East African Medical Journal Vol: 93 No.8 August 2016
DETERMINANTS OF VACCINATION COVERAGE AMONG PASTORALISTS IN NORTH EASTERN KENYA
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ABSTRACT

***Background*: Vaccination is the most cost-effective, highest-impact health intervention to reduce the morbidity and mortality of Vaccine Preventable Diseases (VPDs). Despite success in Kenya implementing the Expanded Programme on Immunisation, VPDs remain prevalent in pastoralist communities. Pastoralism was defined as raising any livestock other than fowl; nomadism was defined by seasonal movement ofanimals for grazing.**

***Objective*: To examine the roles of geographic access and Knowledge, Attitudes, and Practices (KAPs) on vaccination coverage among settled and nomadic pastoralist households (HHs).**

***Design*: A cross-sectional study.**

***Setting*: Lagdera Sub-county, Garissa County, North Eastern, Kenya.**

***Subject*: Twelve mothers were selected for interview per cluster. We used a structured instrument to survey pastoralist mothers with children aged 0–59 months old.**

***Results*: A total of 476 eligible mothers were interviewed with 725 children; 241 mothers (50.6%) belonged to nomadic HHs while 235 (49.4%) belonged to settled HHs. Forty percent of nomadic mothers stated that vaccination was "very important" compared to 87.2% of mothers from settled HHs. Nearly 60% of mothers from nomadic HHs had never vaccinated all their children in comparison to 7.2% of mothers from settled pastoralist. The main reason for non-vaccination among mothers from nomadic HHs was "hospital or clinic was too far away" (78.6%).Analysis of the collected data revealed steep distance decay in the level of vaccine utilisation.**

***Conclusion*: Nomadic pastoralist exhibited very low vaccination coverage than their settled counterpart.This, in turn, calls for proper policy measures for addressing these inequities.**

INTRODUCTION

Childhood vaccination is the most successful and cost-effective public health intervention in terms ofnumbers of deaths prevented per year (1). In the developing countries, it prevents mortality of approximately three million children per year and also has the potential to prevent an extra two million deaths if vaccination programmes are expanded and entirely implemented (2). Vaccination is responsible for the control of many infectious diseases that were once common globally (3). The Expanded Program on Immunisation (EPI) was launched in Kenya in 1981with the objective of reducing morbidity, mortality and disabilities from Vaccine Preventable Diseases (VPDs) by making free vaccination services easily available to all eligible children.

Despite this,VPDs remain the most common cause of childhood mortality among pastoralist in Kenya. Dubale and Mariam (2007) define 'pastoralist' as those whose livelihood depends on and typically derive at least half of their food and income from their livestock (4).In developing countries there are about 50 to 100 million pastoralists, in which 60% are found in sub-Saharan Africa (5). Pastoralism is a common source of livelihood in countries in the Horn of African (6). In Kenya, pastoralism is commonly practiced in arid and semiarid areas of Northern Kenya.

Two forms of pastoralism are practiced in Kenya. The first group is nomadic pastoralists where herders adapt to spatial-temporal variability in pasture and water availability through carefully calculated herd movements (7). The second group is the settled pastoralists who usually keep smaller herds than

those found in nomadic pastoralists because they no longer rely solely on livestock and depend on a finite grazing area which can be reached from their villages within a day (8). Pastoralists are some of the poorest sub-populations living in remote areas (9). They rarely seem to utilise services of professional health workers including basic vaccination services (10). This results in high child mortality due to VPDs like measles (11).

Widespread disparities in vaccination coverage persist among counties/regions in Kenya to the disadvantage of children of parents from pastoral communities in Northern Kenya. The Kenya Demographic and Health Survey (KDHS) of 2014 reported a declinein vaccination coveragefor fully vaccinated children aged 12–23 months from 77% in 2008–09 to 71% in 2014 (12). The highest percentage of fully vaccinated children was in Nandi County (86%) an entirely settled population, whereas Garissa County, which is largely pastoral population,recorded a lower proportion of fully vaccinated children (54.4%) (12). A study among the settled and nomadic Rendille in Northern Kenya revealed that all children over one year of age in settled villages had full vaccination coverage while among their nomadic counterparts vaccination coverage was nearly zero (13).

In Kenya a child should receive BCG at birth, three doses of Pentavalent [Diphtheria, Pertussis, Tetanus, Hepatitis B and Haemophilus influenza type b (Hib)] (at 6, 10 and 14 weeks), three doses of Pneumococcal Vaccine (PCV) (at 6, 10, and 14 weeks), four doses of Oral Polio Vaccine(OPV) (at birth and 6, 10 and 14 weeks) and one dose of Measles vaccine (at 9 months) and measles booster dose at 18 months. The routine vaccination of a child requires, at least, six visits to a vaccination centre. At each visit after vaccination, mothers/parents are given an appointment for the next vaccination. Every child is issued with a vaccination card, which the mothers/parents are required to produce on each visit.

Gaps in vaccination coverage present a serious public health challenge. Unvaccinatedpastoralist children can serve as vectorsfor infectious diseases like polio and unwittingly contribute to the continued transmission of VPDs. Diseases earmarked for eradication or elimination like polio and measles cannot be eradicated until pastoralpopulation are fully vaccinated.

Assessing vaccination coverage helps to measure progress in accomplishingprogram objectives and in improving service delivery. Therefore, we designed a survey that sought to assess vaccination coverage for childhood vaccines and maternal factors impacting coverage among settled and nomadic pastoralist households (HHs) in Lagdera Sub-county, Garissa County, North Eastern Kenya. This data will present an accurate picture of vaccination coverage among pastoralists and will inform policy makers of EPI, Ministry of Health (MoH), and other key health sector partners involved in vaccination.

MATERIAL AND METHODS

Study area and Population: The survey was conducted as a community-based cross-sectional survey in Lagdera sub-countyof Garissa County, in February 2015. Lagdera Sub-county is largely a pastoral area that covers a vast arid area of about 8,389.8 km^2 with a population of about 92,636 individuals (2009 census). The study targeted mothers with children aged between 0–59 months. To be eligible for recruitment into the survey, mothers were required to give consent, live in Lagdera sub-county, and have children aged 0–59 months.

Sampling frame: One of the inherent challenges in studying nomadic populations relates to creating a sampling frame for a population that is fluid in its composition and location during over time. The most precise frame available for Sub-county localities is that developed by health centers for polio micro planning. The micro-plan developed for the polio outbreak by the Lagdera health team listed 119 permanent settlements and 75 nomadic sites. We validated the micro-plan by conducting key informant interviews at the Sub-county and division headquarters. The first validation verified 121 settled sites and 62 nomadic sites. After the 1st validation, we received additional map layers from other sources that increased the scope of our sampling frame in the second validation. Using maps as a mnemonic prompt during subsequent key informant interviews, we were able to elicit a complete and accurate data on seasonal nomadic sites, which increased to 148 while settled sites increased to 136. The 148 seasonal sites are all the possible areas that may be inhabited by nomads in a one year cycle; some areas may be occupied in one season while others may be occupied in the next seasons.

Sample size determination: To estimate the sample, the desired confidence interval was taken to be 95%. The desired level of precision of the estimates was ±7.7%. A routine coverage of 30% was assumed for pastoralist. The total sample size (minimum) was 135 per each group (nomads and settled) and was raised by 100% = 270 and rounded to 300to take care of non response. The total sample size was selected from 25 clusters (12 mothers per cluster).

Sampling technique: Using a computer algorithm, 25 settled pastoralists' clusters were randomly selected by Probability Proportional to Size sampling from the sampling frame. Similarly, 25 nomadic pastoralist clusters were also selected using simple random sampling with replacement in cases where the cluster is not available seasonally. Within each cluster (in

both groups), 12 mothers with children younger than five years of age from non-contiguously located households within the cluster was randomly selected for the survey. A house hold was defined as those in which one or several families share the kitchen/ cooking area. Only one family (mother and children) was selected per household. Within each cluster, the systematic random method was used to select the first household. Subsequent households were selected following the "5th household from the last household to the right" criteria until the required sample size for the cluster was obtained.

Data collection: A structured survey instrument was used to collect quantitative data such as social-demographic and KAPs of the study groups and was administered by six trained interviewers. We pilot tested the survey instrument in July 2014. Based on the results of the pilot and interviewer feedback, we added, deleted or modified some survey questions. Because of the complex skip pattern we adopted an automated survey instrument that uses mobile devices that can transmit data to an online server. The survey instrument was programmed in both English and Somali using Open Data Kit (ODK)software;it was then loaded into Samsung tablets for data collection and data transmission into an online server. Interviewers were recruited and trained for three days on the best practices of survey administration on an ODK platform,use of GPS devices, and the study protocol of sampling participants.Interviewers visited the homes of selected or sampled mothers; obtained informed consent and completed survey instrument using the ODK platform. Every eligible mother was asked to produce a vaccination card for all her children aged 0–59 months. In cases where the vaccination card is not available or lost, the mother was asked to recall the vaccines antigens administered to the child. Geo-coordinate of the current household position and for all vaccination centres in the Sub-county was captured using handheld global positioning devices (GPS) to estimate physical access to services. After completing the survey instrument, the data were automatically transmitted from the tablets to an online server via a secure cellular network.

Data management and analysis: During field operation, at the end of each day of data collection all survey data were reviewed by the principal investigator to ensure that all variables were correctly filled and securely transmitted to the server. Tablets were password protected and data transmission between the tablets and the server were secured through encryption. Data cleaning and validation were performed by theprincipal investigator. The online server or the computer hosting the database was accessible only to the principal investigator and was password protected.

We used four measures to describe the vaccination status of children: "never vaccinated" to indicate that a child received none of the five vaccines {BCG, Pentavalent, OPV, PCV and Measles at 9 month}; "partially vaccinated" to indicate that a child received, at least, one complete dose of either BCG, Pentavalent, OPV, PCV or Measles at 9 months, but did not receive all recommended doses of all five vaccines; "fully vaccinated" to indicate that a child received all recommended doses of all five vaccines and "age appropriately vaccinated" to indicate that a child received all recommended vaccines as per his/her age and vaccination schedule. For every mother, vaccination data were collected for all her children aged between 0–59 months. Because of multiple children per mother, we scored the mother using vaccination status of her children (Mother's Vaccination Score). A score of "0" if her all her children were unvaccinated, ascore of "1" if some of her children were unvaccinated or partially vaccinated and ascore of "2" if all her children were fully vaccinated or age-appropriately vaccinated.

The dependent variable was Mothers' Vaccination Score (MVS) while Independent variables were socio-demographic characteristics, mothers KAPs on vaccination, sources of information on vaccination and euclidean (straight line) distance to ahealth facility. Euclidean distance to the nearest health facility was computed from the household and health facility GPS data. Ordinal logistic regression method was conducted to determine the predictors of MVS for both settled and nomadic mothers. A p-value < 0.05 was considered to indicate statistical significance. SPSS version 22 was used for statistical analysis while ArcGIS 10.2 was used for spatial analysis.

Ethical consideration: Ethical approval was sought from Ethical Review Committee (ERC) of Kenya Medical Research Institute (KEMRI). Permission to conduct the study was also sought from LagderaSub-county authorities.

RESULTS

Social demographic characteristics: A total of 553 mothers were visited by the interviewers in Lagdera sub-county. However, 77(13.9%) mothers were excluded on account of not meeting the eligibility criteria. Thus, there were 476(86.1%) eligible mothers for a total of 725 children aged 0–59 months with an average 1.5 children per mother. A total of 241(50.6%) mothers belonged to nomadic HHs and 235(49.4%) belong to settled HHs. Table 1 summarises the socio-demographic characteristics of the mothers and children.

Table 1
Socio-demographic characteristic of the mother and children

Variable	Nomadic N=241(%)	Settled N=235(%)
Mothers Age group(years)		
< 20yrs.	32(13.3%)	12(5.1%)
20–29yrs.	74(30.7%)	82(34.9%)
30–39yrs.	106(44%)	115(48.9%)
≥ 40yrs.	29(12%)	26(11.1%)
Marital status		
Married	238(98.8%)	229(97.4%)
Single	3(1.2%)	6(2.6%)
Marriage Type		
Monogamous	216(89.6%)	211(89.8%)
Polygamous	25(10.4%)	24(10.2%)
Education status		
Islamic education		
No	92(38.2%)	42(17.9%)
Yes	149(61.8%)	193(82.1%)
Formal education		
No formal education	239(99.2%)	225(95.7%)
Lower primary school	1(0.4%)	5(2.1%)
Upper primary school	0(0%)	3(1.3%)
Secondary school and above	0(0%)	0(0%)
Missing data	1(0.4%)	0(0%)
No of biological children <5yrs.		
1	126(52.3%)	130(55.3%)
2	100(41.5%)	91(38.7%)
3	15(6.2%)	14(6%)
Mean age ± SD (months) of children	27±15.08	24±14
Gender of children		
Male	194(52.3%)	202(57.1%)
Female	177(47.7%)	152(42.9%)

The mean age (± standard deviation) of nomadic mothers was slightly lower than (29.8 ±7 years) than mothers from settled pastoralist (31.17±6). The majority of mothers in both groups (nomadic and settled HHs) were married (>97%) with approximately 10% of them in polygamous marriages. Nearly all the mothers in both groups (nomadic and settled) received no formal (western) education (>95%) but Islamic education had a significant penetration; 61.8% for nomads and 82.1% for settled pastoralist. Out of the 725 children aged 0–59 months, 371(51.2%) were born to nomadic mothers while 354(49.8%) were from settled pastoralist. The mean age (± standard deviation) of children was 27±15 months for nomads and 24±14 months for settled pastoralist.

Mothers' Knowledge on vaccination: The majority of mothers from settled household (94%) stated that vaccination "protects children from diseases" as compared to mothers from nomadic pastoralist (68.9%). Most of the nomadic mothers did not know when to start vaccination for their children; only 14.9% of nomads stated that vaccination should be started at birth as compared to mothers from settled HHs (66.4%). Nomads also

demonstrated lower knowledge on the question when measles vaccine is administered to their children; 20.33% of nomads and 58.7% of settled pastoralist stated nine months as atime for measles vaccination. Nearly two-thirds of mothers from both groups were generally knowledgeable about symptoms of measles with 62.1% of settled and 65.1% of nomads mentioning rash as a symptom but the picture was different for polio; only 28.2% nomadic pastoralist were able to recognize sudden onset paralysis as compared to 48.5% of their settled counter part. Eighty per cent of mothers from nomadic households and 61.7% of mothers from settled HHs didn't know the cause of polio with many of them citing non-biological causes like wind and ghost while others directly attributing to God. Table 2 summarises the mothers' knowledge on vaccination.

Table 2

Mothers' knowledge on vaccinationby nomadic and settled pastoralist

Variable	Nomadic N=241(%)	Settled N=235(%)
Purpose of vaccination		
Help a child grow	4(1.7%)	5(2.1%)
Protect a child from certain diseases	166(68.9%)	221(94%)
Gives the child strength	5(2.1%)	2(0.9%)
Don't know	65(27%)	7(3.0%)
Others	1(0.4)	0(0%)
Age at first vaccination		
At birth	36(14.9%)	156(66.4%)
1 to 2 weeks after birth	3(1.2%)	12(5.1%)
1 month after birth	11(4.6%)	4(1.7%)
40 days after birth	43(17.8%)	33(14%)
Others	1(0.4%)	0(0%)
Don't know	146(60.6%)	29(12.3%)
Missing data	1(0.4%)	1(0.4%)
Age at measles vaccination		
9 month	49(20.3%)	138(58.7%)
Other times	31(12.9%)	10(4.3%)
Don't know	161(66.8%)	87(37%)
Symptoms of Measles*		
Red month	55(22.8%)	90(38.3%)
Rash	157(65.1%)	146(62.1%)
Cough	81(33.6%)	106(45.1%)
Fever	160(66.4%)	149(63.4%)
Diarrhoea	4(1.7%)	6(2.6%)
Vomiting	8(3.3%)	12(5.1%)
Others	1(0.4%)	12(5.1%)
Symptoms of Polio*		
Red month	3(1.2%)	2(0.8%)
Rash	4(1.7%)	3(1.3%)
Cough	8(3.3%)	5(2.1%)
Fever	28(11.6%)	19(8.1%)
Diarrhoea	8(3.3%)	12(5.1%)
Vomiting	6(2.5%)	0(0%)
Sudden paralysis	68(28.2%)	114(48.5%)
Others	10(4.1%)	3(1.3%)
Don't know	162(67.2%)	116(49.4%)
Causes of Polio		
Don't know	193(80.1%)	145(61.7%)
Wind/Ghost/God	45(18.7%)	86(36.6%)
Lack of vaccination	0(0%)	2(0.9%)
Others	3(1.2%)	2(0.9%)

*Multiple response questions

Mothers' Attitude on vaccination: Most of themothers from settled HHs (87.2%) stated that vaccination was "very important" whereas only 40.2% of their nomadic counterparts thought vaccination was very important. Similarly, when we posed the question "do you feel that vaccinations are safe" 95.7% of mothers from settled HHs stated that vaccination was "safe" or "very safe" whereas less than half (48.5%) of their nomadic counterparts believed vaccination was safe. More than 85% of mothers (in both groups) whose children received vaccines were willing to accept any remaining vaccine antigens and were also willing to pay for the vaccines. The attitudes of mothers' on vaccination in both groups are shown in Table 3 below.

Table 3
Mothers' Attitude on vaccinationby nomadic and settled pastoralist

Variable	Nomadic	Settled
Importance of vaccination	n=241	n=235
Not very important	9(3.7%)	6(2.6%)
Somewhat important	65(27%)	17(7.2%)
Very important	97(40.2%)	205(87.2%)
Don't know	70(29%)	7(3%)
Do you feel that vaccination is safe		
	n=241	n=235
Not Safe	61(25.3%)	6(2.6%)
Somewhat safe	60(24.9%)	4(1.7%)
Safe	68(28.2%)	142(60.4%)
Very safe	49(20.3%)	83(35.3%)
Missing data	3(1.2)	0(0%)
Willing to accept remaining vaccines		
	n=101	n=219
Probably not	7(6.9%)	0(0%)
Unsure	4(4%)	11(5%)
Probably yes	2(2%)	8(3.7%)
Yes	88(87.1%)	200(91.3%)
Willing to pay for vaccines	n=101	n=219
No	14(13.9%)	16(7.3%)
Yes	86(85.1%)	194(88.6%)
It depends on the cost	1(1%)	7(3.2%)
Others	0(0%)	1(0.5%)
Don't know	0(0%)	1(0.5%

Practices of mothers

Out of 371 children from nomadic HHs,only 11.6% were fully vaccinated. Similarly, out of 354 children from settled HHs,only 50.3% were fully vaccinated. A huge proportion of nomadic children (61.7%) were never vaccinated as compared to their settled counterpart (9.6%) (Table4). Nearly 60% of mothers from nomadic HHs and 7.2% of mothers from settled pastoralist had never vaccinated all their children or MVS=0. Reasons cited by mothers from nomadic HHsfor non-vaccination were; hospital or clinic was too far away (78.6%); 23.6% reported that they did not know the child needed vaccination and 44.3% stated that "no one comes to our village" which suggests that they are relying on health centres for outreach. However, only 29.6% children from nomadic HHs and 38.1% of children from settled communities possessed a vaccination card. The most common form of transport to ahealth facility in both groups is pedestrian; 98.8% for nomads and 81.3% for settled pastoralist.

Table 4
Practices of mothersby nomadic and settled pastoralist

Variable	Nomadic	Settled
Child Vaccination Status	n=371	n=354
Fully vaccinated	43(11.6%)	178(50.3%)
Age Appropriately vaccinated	24(6.5%)	53(15%)
Partially vaccinated	75(20.2%)	89(25.1%)
Never vaccinated	229(61.7%)	34(9.6%)
Mothers Vaccination Score(MVS)	n=241	n=235
0 - All children never vaccinated	143(59.3%)	17(7.2%)
1 - Some children are partially/never vaccinated	73(30.3%)	82(34.9%)
2 - All children are fully/age appropriately vaccinated	25(10.4%)	136(57.9%)
Mode of transport to health facility*	n=241	n=235
Walk/on foot	237 (98.8%)	191(81.3%)
Bus	7(2.9%)	33(14%)
Motorcycle	1(0.4%)	0(0%)
Private vehicle	0(0%)	5(2.1%)
Others	1(0.2%)	7(3%)
Vaccination card possession	n=142	n=320
Yes	42(29.6%)	122(38.1%)
No	100(70.4%)	198(61.9%)
Place children get vaccinated	n=101	n=219
At health facility	50(49.5%)	156(71.2%
Outreach	5(5%)	29(13.2%)
Both health facility and outreach	44(43.6%)	33(15.1%)
Private clinic	0(0%)	1(0.5%)
Others	2(2%)	0(0%)
Husband accompanying mother during child vaccination visits		
	n=101	n=219
No	61(60.4%)	141(64.8%)
Yes	10(9.9%)	27(12.3%)
Sometimes	30(29.7%)	50(22.8%)
Reason for non-vaccination*	n=140	n=16
Did not know they needed vaccination	33(23.6%)	5(31.3%)
Don't know where to go	8(5.7%)	0(0%)
Hospital/clinic too far away	110(78.6%)	7(43.8%)
Local clinic does not offer vaccination	5(3.6%)	0(0%)
No one comes to our village	62(44.3%)	4(25%)
Side effects of vaccination/safety	17(12.1%)	6(37.5%)
No time/Busy with household chores	19(13.6%)	4(25%)
Children too young	1(0.7%)	0(0%)
The clinic charges for vaccines	1(0.7%)	0(0%)

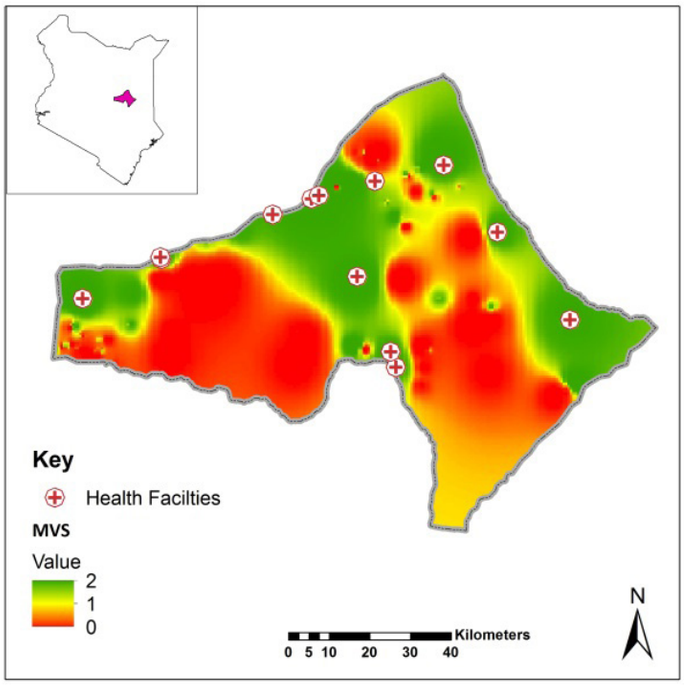
*Multiple response questions

Distance to health facility: The average distance to ahealth facility was 4.8Km for settled HHs while it was 13.1Km for nomadic pastoralist. A total of 151(64.3%) mothers from settled HHs were within 5Km to a health facility, in which 96 mothers had MVS of 2 as compared to mothers from nomadic HHs; only 5(2.1%) mothers were within 5Km to ahealth facility, in which all of them had MVS of zero. Similarly, 86(35.7%) mothers from nomadic HHs were above 15Km to ahealth facility, in which 61 mothers had MVS of zero while 21 mothers from settled were above 15Km to ahealth facility, in which none of them had MVS of zero (Table 5). Figure 1 visualizes how distance to health facility affects uptake of vaccination.

Table 5
Cross-tabulation of distance to health facility and MVS

Distance to Health facility	Nomadic				Settled			
	MVS=0	MVS=1	MVS=2	Total	MVS=0	MVS=1	MVS=2	Total
< 5Km	5	0	0	5(2.1%)	9	46	96	151(64.3%)
5 to 10Km	44	30	11	85(35.3%)	6	16	18	40(17%)
10 to 15Km	33	23	9	65(27%)	2	13	8	23(9.8%)
>15Km	61	20	5	86(35.7%)	0	7	14	21(8.9%)
Total	143	73	25	241(100%)	17	82	136	235(100%)

Figure 1
Spatial distribution of combined MVS for both nomadic and settled pastoralist in arelationship with health facility locations. The map illustrates how geographical proximity to health facilities influences MVS



Vaccination coverage for routine vaccinesantigens: The coverage of BCG, Pentavalent3, OPV3, PCV3 and measles at 9 month for nomadic pastoralist was 36.9%, 16.9%, 15.2%, 17.2% and 23.9%, while for settled pastoralist was 87.3%, 71.2%, 71.2%, 70.5% and 78.6% respectively(Table 8). The coverage for measles at 18 months (booster) was poor in children from settled HHs (32.9%) while it was worse in their nomadic counterpart (5.4%). The dropout rate for nomadic pastoralist was 16.1% while the settled group was 14% (Pentavalent1-Pentavalent 3).

Table 6
Vaccine antigen coverage for routine vaccination

Antigens	Nomadic		Settled	
	N	%	N	%
BCG (at birth)	371	36.9	354	87.3
OPV0 (at birth)	371	15.9	354	61.0
Pentavalent1(at 6 weeks)	355	33.0	337	85.2
OPV1 (at 6 weeks)	355	32.1	337	84.3
PCV1 (at 6 weeks)	355	32.7	337	84.3
Pentavalent2 (at 10 weeks)	351	25.6	326	83.1
OPV2 (at 10 weeks)	351	26.5	326	81.6
PCV2 (at 10 weeks)	351	25.4	326	83.1
Pentavalent3(at 14 weeks)	349	16.9	319	71.2
OPV3 (at 14 weeks)	349	15.2	319	71.2
PCV3 (at 14 weeks)	349	17.2	319	70.5
Measles(at 9 month)	322	23.9	295	78.6
Measles Booster (at 18 month)	261	5.4	231	32.9
Never vaccinated	371	61.7	354	9.6

Factors associated with MVS: The factors that were significantlyassociated with MVS in settled group areKAPs indicators like; purpose of vaccination (p=0.001), importance of vaccination (p<0.0001), age of first vaccination (p=0.015), safety of vaccines (p<0.0001), communication indicators like radio ownership (p=0.02)and 5km euclidean distance to health facility (p=0.018). Similarly, the factors that were significantly associated with MVS in nomadic group are KAPs indicators like; purpose of vaccination (p<0.0001), importance of vaccination (p<0.0001), age of first vaccination (p<0.0001), safety of vaccines (p<0.0001), communication indicators like radio ownership (p=0.011) and 15km euclidean distance to health facility (p=0.018). Surprisingly, Islamic education/Quranic (p<0.0001) and mobile phone ownership (p=0.001) was significantlyassociated with the nomadic group only. (Table 9 and 10 summarizes the independent variables that are associated with MVS)

Table 7
Factors affecting the rate of MVS for nomadic and settled mothers

	Nomadic				Settled			
Independent Variable	OR	95% CI		P value	OR	95% CI		P value
		Lower	Upper			Lower	Upper	
Social –demographic characteristic								
Age of Mother								
>40yrs	3.796	1.344	10.708	0.012	0.451	0.114	1.775	0.254
30 to 39yrs	3.435	1.585	7.433	0.002	0.803	0.254	2.535	0.708
20 to 29yrs	1.317	0.604	2.869	0.489	0.747	0.231	2.413	0.626
<20yrs	1	-	-	-	1	-	-	-
Islamic Education/Quran								
No	3.077	1.747	5.414	<0.0001	1.55	0.813	2.965	0.183
Yes	1	-	-	-	1	-	-	-
Mobile phone ownership								
No	2.638	1.504	4.627	0.001	0.836	0.494	1.415	0.505
Yes	1	-	-	-	1	-	-	-
KAPs								
Purpose of Vaccination								
Doesn't Knows	13.860	5.737	33.48	<0.0001	6.203	2.149	17.903	0.001
Knows	1	-	-	-	1	-	-	-
Importance of Vaccination								
Not very important								

/Don't Know	15.487	6.411	37.41	<0.0001	21.520	6.560	70.598	<0.0001
Somewhat important/Very important	1	-	-	-	1	-	-	-
At what age should a child receive its first vaccine								
Other times/Don't know	7.221	3.540	14.75	<0.0001	1.944	1.140	3.317	0.015
At Birth	1	-	-	-	1	-	-	-
Do you feel Vaccination are safe								
Not safe/Somewhat safe	4.549	2.633	7.854	<0.0001	53.732	12.122	238.174	<0.0001
Safe/very safe	1	-	-	-	1	-	-	-
Communication								
Having a working Radio								
No	2.540	1.241	5.202	0.011	2.586	1.435	4.660	0.02
Yes	1	-	-	-	1	-	-	-
Distance to health facility								
Euclidean distance								
≥ 15Km for Nomads;								
≥ 5Km for settled	2.195	1.261	3.819	0.005	1.883	1.113	3.190	0.018
< 15Km for Nomads;								
< 5Km for settled	1	-	-	-	1	-	-	-

DISCUSSION

The uptake of formal (western) education among mothers is poor in both groups. Leggett (2005) reported that pastoralistsin North Eastern Kenya generally have alowlevel of formal education with a huge gender gap that favours boys (14). As observed elsewhere,Islamic/Quranic education is generally accepted in both groups and is seen as religious obligation (15). Mobile phone ownership was significantly associated with MVS; only in the nomadic group (p=0.001), indicating that some of the nomadic pastoralists canaccess acellular network and health facilitywhich are often co-located.

In this study,Knowledge about vaccination is strongly associated with vaccination status of a child/MVS. This finding is in conformity with previous studies (16, 17). Mothers from nomadic HHs exhibited lower knowledge on vaccination as compared to the settled group and is the same group that recorded high non-vaccinated children (61.7%). Low vaccination knowledge among nomads may be due to lack of awareness and high illiteracy levels. For settled group, knowledge on vaccination was lower as compared to other rural settled setting; for example, a study conducted in rural Ghana had higher knowledge indicators (18).

Mothers from settled HHs had higher positive attitudes towards vaccination, which the majority in this group regarded as an important intervention (87.2%)compared to their nomadic counterpart (40.2%). The importance of vaccination was astrong predictor of MVS in both groups (p=0.001).Positive attitudes about vaccination are reported in many previous studies (19-21). However, a study by Zelaya-Bonilla *et al*. stated that a positive attitude may not translate to full vaccination; despite the positive attitude, mothers may sometimes not complete vaccination schedule because of poor knowledge on vaccination (22).

Nearly 60% ofmothers from nomadic HHs have never vaccinated all of their children in comparison to 7.2% of mothers from settled HHs. These findings are in agreement with many otherstudies that examined access to health among the nomadic pastoralist in chad, Nigeria, and elsewhere (23, 24). Reasons cited by researchers for low health service utilisation among the nomadic pastoralist are spatial mobility, illiteracy, social-cultural barriers and exclusion by health policy makers (25-27).We could only observe cards for 35.5% of the children – more in the settled (38.1%) than in the nomads (29.6%),implying that mothers in both groups do not understand the importance of vaccination cards.

The distance a mother travels had a significant impact on the utilisation of vaccination services in both nomadic and settled pastoralist. Many studies in Egypt, Mozambique, Yemen, and Nigeria have documented service inaccessibility as an important cause of partial or non-vaccination (28-31). We were able to show the distance decay effect, observed elsewhere in Kenya,Malawi, and Niger, where vaccination diminishes with increasing distance from the health facility (32-34). However, a study conducted in Western Kenya failed to link distance and vaccination uptake (35). It may be because 29% of the population in the North Eastern Kenya lives within 5 km of a public health facility, suggesting that geographical access is abarrier to vaccination uptake than in areas where health facilities are close to one another (36).

The coverage ratesfor settled pastoralist (BCG

87.3%, Pentavalent3/OPV3 71.2%, PCV3 70.5%, Measles at 9 month 78.6%) was slightly lower than the findings of KDHS, 2014 for Garissa county except for BCG (BCG 80.3%, Pentavalent3 91.6%, OPV3 75.9%, PCV3 84.7%, Measles at 9 month 81.2%) (12).Sadly, the coverage rates for nomadic pastoralist are very low(BCG 36.9%, Pentavalent3 16.9%, OPV3 15.2%, PCV3 17.2%, Measles at 9 months 23.9%); supporting the argument that nomads are being reached with vaccines. Similar findings were reported from nomadic populations in Chad and Tanzania (37, 38).

Possible solutions to improve vaccination rates of nomadic and other hard-to-reach populations can be found from the experience of countries such as Ethiopia and Chad. In Ethiopia, community health workers adopted a proactive approach by following nomadic pastoralist to locate their children in the respective sites and vaccinate them. This approach made it possible to markedly increase vaccination rates within a short period of time (39); however, sustaining such a robust outreach services over long distances and time periods is a continuing challenge. In Chad, an innovative approach called "one health" has been established to increase vaccinationrates (11, 37, 40, 41). In a region where almost allthe children are unvaccinated among nomadic pastoralists; humanand animal vaccination services were combined.This enabled the health workers to drastically increase vaccination coverage for the first time in this population (11, 37, 40, 41). The one health campaign approach is innovative, appreciated by nomadic pastoralists and less expensive than separate vaccination (42).

In conclusion our study revealed very low vaccination coverage among the nomadic pastoralist as compared with their settled counterpart.Stronger involvement of nomadic pastoralist, re-organisation of the current outreach services and adoption of new innovative methods like "one health" are urgently required to increase vaccination coverage in these remote rural areas of Kenya.

ACKNOWLEDGMENT

To Victoria Gammino (Centre for Disease Control and Prevention, Atlanta), Nina Marano (Centre for Disease Control and Prevention, Kenya), MillicentAketch (Kenya Medical Research Institute, Nairobi), Daniel Macharia (Centre for Disease Control and Prevention, Kenya), Sara Lowther (Centre for Disease Control and Prevention, Kenya), Leonard Cosmas (Centre for Disease Control and Prevention, Kenya) and KathleenWannemuehler(Centre for Disease Control and Prevention, Atlanta) for their technical input.

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