabbed twice, once with a plain Amies swab and once with an Amies charcoal swab (Thermo Fisher Scientific, Newport, UK). Swabs were removed gently and immediately inserted into the respective Amies tubes, and then labelled and stored in cool boxes with ice packs before being transported to the laboratory for analysis within 5 hours – the time between the first sample collection and arrival at the laboratory. Environmental samples were collected by using 1 pair of boot cover swabs (BTSW-001 DRY Sterile Boot Cover Swab for Sampling Poultry Housing, Solar Biologicals Inc., Newark, NJ, USA) per farm and walking along the diagonals of the chicken house or yard. Dry boot cover swabs were used rather than premoistened swabs to avoid bacterial growth prior to use, which was deemed a risk under Tanzanian temperature and moisture conditions. Boot socks were worn over boot covers (Fearing Disposable Boot Covers, Smiths Animal Health, Ashbourne, UK) as per the directions of the boot sock manufacturer. Used boot cover swabs were stored in stomacher bags and transported to the laboratory together with the swabs. After collection of environmental samples and cloacal swabs on a farm and before visiting the next farm, all disposable personal protective equipment was changed, and hands and boots were disinfected using 70% ethanol.

Sample Processing

Samples were processed in the bespoke Zoonoses Unit of the Biotechnology Laboratory at the Kilimanjaro Clinical Research Institute in Moshi, Tanzania.[20] Culture methods were based on recommendations from the Food and Drug Administration's Bacteriological Analytical Manual for *Campylobacter* and *Salmonella*.[21,22] The *Campylobacter* culture was initiated on the day of sample collection. All reagents were obtained from Oxoid (Basingstoke, UK) unless stated otherwise. Amies charcoal swabs were removed from transport containers and tips removed aseptically by cutting them off into a plastic universal tube containing 20 ml Bolton broth supplemented with 5% horse blood (TCS Biosciences, Botoph Claydon, Buckingham, UK) and selective supplement SR0208E, vortexed aseptically for 10 seconds and placed into a microaerophilic jar with CampyGen sachets. Samples were incubated at 37±2°C for at least 4 hours before being moved to 42±2°C for a further 42 to 46 hours, and then plated onto modified charcoal cefoperazone deoxycholate agar plates and incubated at 42±2°C in a microaerophilic jar with CampyGen sachets for 48 hours. Plates were examined for typical *Campylobacter* colonies. Suspect colonies were subcultured onto Columbia blood agar, incubated microaerophilically at 42±2°C for 48 hours, and subjected to oxidase and catalase testing and Gram staining for confirmation.

Samples for *Salmonella* detection were stored overnight in a refrigerator between 2°C and 8°C. Tips were aseptically removed from the plain Amies swabs the next day, placed in 20 ml buffered peptone water, vortexed for 10 seconds, and incubated at 37±2°C for 18 to 20 hours. A small volume (0.1 ml) of the enriched buffered peptone water was then transferred into 10 ml of Rappaport-Vassiliadis soya peptone broth and incubated at 42±2°C for 24 hours. One loopful (10 µl) of overnight culture was transferred onto xylose lysine deoxycholate agar with 5 µg/ml novobiocin (Sigma-Aldrich, St. Louis, MO, USA) and streaked for isolation. At least 2 typical *Salmonella* colonies per plate were streaked onto MacConkey agar and incubated overnight at 37±2°C. Lactose-fermenting colonies (those with a pink appearance) were discarded, and nonlactose-fermenting colonies were individually transferred into 5 ml of tryptone broth and incubated at 37±2°C for 4 to 24 hours. Growth from the broth was inoculated onto MacConkey agar to check for purity, then stabbed into lysine iron agar slopes and triple-sugar iron slopes and incubated overnight at 37±2°C to assess phenotype. Kovacks' indole reagent (Merck KGaA, Darmstadt, Germany) was added to the incubated tryptone broth to test for indole production. Presumptive identification of *Salmonella* isolates was based on negative indole test results, alkaline slant and butt (purple colour) in lysine iron agar, and red slope with yellow butt and gas production on triple-sugar iron slopes. Identity was confirmed by testing with poly-H and poly-O agglutination tests (Statens Serum Institut, Copenhagen, Denmark) and Microbact 12A test strips, following the manufacturers' instructions.

Data Analysis

Data were stored and checked for missing values and outliers in Microsoft Excel (Microsoft, Seattle, WA, USA), with additional processing using Excel for visual analysis and Statistix 10 (Analytical Software, La Jolla, CA, USA) for quantitative analysis. To test for an association between farm type and categorical variables (eg, biosecurity characteristics or health management), chi-square (X^2) analysis was used. Unless stated otherwise, there were 3 degrees of freedom for X^2 testing, based on analysis of binary variables across 4 farm types. Nonparametric Kruskal–Wallis ANOVA was used for continuous variables. Statistical significance was declared at $P<.05$. To generate a map of the study area showing the production system and culture results for each farm, QGIS software, version 2.18.3 (https://qgis.org/en/site/) was used.

Feedback Sessions

Two-day feedback sessions were held with poultry keepers and extension officers in Engutoto Ward and at the Arusha Veterinary Investigation Centre, respectively. The aim of the feedback sessions was to share results from the study, create awareness of biosecurity and health management among poultry keepers and extension officers, and to collect their views on current service provision and needs. After initial introductions and presentation of the results, participatory approaches were used, including group discussions guided by questions and opportunities for participants to present their views. Group discussions were facilitated by the first author, who also arranged the farm visits – with help from the extension officers – and administered the questionnaires to the farmers. The first author was selected for this role because of his knowledge of the subject matter, local conditions, and terminology, as well as the rapport that he had developed with the participants through the project; this facilitated informed and open dialogue.

Ethical Approvals

Ethical approval for this work was provided by the National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/2028) and the Kilimanjaro Christian Medical Centre (Research Ethical Certificate No. 832), as part of the Zoonoses and Emerging Livestock Systems project. Approval to conduct the interviews of human subjects was granted by the University of Glasgow College of Medical, Veterinary and Life Science's Ethics Committee (200140183), and poultry sampling was approved by the University of Glasgow School of Veterinary Medicine Research Ethics Committee (Ref. 56a/16). A letter of approval was provided by the Municipal Council of Arusha Urban District, where the research took place.

All interviewees provided informed consent before participating in the study. Consent was given verbally in the presence of extension officers rather than in writing to prevent exclusion of participants based on literacy.[20] Details that might disclose the identity of participants in the study are not shown.

RESULTS

Prevalence of Foodborne Pathogens

Visits and interviews were conducted at 40 farms, divided over 4 production systems and 10 wards, with 1 farm per production system per ward. Out of a target number of 400 birds, 386 were swabbed: 99 from broiler flocks (9 farms with 10 birds, 1 farm with 9 birds), 99 from intensive flocks (9 farms with 10 birds, 1 farm with 9 birds), 98 from semi-intensive flocks (8 farms with 10 birds, 2 farms with 9 birds), and 90 from extensive flocks (8 farms with 10 birds, 2 farms with 5 birds). Environmental samples were collected from all farms. Six (15%) of 40 farms and 8 (2.1%) of 386 birds tested positive for *Salmonella*. Increased farm intensification was associated with nonsignificant increases in the numbers of positive farms and birds (Table 1; X^2=2.3, *P*=.51 at farm level; X^2=4.6, *P*=.20 at bird level). Due to logistic issues, samples from 26 farms only were tested for *Campylobacter*, of which 13 (50%) were positive. Animal-level prevalence of *Campylobacter* (23 of 255 birds, 9.0%) was higher than for *Salmonella* but without an obvious association with farm intensity (Table 1). Joint occurrence of *Salmonella* and *Campylobacter* was detected on 3 farms, as would be expected by chance under the assumption of independent occurrence of the 2 bacterial genera. The distribution of farms in the study region, including farm type and farm status, with regards to *Salmonella* and *Campylobacter*, is shown in Figure 2.

Farmer Demographics

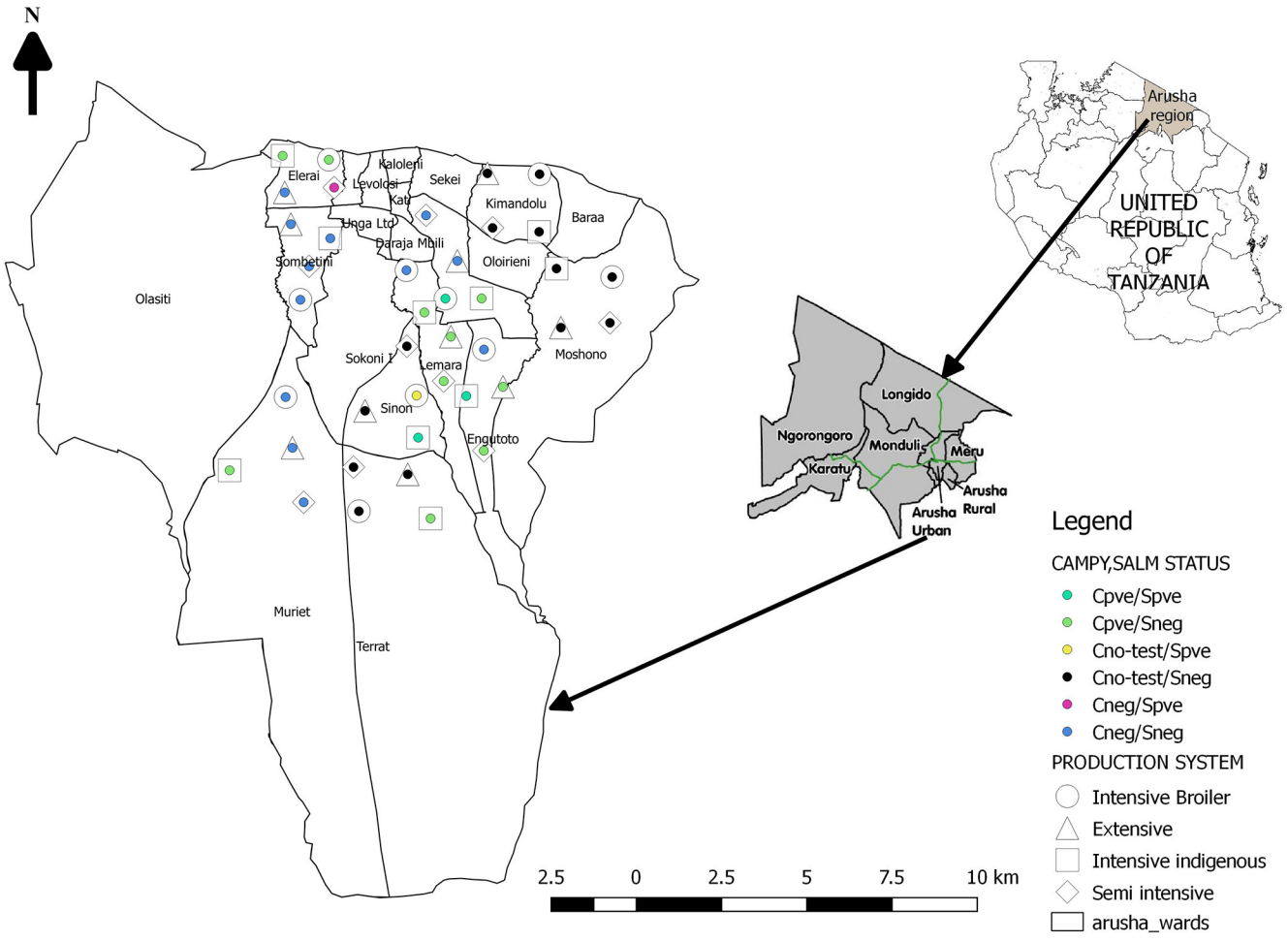
Poultry management was generally the responsibility of women, with a mean of 7 of 10 farms per production system managed by a woman (range, 6 to 8). Only 2 interviewees identified chicken production as their main occupation. Other sources of income included crop production, formal or informal business, and civil service. The majority (n=32, 80.0%) of people responsible for chicken management were over 40 years of age. Of those under 40 years of age, half managed semi-intensive farms, and only 1 was younger than 30. A wide range of education levels was reported, from primary school education (standard 7, equivalent to 7 years of primary education up to age 13), via ordinary and advanced secondary education (form 4 and form 6, respectively), to postsecondary and adult education. Broiler farming was the only sector where none of the respondents reported university-level education, although differences between sectors were not significant. Half of the participants

TABLE 1. Prevalence of *Campylobacter* spp. and Nontyphoidal *Salmonella* in Tanzanian Poultry Farms Across a Gradient of Intensification

Pathogen	Farm Type	Farm Level Positive/Tested (%)[a]	Bird Level Positive/Tested (%)	Boot Socks Positive/Tested (%)
Campylobacter spp.	Extensive	2/6	5/55 (9.1)	NA
	Semi-intensive	3/6	7/60 (6.7)	NA
	Intensive	7/8	12/80 (15.0)	NA
	Broiler	1/6	3/60 (5.0)	NA
	All	13/26 (50)	27/255 (10.6)	NA
Nontyphoidal *Salmonella*	Extensive	0/10	0/90 (0.0)	0/10
	Semi-intensive	1/10	1/98 (1.0)	1/10
	Intensive	2/10	3/99 (3.0)	2/10
	Broiler	2/10	4/99 (4.0)	2/10
	All	5/40 (12.5)[b]	8/386 (2.1)	5/40 (12.5)[b]

[a] Percentage only calculated for denominator values greater than 25.
[b] In total, 6 of 40 farms were positive for *Salmonella*: 1 semi-intensive farm, 2 intensive farms, and 3 broiler farms (1 farm demonstrated positivity via cloacal swabs only, 1 farm via boot socks only, and 4 farms via both).
Abbreviations: NA, not applicable; spp., several species.

FIGURE 2. Map of Study Area Showing *Campylobacter* and *Salmonella* Status by Farm Type and Location



The maps show the position of Arusha Region (grey) within the United Republic of Tanzania and the position of the study area, Arusha Urban within Arusha Region. Wards within Arusha Urban District are shown with approximate (anonymised) farm locations. Farm type is indicated by the shape of the symbol, with coloured dots indicating farm status ("pve", "neg", and "no-test" meaning positive, negative, and not tested, respectively) with regards to *Campylobacter* (C) and *Salmonella* (S).

on extensive and semi-intensive farms reported to have skills in poultry production, as did the majority of participants on intensive (8 of 10) and broiler (9 of 10) farms.

Husbandry

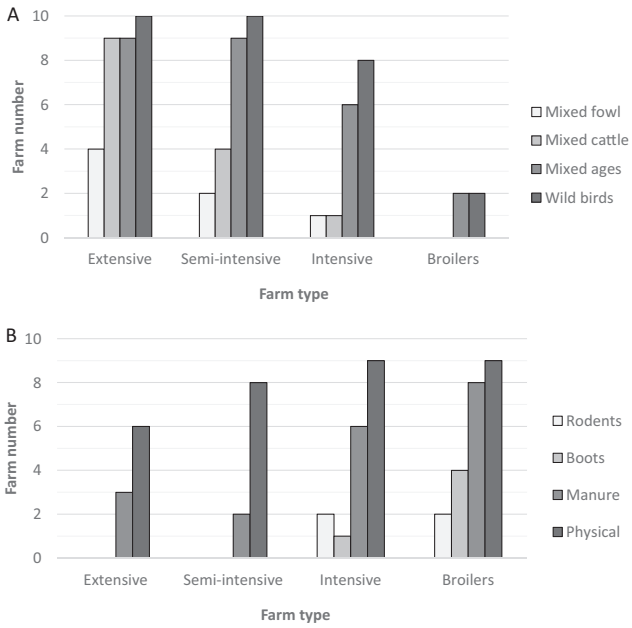
On extensive farms, 13 to 75 birds (mean, 39; median, 34) were housed in a single chicken house. On semi-intensive farms, 35 to 105 birds (mean, 57; median, 49) were housed in 1 to 4 houses (median, 1). On intensive farms, 15 to 700 birds (mean, 199; median, 113) were distributed over 1 to 4 houses (median, 2). Finally, on broiler farms, there were 200 to 1,500 birds (mean, 715; median, 600) across 1 to 3 houses (median, 3). The number of birds was significantly higher on broiler farms than on extensive or semi-intensive farms, whereas the number of houses per farm was significantly higher on broiler and intensive farms than on extensive farms (Kruskal–Wallis 1-way ANOVA with post-hoc Dunn's pairwise comparison, $P<.001$ for both analyses). Bedding use reflected intensification of the production system, with litter used on 10, 4, 3, and 1 broiler, intensive, semi-intensive, and extensive farms, respectively ($X^2=18.2$,

$P<.001$). Chickens were fed tap water in 5 to 8 farms per farm type, and only extensive farmers used river water. Commercial feed was used on all broiler farms, and homemade feed was used on 9 of 10 intensive farms. Semi-intensive farms used a variety of feed sources, and birds scavenged for food on all extensive farms. All farmers fed their chickens minerals, multivitamins, or both. All producers had purchased their birds, except for 2 extensive producers and 1 semi-intensive producer, who received chickens as gifts.

Biosecurity

Biosecurity improved as farm intensification increased (Figure 1 and Figure 3). Mixing of birds of different age groups was common on extensive and semi-intensive farms but not on broiler farms ($X^2=14.5$, $P=.002$). With intensification, the number of farms where chickens mixed with other types of fowl decreased ($X^2=6.1$, $P=.11$), as did the number of farms where chickens were in contact with ruminant species (cattle, n=14, $X^2=21.5$, $P<.001$; goats, n=8, $X^2=11.3$, $P=.01$; sheep n=6, $X^2=7.1$, $P=.07$). Other types of fowl included ducks, geese, and turkeys on n=7, 3, and 3 farms, respectively. Contact with wild birds was common on most farms other than broiler farms ($X^2=22.9$, $P<.001$), and all farms reported contact of chickens with rodents, except for a single broiler farm. Contact was also reported with dogs, cats, donkeys, and bats, but not with pigs. The presence of layer hens was reported on half of the extensive farms and most of the semi-intensive and intensive farms but not on broiler farms. All broiler farms practised the all-in, all-out system, but none of the other farms did. Sick chickens were generally not removed from farms, regardless of farm type, although some were sacrificed (on 2 broiler farms and 1 intensive farm), sold (2 intensive farms), or slaughtered for home consumption (on 1 broiler, 1, intensive, 3 semi-intensive, and 4 extensive farms). Physical barriers limiting access to chickens, separate manure storage, dedicated boots, and rodent barriers were generally more common at the higher levels of intensification (Figure 3B). The association with farm type was significant for manure storage ($X^2=9.1$, $P=.028$) and use of dedicated boots ($X^2=9.8$, $P=.020$), but not for the other barriers, nor for the use of food baths, which was limited to a single broiler farm.

FIGURE 3. Association Between Farm Intensification and Biological and Physical Biosecurity in Poultry Production Systems in Arusha Urban District, Northern Tanzania



(A) Number of farms with chickens in contact with other animals (other fowl, cattle, chickens of other age groups, or wild birds). (B) Number of farms using biosecurity barriers (ie, rodent barriers, dedicated boots, dedicated manure storage, or physical barriers to access to poultry). Ten farmers were interviewed per farming system.

Health Management

Vaccines to prevent viral diseases were commonly used, with half of the farmers using a vaccine against Newcastle disease (Table 2). Vaccination against Newcastle disease was significantly more common on extensive and semi-intensive farms, and pox vaccination was more common on intensive and broiler farms. Half of the farmers reported use of anthelminthics, with a nonsignificant association between anthelminthic administration and farm intensification (Table 2). Antimicrobial use was reported by a clear majority (n=38, 95.0%) of farmers, whereas traditional herbs were predominantly used by extensive farmers. Routine use of antimicrobials was significantly more common on broiler farms than other farm types ($P=.002$), where antimicrobials were reported to be used occasionally or only when birds were sick. With a few exceptions (1 each among extensive and semi-intensive farms, and 2 among intensive farms), treatments were administered to the entire flock rather than to individual sick birds. The choice of drugs was mostly based on advice from drug sellers, with a minority of farmers primarily relying on veterinary advice or personal experience. Only 1 semi-intensive farmer reported consulting an extension officer before treatment. Few farmers were aware that poultry feed might contain antimicrobials. Across farming systems, almost half of all farmers said that they were aware of the impact of antimicrobial residue on human health and the existence of withdrawal times after antimicrobial use, but only a quarter abided by rules around withdrawal times (Table 2).

TABLE 2. Use and Knowledge of Vaccines and Drugs on Tanzanian Poultry Farms Across a Gradient of Intensification

	Farm Type				Statistics	
Topic	Total n	Broiler n	Intensive n	Semi-intensive n	Extensive n	Chi-square	*P* Value
Vaccines							
Gumboro	1	0	1	0	0	3.1	.38
Newcastle disease	20	0	5	7	8	15.2	.002
Pox	13	6	5	2	0	10.4	<.02
Drugs							
Antihelminthics	20	7	6	4	3	4.0	.26
Antimicrobials							
Routinely	10	7	1	1	1	14.4	.002
Occasionally	12	2	5	4	1	4.8	.19
When birds are sick	16	1	4	5	6	5.8	.12
Traditional herbs	8	1	2	0	5	8.8	.03
Drug choice based on							
Personal experience	9	4	2	3	0	5.0	.17
Drug seller's advice	21	4	4	5	8	4.3	.23
Veterinary advice	9	2	4	2	1	2.5	.48
Knowledge of							
Antimicrobials in poultry feed	4	2	1	1	0	2.2	.53
Residue impact on people	17	5	4	4	4	0.3	.99
Withdrawal time							
Aware	17	7	5	3	3	4.4	.22
Abides	9	3	3	1	2	1.6	.66

Extension and Training

All farmers expressed the need to receive information on poultry keeping. Most farmers were members of 1 or 2 professional groups, including farmer field schools or poultry associations, but only a minority considered this useful. Most farmers – particularly broiler farmers – relied on input suppliers for extension services. Some farmers – particularly those on extensive farms – relied on government extension officers for extension services. Information on poultry farming was mostly obtained from colleagues and occasionally from farmer field schools, input suppliers, or social media. None of the associations between information source and farm type were significant (Table 3). Farmers' own resources were the most common sources of funding for training on all but extensive farms, where the government was the most common source of funding for access to information (data not shown). Nongovernmental organisations occasionally funded access to information, but they were never cited as the main source of information.

Issues impacting the use of extension services by farmers were identified by farmers and extension officers in separate feedback sessions. The 2 major issues identified by both groups were timeliness of the extension officers' responses to requests from farmers and the fact that extension officers provide advice without being able to offer treatment or vaccination. Timeliness of service provision was affected by a lack of available transport and by competing demands on the extension officers' time, while the quality of the service

TABLE 3. Engagement of Poultry Farmers With Farmers Groups, Extension and Information Providers, and Vaccine Suppliers Across a Gradient of Farm Intensification in Northern Tanzania

	Farm Type					Statistics[a]	
Topic	Total n	Broiler n	Intensive n	Semi-intensive n	Extensive n	Chi-square	*P* Value
Farm group membership[b]	32	6	10	8	8	5.0	.17
Farmer field school	25	8	5	6	6	2.0	.57
Poultry association	15	2	5	4	4	1.3	.72
Useful	10	3	2	1	4	2.7	.46
Main extension provider							
Government	8	0	1	3	4	6.3	.10
Input supplier	21	8	5	4	4	4.3	.23
Nongovernmental organisation	1	0	1	0	0	3.1	.38
Information sources							
Farmer field school	8	1	1	2	1	0.7	.88
Input supplier	5	1	1	2	1	0.7	.88
Social media	5	1	1	3	3	2.5	.48
Colleagues	22	7	7	3	5	4.4	.22
Vaccine provider							
Government extension	1	0	0	1	0	3.1	.38
Input supplier	38	10	10	9	9	2.1	.55

[a] *P* values indicate significance of an association between farm type and engagement (yes/no) based on chi-square analysis.
[b] Ten farmers were interviewed per farm type, and numbers indicate the farmers using the specified membership or service. Some farmers did not use any of the service providers listed, so numbers may not add up to 10 per farm type.

that could be offered was affected by a lack of mentoring, extension kits, and medicines. An additional issue was the lack of appropriate introductions of extension officers to farmers by the relevant authorities. Private veterinarians and input suppliers can provide advice more quickly. Moreover, they have the ability to offer treatment products, although farmers recognised that they sometimes prescribe drugs that are available in their shop without due consideration of the suitability of the treatment. Suggestions for improvement largely revolved around related issues, including provision of transport and extension kits and changes to the chain of command for extension officers. In addition to health information, farmers desired information that could help them develop their business and access markets, as well as government involvement in inspections of hatcheries and parent stock. Feedback from research was particularly valued by extension officers and was summarised as follows in a vote of thanks on behalf of the group: "It is my first time in 25 years working experience to receive feedback from researchers, so we thank you very much and send our message to your sponsors and universities: We welcome you again".

DISCUSSION

Campylobacter and nontyphoidal *Salmonella* are important human pathogens in sub-Saharan Africa and may be transmitted through food of animal origin, including poultry products derived from healthy birds. Many foodborne human pathogens are commensals in the gastrointestinal tracts of animals, ie, bacteria that are carried without causing disease. Indeed, all *Salmonella* and *Campylobacter* isolates in the current study originated from clinically healthy birds. Small-scale outbreaks of foodborne disease due to contamination of

human food with enteric commensals from animals have probably occurred throughout human history. They gained prominence in public health and scientific research in the latter part of the 20th century, when large outbreaks of salmonellosis and listeriosis in the United States and mortality due to *Escherichia coli* O157 stimulated public awareness and the development of the scientific discipline of food safety.[23–25] Several major foodborne disease outbreaks in the United States and the United Kingdom occurred as a result of intensification and expansion of food production and distribution networks – processes that are currently taking place in much of sub-Saharan Africa.[24,25]

Traditional poultry keeping practices in Tanzania are changing as the country's poultry industry expands to meet the demands of a growing and increasingly urban consumer population. While intensification of food production is needed to provide food security, it must not come at the expense of food safety. Development and implementation of hazard analysis critical control point (HACCP) approaches across networks in the food industry may limit the risk of foodborne disease. For example, implementation of the Lion Code to control *Salmonella* Enteritidis in the British poultry industry has been followed by a significant decrease in human infections with this organism.[26,27] In Africa, intensification of poultry production has been linked with increased prevalence of *Salmonella* and decreased prevalence of *Campylobacter*, but little is known about the association between farm management, biosecurity, and pathogen prevalence in relation to the emerging poultry systems in Tanzania.[8,17] Moreover, it is largely unknown how farmers access information on these topics.

Specific Risk Factors for the Presence of Foodborne Pathogens are Difficult to Identify

The prevalence of *Salmonella* in clinically healthy poultry was low in our study in Arusha, which is a positive outcome. A previous study of *Salmonella* in Tanzanian poultry also found a low prevalence, but that study focused on *Salmonella enterica* subspecies *enterica* serovar Gallinarum in layer hens.[28] In our study, layers were not included, and serotyping of isolates was beyond the scope of this work, making it difficult to compare data across studies. A range of biosecurity measures were considered in our study, and many differed between farm types, including mixing of chickens with wild birds or ruminants. Although livestock, wild birds, and other wildlife may act as a source of *Salmonella* and introduce the organism into poultry flocks, we observed no association between farm types with different biosecurity levels and *Salmonella* prevalence.[7,29]

A lack of identifiable risk factors was also reported in a large study from Canada, where permanent locking of the poultry house was the only factor significantly associated with *Salmonella* prevalence.[16] This risk factor was interpreted as a proxy for general biosecurity measures, but specific measures, such as boot washing, professional rodent control, or absence of contact with other host species were not significant.[16] An alternative source of *Salmonella* exposure for chickens is poultry feed. A recent study on commercially produced chicken feeds from 3 feed mills in Dar es Salaam, Tanzania, showed that *Salmonella* prevalence ranged from 15% to 48% of feed bags, with significant differences between feed mills.[30] This suggests that the "farm-to-fork" or "stable-to-table" concept should include poultry feed, as is the case with the British approach to *Salmonella* control.[26] To determine the importance of feed as a source of *Salmonella* carriage in chickens or the importance of carriage in chickens as a source of human foodborne disease, strain typing of isolates from feed, chickens, and people would be required. In Burkina Faso, poultry, cattle, and pigs were shown to have similar levels of intestinal carriage of *Salmonella*, but only poultry isolates were genetically similar to those from humans, implicating poultry as the most likely source of human pathogens.[7]

Flock-level prevalence of *Campylobacter* carriage was 50% in our study, again without noticeable health impacts on the animals and without identification of specific risk factors, making it difficult to provide reasons and recommendations for *Campylobacter* control based on poultry health alone. Moreover, occurrence of *Salmonella* and *Campylobacter* was independent, suggesting that they are driven by different underlying processes and may require distinct control strategies. The fact that foodborne pathogens do not cause disease in animals poses a significant challenge because interventions that contribute to improved food safety and public health do not necessarily provide benefits to animal health. This is illustrated by the situation with *E. coli* O157:H7 in the United Kingdom, where vaccination of cattle would have major public health benefits but no animal health benefits, and uptake by farmers is low due to lack of economic incentives.[31] Likewise, resource-constrained poultry producers in Tanzania may have low incentive to invest in control of foodborne pathogens that do not affect the health of their birds.

Antimicrobial Use is Common in Poultry Production and May Pose a Risk to Public Health

In addition to the issues of food safety and food security, both of which should be considered One Health issues, a third One Health issue was identified through questionnaires: a lack of guidance and knowledge around the use of antimicrobials. Fewer than half of the farmers were aware of the existence of withdrawal times after antimicrobial use, and even fewer abided by the withdrawal guidelines. Considering global concerns about antimicrobial resistance (AMR), the observed lack of awareness and compliance with withdrawal times needs to be addressed. Awareness and compliance were more common among intensive and broiler farmers, hinting at potential benefits of intensification in terms of farmer education.

At the same time, broiler farmers were more likely to use antihelminthics and to use antimicrobials routinely. Broiler farmers were also more likely than other farmers to rely on input suppliers for extension services and on colleagues or personal experience for information and treatment decisions. Lack of independent, professional advice could contribute to frequent drug administration, which might contribute to higher selection pressure in favour of AMR, suggesting a potential hazard of farm intensification. The numbers in our study are small and associations are mostly nonsignificant, but the lack of unbiased professional input towards health management and treatment decisions may warrant more thorough socio-anthropological investigation of this issue. Tanzania's National Action Plan on AMR includes an analysis of strengths, opportunities, weaknesses, and threats and recognises that inadequate promotion of food safety along the chain and dispensing of antimicrobials by nonprofessionals are threats to AMR prevention.[32]

Poultry Farmers and Extension Officers Agree on the Need for Improved Service Provision

The importance of communication and access to information and drugs were also raised in feedback workshops. The fact that extension officers offered advice on health management and disease prevention rather than products for disease treatment was seen as a major weakness of the service they provide. This has been a longstanding problem in preventive veterinary medicine throughout the world, and cycles of rise and fall in interest in preventive rather than curative approaches have been described in detail in the United Kingdom.[33] Briefly, in times of need, urgency tends to take precedence over long-term consequences, and resources are diverted towards curative approaches. Use of resources for disease prevention is more likely in periods of relative wealth and calm. In Europe, differences still exist between production sectors, whereby preventive health management is now the standard on poultry farms, and cattle practice is often still largely responsive. Currently, only 20% of livestock farmers in Tanzania use livestock services.[34] Policy priorities for improved livestock services were recently identified by means of a livestock field officer survey.[34]

The survey identified better transport, improved balance between administrative and technical duties, and supervision for livestock officers as policy priorities. These priorities were echoed in our feedback workshops. Additional priorities were regulation of fees charged by livestock officers – who may also act as private input suppliers – and better communication between central and local government staff on livestock-related policy.[34] Our data suggest that improvement in communication is not only needed within the government-regulated livestock system but also between the government system and poultry producers, particularly producers in intensive systems. If trends in population growth and urbanisation continue, so will the intensification of poultry production. Considering that the average broiler flock in the study area was almost 20 times as large as the average extensive flock, a growing proportion of poultry meat will originate from broiler farms. Unbiased information on disease prevention and control, along with incentives to limit the use of antimicrobials and the risk of AMR, will become increasingly important as the intensification of poultry production continues.

Limitations

This study had several limitations, such as the limited number of farms per production system and the narrow geographic focus on Arusha Urban District. However, all relevant levels of intensification were represented, and the information obtained from the study has yielded valuable insight into the complexity of managing poultry health and public health in an economically viable manner. Particularly, our results suggest that biosecurity measures, which farmers implement to protect poultry health, are not directly linked with the prevention of foodborne pathogens, and that different foodborne pathogens may have different drivers of prevalence. A much larger study would be needed to identify risk factors for all relevant poultry health and public health hazards, and it would need to be accompanied by economic studies to understand how to incentivise poultry keepers to take measures to prevent multiple hazards, including those that are not directly related to poultry health. A second limitation of this study is that *Salmonella* and *Campylobacter* isolates were not identified to strain level, and they were not compared with isolates of human origin. Thus, their potential contribution to the human disease burden was not demonstrated at the molecular level. Isolates have been archived at Kilimanjaro Clinical Research Institute so that molecular epidemiological investigations can be conducted at a future date.

CONCLUSION

Population growth, urbanisation, and the associated emergence of intensified poultry production systems in Tanzania bring opportunities and risks for poultry farming, public health, and food safety. Based on our findings, biosecurity and awareness of antimicrobial residues is better on large, intensive farms than on small, extensive farms, implying that intensification may bring benefits for poultry health (reduced risk of disease introduction through better biosecurity) and for human health (reduced risk of antimicrobial residue in food for human consumption). In contrast to extensive producers, who receive advice from government extension officers, intensive producers tend to receive poultry health and treatment advice from private commercial suppliers who may have inherent conflicts of interest related to provision of information and products. This could contri-

bute to overuse of antimicrobials and might constitute a risk to public health. Biosecurity measures were not linked to detection of *Salmonella* or *Campylobacter*, implying that farm management strategies to protect poultry health do not necessarily protect human health. Separate control strategies may need to be developed to limit the presence of foodborne pathogens. This is further complicated by the fact that occurrence of the 2 pathogens seems to be independent, suggesting that different transmission mechanism and control strategies are involved. For the sake of food security and public health, it seems important that the Tanzanian government develops ways to engage with its emerging poultry production system so that the potential benefits of intensification for biosecurity, food security, and food safety can be reaped without increasing the risk of overuse of antimicrobials.

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