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Epidemiological factors associated with helminths and coccidia in zebu calves under pastoralism in Isiolo County Kenya

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Abstract

In Kenya, helminthosis and coccidia infections in cattle, are the second highest cause of death in zebu calves up to 12 months old, estimated at 12% mortality rate. The aim of our study was to investigate the factors associated with helminth and coccidia infection among zebu beef calves in Isiolo County Kenya. A cross-sectional study was conducted between November and December on 2020 in Isiolo North and South Constituencies. Garbatulla and Burat wards in Isiolo North and Kinna in Isiolo South were purposively selected due to high number of large cattle herds compared to other areas. A total of 411 calves from 34 herds aged between 3 weeks and 12 months were randomly selected for the study. Calf level and management and environmental data were collected through semi-structured questionnaires, observations and physically. Faecal samples were obtained from the rectum or immediately after defaecation for laboratory analysis located in Kinna Ward in Isiolo South Constituency. In the laboratory, faecal egg counts were estimated using the McMaster faecal floatation technique. Descriptive, univariate and multivariable logistic regression analyses were carried out with outcome as parasites eggs or oocysts per gram of faecal sample. The factors associated with coccidia infections in the final multivariable logistic regression analysis for coccidia were: Location (Constituencies), availability of drinking water, lush pasture, floor condition, availability of extension services and herd size. In the multivariable logistic regression final model for strongyle infection, age of the calf, herd size, co-infestation with other parasites, and availability of extension services were significant. The results of this study indicated that prevalence of helminth and coccidia infections in calves is high and the calf, environmental and management factors were associated with such infections.

Keywords: *Epidemiology; pastoralism; calves; helminths; coccidia*

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Introduction

Approximately 80% of Kenyan land is categorized as arid and semi-arid lands (ASAL) and nomadic pastoralism is the main source of livelihood and income to the large number of people inhabiting these areas (Amwata *et al*., 2016). Approximately, 75% of cattle herds in Kenya are under nomadic pastoralism who supply the bulk of meat consumed in country

(Kenya National Bureau of Statistics, 2019). In African Countries, pastoralism contributes 10% to 44 % of the gross domestic product that supports 1.3 billion people (Nyariki and Amwata 2019).

Helminthosis is a gastrointestinal infection caused by nematodes, cestodes and trematodes, which cause sub-optimal production, reproduction, early culling, reduced work capacity, extra cost of treatment, reduced market values of the affected animals and death (Rafiullah *et al*., 2011; Regassa *et al*., 2006). Helminthosis is among the most prevalent infections occurring globally in freely grazing animals (Fitzpatrick, 2013; Charlier *et al*., 2018). Gastrointestinal parasitic infection (GIP) mainly causes chronic and subclinical infections leading to low growth rate, poor production and infertility (Morgan *et al*., 2013). The effect of helminthosis depends on parasite involved, the level of infection, animal factors like age and species and seasons (Singla *et al*., 2014). In Kenya, helminthosis in cattle, is the second highest cause of death in zebu calves up to 12 months old, with an estimated mortality rate of 12% and is ranked behind East Coast fever (ECF) with a mortality rate estimate of 50% in severely affected herds (Thumbi *et al*., 2013). *Haemonchus*, *Cooperia*, *Oesophagostomum*, *Trichostrongylus*, *Nematodirus and Trichuris*, are the commonly reported nematodes in Kenya, with higher prevalence during wet season (Waruiru *et al*., 2000; Thumbi et al., 2013).

The main risk factors for helminthosis include both the animal and environmental factors. Host factors such as immunity of the calf, age and breed, presence of intermediate hosts and vectors, level of grazing fields' contamination are important determinants of GIP infection (Kagira *et al*., 2012). Environmental temperatures, level of humidity type of the pasture/fodder and management factors are highly associated with coccidiosis (Debela, 2002). Clinical coccidiosis depends on level of exposure, species of parasite involved, age of the animal, concomitant infections and management factors. Conditions like poor hygiene, poor nutrition and heavy stocking are associated with low animal resistance that enhance coccidia infections (Oluwadare *et al*., 2010). For helminths, type of the specific helminth involved in the infection determines the severity of the infection and species of the host infected. The most common clinical manifestations include anorexia, weakness and loss of weight, diarrhea, depression and anemia (Alula *et al*., 2013). Bovine coccidiosis is mainly associated with hemorrhagic diarrhea, dehydration, loss of weight, anorexia, depression and death in severely affected animals (Squire *et al*., 2013).

For control of coccidia infection, management strategies such as hygiene, proper stocking rate, help to reduce the incidence of coccidiosis (Catchpole, 1989). Proper feeding of the dam and the calves enhance the immunity and single housing also help in reducing the incidence of coccidiosis (Pavlasek *et al*., 1984).

Chemotherapy composed of amprolium, toltrazuril, Lasalocid sodium and Sulfaquinoxaline give 100% efficacy post-treatment (Sultana *et al.,* 2017).

Ionophores like monensin are preferred due to their ability to allow animals to mount an immune response after initial infection (Chapman *et al*., 2010). Control of bovine coccidiosis should be directed at improving the immune status of the animals by; good hygiene, and avoiding overcrowding, isolation and treatment of the affected, early and sufficient colostrum consumption (Worku *et al*., 2019).

The control of helminthosis in cattle rely mostly on use of chemical anthelmintics which has led to development of resistance by the helminths. Benzimidazoles were the first to be discovered which include albendazole, oxfendazole (Campbell, 1990). Macrocyclic lactones were discovered in 1980s which include ivermectin. Levamisole and pyrantel belonging to nicotinic agonist group are widely used as broad-spectrum (Martin, 1997). Farmers were quick to adopt anthelmintics for control of parasites due to their broad-spectrum aspect, low toxicity, high efficacy and can be used in different production systems with maintenance of husbandry practices (Nansen, 1993). Some helminths have been able to tolerate recommended doses of several drugs that initially killed the particular species, transmitting the resistant gene to the

future generations (Prichard *et al.,* 1980). Development of resistance depends on genetic diversity of the parasite, selection pressure caused by exposure to a particular drug and time (Prichard, 2001).
The gastrointestinal parasitic infection has a high prevalence in Kenya and globally, with freely grazing animals being highly exposed than zero-grazed animals (Kanyari *et al.,* 2010). Studies on helminthosis and coccidiosis and the predisposing factors are mainly focused on dairy cattle with little epidemiological information available in indigenous and traditionally raised cattle. Research on gastrointestinal parasitism in cattle under nomadic pastoralism system is scanty in Kenya, and targeted research in these areas will help add the knowledge on epidemiology of helminths and coccidia infections.

There is an ever increasing human population globally which translates to high demand for protein including animal sourced proteins. Control of diseases of animals particularly gastrointestinal parasitic infections help in improving livestock production to meet the demand of animal proteins and to fit the reduced natural resources for production and meet global requirement for greenhouse gas emission (Charlier *et al.,* 2017). Understanding the epidemiology of gastrointestinal parasites help in determination of control measures to be applied (Ento, 2005).

Materials and Methods

Study area

The study was carried out in Isiolo County, which is located 285km North of Nairobi at 0.3524° N, 38.4850° E. The average altitude is 770 meters above sea level. There are two Constituencies namely Isiolo North and Isiolo South. Livestock production is the biggest economic activity with approximately 80% of the population relying on it. Isiolo County is categorized as an arid and semi-arid area with low-lying land mainly. About 80% of the area cannot support crop production and is mainly used for grazing and agro-pastoralism is rarely practised.

The weather is hot and dry and has two rainy season, with long rain experienced from March to May and short rain occurring from October to December. The mean annual temperature is 29^0C (Republic of Kenya. 2017). There are three agro ecological zones described in Isiolo County as semi-arid, arid and very arid with only 5% of the land is semi-arid, 30% is classified as arid and 65% of the land is classified as very arid (GoK, 2013). In Isiolo North Constituency the semi-arid zone covers Burat Ward, Bulla Pesa Ward and Wabera Ward, Bulla Pesa Ward, and some parts of Burat and in Kinna Ward in Isiolo South Sub-County. 80% of the land is communally owned under the trusteeship of the County government and only 10% is owned privately and 10% belongs to government facilities like health and administration departments. (GoK, 2013).

Study design

A cross-sectional study was carried in cattle calves under pastoralism grazing system households in Isiolo North and Isiolo South Sub-Counties.Burat and Ngaremara Wards from Isiolo North and Kinna Ward from Garbatulla Sub-County in Isiolo South areas were selected purposively due to availability of large number of cattle herds. A total of 34 herds were selected; in Isiolo North, 16 herds were selected and in Isiolo South, a total of 18 herds which were conveniently selected, considering accessibility of various locations, security and willingness of the pastoralists to participate in the study. Selection of the animal for the study was done by simple random selection. Animals were given a random number, and all the calves bearing even numbers were selected in ascending order until the numbers required in a herd was achieved. Each herd contributed between 3 to 20 calves, and this range was determined by the number of calves in the farm whereby herds with 6 calves, contributed the minimum selecting ones bearing even number (2, 4, 6…). Herds with 40 calves and above contributed the maximum number of 20 calves.

Figure 1. Map of Isiolo County Kenya

Sample size calculation

The sample size was calculated using 50% as the expected prevalence due to lack of previous studies in the selected study sites and based on confidence interval of 95% and a 5 % precision (Thrusfield, 2007),

$$N = \frac{z^2 \times pexp\,(1-pexp)}{d^2} = \frac{1.96^2 \times 0.5(1-0.5)}{0.05^2} = 384$$

Where:

N = required sample size

z=is the statistic corresponding to level of confidence

pexp=expected prevalence,

d = desired absolute precision.

The figure was rounded off to 400 calves. Isiolo North Constituency contributed 201 calves while Isiolo South contributed 210 calves making a total of 411 calves sampled which was slightly above the target. The herd qualified to be selected if the number of calves was 6 and above.

Data collection

Data were obtained from the owners of the animals or a relative/person who was fully knowledgeable about the household and the animals. The data were collected using semi-structured questionnaires and administered by the principal investigator with the help of a local animal health service provider who was conversant with the local dialects where interpretation was required. The data collected included information on household demographics, constraints affecting pastoralists, land ownership for grazing, control of gastrointestinal parasites, types of dewormers used, dosing and frequency of administration and diseases and conditions that affected calf production in the year 2020.

Details of individual calves and management factors were collected and this included body weight, height at withers (using a measuring weighing band), age, and provision of concentrates and mineral salts. Other data collected were; sex, breed, body condition score, hair coat appearance, fecal consistency, color of oral mucous membranes and size of the abdomen, hygiene of the sleeping floor area, type of the pasture and status (dry or lush), and animal grouping (based on age).

Faecal sample collection

Fresh faecal samples were obtained from the rectum of each calf using gloved hand where new gloves were used in each calf, or immediately post defaecation using gloved hand, placed in plastic fecal vials, labelled and transported to the laboratory in cool boxes with ice packs at 4°C and refrigerated prior to processing within 12 hours post collection to prevent hatching of the eggs. Before the collection, the sample vials were carefully labelled to ensure the correct identity of the sample. While collecting faecal samples, details including the name of the owner, date of sampling, sex, age, breed, body condition score, health history, housing, hygienic status of the floor and prophylactic treatment, feeding were recorded in a record sheet for each calf.

Laboratory analysis of faecal samples

McMaster technique was used to identify and quantify helminth (nematodes and cestodes) eggs and coccidia oocysts and counted as helminths/coccidia eggs/oocysts per one gram of the faecal sample (Zajac and Conboy, 2012). The test works by separating parasite eggs from debris based on density. The eggs float to the surface while the debris settle on the bottom of the counting chamber. This test uses a special microscope slide with a grid, making identification and counting of parasite eggs or oocysts possible. The faecal sample were processed individually by grinding 2 grams into 28 milliliters of concentrated sodium chloride solution with a 1.2 specific gravity. The mixture was then sieved and two McMaster slide chambers were filled with a processed faecal sample using Pasteur pippete and allowed to settle for 5 minutes for the eggs/oocysts to float. The light microscope was used (magnification of x10) and all eggs and oocysts in the marked areas of the chambers were identified and estimated. They were calculated as the number of eggs within the grid of each chamber multiplied by a factor of 50 to convert the number to eggs or oocysts per gram of fecal sample (Soulsby, 1982).

Data handling and analysis

Data collected were entered and stored in Microsoft Excel spread sheet version 10, Microsoft office professional plus 2016, and then coded for analysis where applicable. Descriptive analysis on household demographics, management and calf factors were summarized or carried out through proportions and frequencies.

Both univariate and multivariable logistic regression was used to determine the association between helminth and coccidia infections and the management, environmental and calf variables. Univariate logistical regression analysis was first carried out on all the individual management and calf factors against the helminth and coccidia infections and all factors with a p-value of ≤0.25 were eligible for inclusion in the final multivariable logistic regression model. In the final multivariable logistic regression analyses, factors were considered significant if they had a P≤0.05. The analysis was carried out using manual forward inclusion procedure while controlling for the effects other factors and confounders like age (Dahoo *et al.,* 2009). Variables with a p-value ≤0.05 were retained in the final model. The multivariable logistic model fitness was checked using Hosmer-Lemeshower chi^2 test p-value and Pearson test. A mixed logistic regression model analysis with the herd and Constituencies as random effects, controlled for clustering of animals within herds and herds within Constituencies respectively, was used to confirm the results of logistic regression. All statistical analysis was carried out using STATA version 13 statistical software.

Results

Household and Farm demographics

The household and farm demographic data are summarized in Table 1. The principal farmers were mainly male, comprising of 88% (30/34) and 12% females (4/34). A slight majority of principal farmers (53%) were aged between 25 and 55 years with 47% of the farmers aged above 55 years. The level of education of the principal farmer was as follows: 24% having no formal education, 38% with primary level, while 32% with secondary level and only 6% had tertiary level of education. The size of the families of the respondents were: 38% with between 4-6 family members and 62% having between 7-11 family members.

Mixed livestock rearing was the most common with 72% of the cattle herds mixed with other species such as sheep, goats, camels and donkeys and only 38% of the households rearing cattle only. The average number of cattle was 37 in the selected herds. Goats were the most common among animals co-reared with cattle at 62% with a mean of 35 goats. Only 18% of the participants had camels with an average of 3. Sheep were reared by 59% of the selected herds, having an average number of 22 sheep. All participants relied on community land for grazing with only 21% having private land used mainly as a back-up for grazing during dry seasons and human settlement.

Table 1. Descriptive statistics for demographic variables on 34 beef herds under pastoralism in Isiolo County between November and December 2020

Categorical variables

Variable	**Category**	**Frequency**	**Percentage**
Gender of principal farmer	Male	30	88
	Female	4	12
Age (years)	25 to 55	18	53
	Above 55	16	47
Level of education	None	8	24
	Primary	13	38
	Secondary	11	32
	Tertiary	2	6
Size of the family	4 to 6	13	38
	7 to 11	21	62
Livestock species reared			
	Beef cattle only	13	38
	Goats	21	62
	Sheep	19	59
	Camels	6	18
Land for grazing	Private and community	7	21
	Community land only	27	79

Continuous Variables

Variable	**Mean**	**Median**	**Range**
Private land (acres)	3.5	8	2-200
Distance covered during dry Seasons in such of water/pastures (km)	93.3	80	20-500

Cattle	37	118	10-200
Goats	35	80	20-320
Sheep	22	58	12-175
Camels	3	37	9-60

Distribution of calf management factors in 34 herds selected

The calf management factors are summarized in Table 2. All calves were kept in temporary circular enclosures made of thorny tree branches, with majority (64.7%), being located under a tree shade, while 35.3% were left in open field. The floor was natural dirt ground with no modification or beddings provided. In these calf enclosures, 52.9% of the dirt floors were wet at the time of the study while 47.1% were dry. Only 14.7% of the participants reported having extension services available to them and most farmers, 52.9% solely treated their animals without consulting animal health service providers. Most farmers, 94.2% reported to strategically deworming their animals during the rainy season and only 5.8% of the participants reporting to regularly deworming their animals at an interval of 3 months. Control of ticks was reported to be by the use of acaricides which were administered through hand spraying with 55.8% of the farmers doing control at weekly interval while 44.2% did it beyond one-week interval. Vaccination in cattle was done in 64.7% of the herds mainly funded by the government and non-governmental organizations and was reported to be carried out during research projects as incentives. Some of the constraints that were reported to negatively impact pastoralism were; drought, animal diseases, cattle rustling, tribal conflicts and community grazing land grabbing in the descending order.

Table 2. Descriptive statistics of distribution of management on 34 farms

Factors	Categories	Number of farms	Percentage
Calf accommodation	Under tree shade	22	64.7
	Open field	12	35.3
Floor condition	Dry floor	18	52.9
	Wet	16	47.1
Grazing land	Private and community	7	20.5
	Community land only	27	79.5
Livestock species	Cattle only	13	38.2
	Mixed species	21	61.8
Extension services	Available	5	14.7
	Unavailable	29	84.3
Vet services	Animal health assistant	5	14.7
	Owner/herdsman	18	52.9
	Animal health assistant/owner	11	32.3
Deworming strategy	Regular, 3month interval	2	5.8
	Strategic, during wet season	32	94.2

Use of acaricides	Weekly	19	55.8
	Beyond 1 week	15	44.2
Vaccinations	Available	22	64.7
	Unavailable	12	35.3
Major constraints	Drought	34	100
	Diseases	31	91.2
	Cattle rustling	24	70.6
	Tribal conflicts	5	14.7
	Land grabbing	1	2.9

Factors associated with coccidia infection from the univariable logistic regression

The results of univariable logistic regression are summarized in Table 3. Variables that had a p-value of ≤0.20, were retained for preliminary multivariable logistic regression. Age categories, sex, weaning status, availability of drinking water, floor condition, location (Sub-Counties), type of the pasture and floor condition were significant.

Table 3. Univariable factors associated with coccidia infection in 411 calves

Explanatory variables	Levels	Total	Infected (%)	χ^2	p-value
Age-class	<4months	199	27	8.6	0.0000
	4 to <9 months	107	44		
	9 to 12 months	105	57		
Sub-County	Isiolo-North	200	68	10.7	0.002
	Isiolo-South	211	25		
Sex	Male	222	41	4.4	0.036
	Female	189	51		
Weaning status	Weaned	167	36.5	9.6	0.002
	Unweaned	244	52.1		
Extension service	Available	43	26.7	11.4	0.001
	Unavailable	368	73.4		
Drinking water	Available	200	34.5	22.0	0.000
	Unavailable	211	56.4		
Floor condition	Dry	246	63	9.8	0.003
	Wet	165	33		
Pasture type	Lush	218	74	12.7	0.000
	Dry	193	41		

Herd size	Above 20	318	57	6.2	0.01
	Below 20	93	36		
Fecal color	Green	378	43.9	6.3	0.012
	Yellow	33	66		

Multivariable factors associated with coccidia infection

Multivariable factors associated with coccidia infection are summarized in Table 4 below. In Isiolo North, calves were 4.9 times more likely to contract coccidiosis, compared to calves in Isiolo South. Calves having access to drinking water at least once per day were 0.28 times less likely to get coccidiosis compared to calves not having access to drinking water. Calves in areas covered with lush pastures were 2.6 times more likely to get coccidiosis than calves covered with dry pastures. Animals confined in dry floors were 0.21 less likely to be coccidiosis positive compared to calves in raised on wet floors. Larger herd sizes above 20 cattle were associated with higher prevalence than smaller herd sizes. Calves in herds with access to professional extension services were 0.463 times less likely to contract coccidiosis.

Table 4. Multivariable factors associated with coccidia infection

Variables	Levels	OR	p-value	95% CI
Sub-County	Isiolo-North	4.906	0.000	2.033-11.84
	Isiolo-South	Baseline		
Drinking water	Available	0.282	0.000	0.168-0.472
	Unavailable	Baseline		
Type of pasture	Lush	2.604	0.009	1.273-5.328
	Dry	Baseline		
Floor condition	Dry	0.208	0.000	0.094-0.462
	Wet	Baseline		
Extension service	Available	0.463	0.023	0.239-0.896
	Unavailable	Baseline		
Herd size	Above 20	1.004	0.022	1.001-1.008
	Below 20	Baseline		

OR= Odds ratio, CI= Confidence interval

Factors associated with strongyles in the univariable analysis

The univariable logistic regression analyses of variables association with strongyles are summarized in Table 5. Variables with a chi-square value of 3.84 and above and a p-value ≤0.20 and below were retained for preliminary multivariate logistic regression. Location, color of feces, co-infestation with condition of the abdomen, weaning status, stocking density, drinking water availability, floor condition, type of pasture, herd size, age of the calf, and extension services were significant.

Table 5. Factors associated with strongyles from univariate analysis

Explanatory variables	Levels	Total	Infected (%)	Chi-square	p-value
Sub-County	Isiolo North	196	19.9	16.42	0.000
	Isiolo South	215	38.1		
Abdomen condition	Normal	387	27.7	10.2	0.001
	Pot-belly	24	58.3		
Weaning status	Weaned	167	48.5	49.2	0.000
	Unweaned	244	16.4		
Stocking density	Crowded	235	18.7	30.3	0.000
	Uncrowded	176	43.8		
Drinking water	Available	200	46.5	54.6	0.000
	Unavailable	211	13.3		
Floor condition	Dry	216	22.2	11.4	0.001
	Wet	105	37.4		
Type of pasture	Lush natural grass	306	36.9	32.3	0.000
	Dry natural grass	105	7.6		
Co-infestation	Coinfested	113	72	18.6	0.004
	Non-coinfested	298	39		
Herd size	Above 20	318	42	5.8	0.006
	Below 20	93	53		
Extension services	Available	43	42.4	16.8	0.000
	Unavailable	368	27.4		

Factors associated with strongyles from the multivariable logistic regression analyses

Significant variables in the final multivariate logistic analyses are summarized in Table 6 below. Calves infected by one or more different type of parasites other than strongyles, were 23.23 more likely be test positive for strongyles than calves infected with a single type of gastrointestinal parasitic infection. The odds of calves aged between 4 months to <9 months were 19.7 times more likely to be infected with strongyles lower than calves aged between 9 to 12 months which were 26.7 more likely to be positive for strongyles, compared to calves aged between 3 weeks to less than 4 months as the reference group. Calves in large herd sizes above 20 cattle were 0.99 less likely to be infected with strongyles. Calves in herds where extension services were available, were 3.74 times more likely to be positive to for strongyle infection compared to the rest.

Table 6. Multivariable factors associated with strongyle infection

Variables	**Categories**	**Odds ratio**	**P-value**	**95% CI**	
Co-infestation	Non-coinfested	Baseline	_		
	Coinfested	27.23	0.000	12.76	60.62
Age	3 weeks to <4 months	Baseline	_		
	4 to <9 months	19.7	0.000	7.69	50.59
	9 to 12 months	26.7	0.000	10.32	68.78
Herd-size	Above 20	0.99	0.000	0.98	1.0
	Below 20	Baseline			
Extension services	Unavailable	Baseline	_		
	Available	3.74	0.005	1.499	9.333

Discussion

Majority of herds were headed by males and most of the principal farmers had low level of formal education. Community land was relied on for grazing with cattle being the most popular type of livestock reared in the herds selected. Management practices of the calves and selected herds revealed that calves were kept on earthen floor, confined in circular portions using thorny branches with virtually half of the herds raised in wet floors and in crowded conditions. Most farmers practiced mixed livestock rearing which involved cattle, goats, sheep and camels, with similar observation made in Kenya, making mixed livestock rearing a common practice among pastoralists (Ilatsia, 2012). Veterinary and extension services were unavailable to majority of the farms, leading to farmers and herdsmen treating sick animals. The poor delivery of veterinary and extension services among pastoralists is complicated by constant migration by the herders looking for water, pastures and security (Bett *et al*., 2009). To control helminthosis, almost all farmers used dewormers during the wet seasons with a few following regular deworming protocol. Tick control was directed mainly at reducing the prevalence of East Coast Fever which was done by hand-spraying the animals using acaricides. More than a half of the selected herds, the owners and their representatives reported that their animals were being irregularly vaccinated against unspecified diseases by the County government and researchers as a part of incentive for their cooperation to participate in the study by providing data. The main challenges that were reported by the pastoralist included; drought, diseases, cattle rustling, tribal conflicts and land grabbing. In another study in Kenya, climate change was also indicated as the main challenge by the pastoralists leading to shortage of water and pastures (Bobadoye *et al*., 2016).

The final model results for coccidiosis revealed significant factors which included location difference with Isiolo North Sub-County having higher odds of infection than Isiolo South. Drinking water availability was associated with lower prevalence of coccidiosis, which can be explained by dehydration stress relief by providing drinking water to calves, hence improving resistance to coccidiosis. Calves raised in environments covered with lush pastures which was used as an indicator of recent rainfall, a condition that favors development of oocysts by sporulating, had higher odds of having coccidiosis, compared to calves in raised in dry pastures indicating dry season (Rodriguez *et al*., 1996; Waruiru *et al*., 2000). Calves raised in confinement with dry floor had lesser odds of coccidiosis compared to calves raised on wet floor. Calves in large herd size above 20 cattle, were 1.004 times more likely to test positive for coccidia than calves in herds with less than 20 cattle, with similar observations made in Ethiopia and Mexico (Rodriguez *et al*., 1996; Kemal *et al*., 2013) which is expected due to high level of pasture contamination and high stocking density in large herds compared to small herds (Vorster and Mapham, 2012).

Multiple logistic regression for strongylosis revealed several factors that were significantly associated with the coccidia infection. Co-infected calves by different groups of parasites in the current study, had higher odds of having strongyles, than calves with single type of gastrointestinal parasite, a finding which was in concurrence in a similar study in Kisumu, Kenya (Kanyari *et al*., 2010). Calves in herds above 20 were 0.9896 less likely to test positive for strongyles, probably because large herds were economically more viable and control of diseases like strongylosis by deworming were practised more efficiently than in smaller herds. Calves that were in farms with extension services available had higher odds of having strongylosis than in calves in herds without extension services an indication that extension services providers and pastoralists did not apply control measures appropriately. Older calves between 9 to 12 months had highest odds of strongylosis, with calves aged between 4 to less than 9 months had higher odds of strongylosis, compared to younger calves, with similar observation made by others (Waruiru *et al*., 2000; Kanyari *et al*., 2010). The higher prevalence in older calves could be attributed to grazing post-weaning leading to higher exposure to infective larvae, compared to unweaned younger calves with lower prevalence.

Conclusion

The study showed that day to day calf management by the owners, individual calf and environmental factors were associated with helminth and coccidia infections. It is recommended that regular random sampling of faecal samples to screen for coccidiosis and helminthosis and other gastrointestinal parasites is therefore useful. The regular screening of the calves will enable the pastoralists to make informed decisions of the treatment and control measures. Robust deworming strategy and treatment for coccidiosis in the affected calves is recommended and organized extension services from trained animal health providers are important with emphasis to gastrointestinal parasitic infection.

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