RISK FACTORS ASSOCIATED WITH GASTROINTESTINAL NEMATODE INFECTIONS OF CATTLE IN NAKURU AND MUKURWEINI DISTRICTS OF KENYA

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Abstract

A study was carried out in Nakuru and Mukurweini districts of Kenya to identify the risk factors associated with gastrointestinal nematode (GIN) infection in cattle on 128 dairy farms between June 16th 2010 and August 30th 2010. Faecal samples were collected from the rectum of 419 heads of cattle that were above three months of age on the selected farms, refrigerated and delivered to the Department of Veterinary Pathology, Microbiology and Parasitology, Faculty of Veterinary Medicine, University of Nairobi, for GIN analyses (McMaster method) within 7 days.

Questionnaires were administered on every farm to collect individual animal and farm management data. Logistic regression analysis was carried out (univariable and multivariable), and a model developed using a backward elimination method.

The univariable analysis revealed that animal age, district, time to last deworming, frequency of manure removal, source of forages, and the type of dewormer used last as the factors associated with GIN infections in cattle. The final regression model indicated that animal age, farm district, time to last deworming, and the type of dewormer used last as the factors associated with nematode infections in cattle. The study concluded that grazing management and the deworming management, particularly among young animals, were the main factors associated with cattle GIN infections.

Key words: Risk factors, cross-sectional design, cattle, gastrointestinal nematodes.

FACTEURS DE RISQUE ASSOCIES AUX INFECTIONS AUX NEMATODES GASTRO-INTESTINAUX DES BOVINS DANS LES DISTRICTS DE NAKURU ET DE MUKURWEINI AU KENYA

Résumé

Une étude a été réalisée dans les Districts de Nakuru et de Mukurweini au Kenya dans le but d'identifier les facteurs de risque associés à l'infection aux nématodes gastro-intestinaux (NGI) chez les bovins dans 128 fermes laitières entre le 16 juin 2010 et le 30 août 2010. Des échantillons de matières fécales ont été prélevés dans le rectum de 419 bovins âgés de plus de trois mois sur les fermes sélectionnées, réfrigérés et remis au Département de Pathologie Vétérinaire, Microbiologie et Parasitologie de la Faculté de Médecine vétérinaire de l'Université de Nairobi, aux fins d'analyses des GIN (méthode McMaster) dans un délai de 7 jours.

Des questionnaires ont été distribués à chaque ferme afin de recueillir les données sur chaque animal et sur la gestion de la ferme. Une analyse de régression logistique a été réalisée (à variable unique et à plusieurs variables) et un modèle développé en utilisant une méthode d'élimination régressive.

L'analyse univariable a révélé que l'âge des animaux, le district, le temps écoulé depuis le

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dernier déparasitage, la fréquence d'enlèvement du fumier, la source des fourrages, ainsi que le type de vermifuge utilisé la dernière fois étaient des facteurs associés aux infections GIN chez ces bovins. Le modèle de régression final a indiqué que l'âge de l'animal, le district où se situe la ferme, le temps écoulé depuis le dernier déparasitage, et le type de vermifuge utilisé la dernière fois étaient des facteurs associés aux infections par des nématodes chez les bovins. L'étude a conclu que le mode de gestion des pâturages et du déparasitage, en particulier chez les jeunes animaux, étaient les principaux facteurs associés aux infections GIN chez les bovins.

Mots-clés facteurs de risque, analyse transversale, bovins, nématodes gastro-intestinaux.

Introduction

Gastrointestinal nematode (GIN) infections in ruminants are an important problem of the developing world, causing mortality and reduced productivity (Wanyangu and Bain, 1994; Gatongi *et al.,* 1997), particularly where nutrition and sanitation are poor (Sharkhuu, 2001; Faye *et al.,* 2003. The problem is greatest in tropical countries with good rainfall (Radostits *et al.,* 1994).

The epidemiology of GIN infections is determined by several factors influenced by parasite-host-environment interactions (Barger, 1989; Thamsborg *et al.,* 1996; Ng'ang'a *et al.,* 2004). The major risk factors can therefore, be broadly classified as parasite factors (anthelmintic resistance of the different species), host factors (genetic resistance, age and physiological status of the animal), and environmental factors (climate, stocking density and management). The importance of GIN infections will vary greatly from one year to the next and between geographical locations, depending on the prevailing climatic conditions and management (Wanyangu *et al.,* 1994). Moreover, stress, poor nutrition and concurrent disease may be associated with the release of hypobiotic larvae from the dormant state, leading to clinical GIN helminthosis. There is also a great variation in resistance between GIN species. While some studies have reported that goats are more susceptible than sheep to a similar challenge, others have reported that sheep usually suffer heavier worm burdens because of the difference in their grazing habits (Tembely and Hansen, 1996).

In order to control gastrointestinal nematodes, it is important to identify the risk factors associated with GIN infection. In Kenya, farmer's education, animal age category, deworming and grazing system have been identified as the main predictors of GIN infections (Odoi *et al.,* 2007). This paper describes a cross-sectional study that was carried out to identify the risk factors associated with GIN infections in dairy cattle of Kenya.

Material and Methods

Study area

The study was carried out in Mukurweini District of Nyeri County and Nakuru District of Nakuru County in Kenya between June 16th 2010 and August 30th 2010. Nyeri County is one of the five counties of Central Province and forms part of Kenya's central highlands (The Constitution of Kenya, 2010). Dairy farming is an important enterprise in Mukurweini District, with the farmers practicing zero-grazing methods, where pastures are cut and carried to the cattle.

Nakuru County is one of the 14 Counties of the Rift Valley Province and lies within the Great Rift Valley (The Constitution of Kenya, 2010). Dairy farmers in the area practice both zero-grazing, and semi-zero-grazing, where the cattle are housed but allowed to graze at certain times.

Study design

In Nakuru and Mukurweini Districts of Kenya, 64 farms were selected from each district to participate in the study. In Nakuru, a simple random selection was employed at the farm level using a sampling frame of the dairy farms provided by the District Livestock Production Officer. For logistical reasons, a purposive sampling method was used in Mukurweini, as the research was conducted alongside another project comparing smallholder dairy farms with and without biogas digesters (Dohoo *et al.,* 2012a; Dohoo *et al.,* 2012b). In that study,

biogas digesters were distributed to a group of smallholder dairy farmers considered representative of the various sub-districts and demographics of smallholder dairy farmers in the area, and the referent group of farmers was randomly selected. Due to the similarity of farming practices across smallholder dairy farms in the district (virtually all zero-grazing units), the Mukurweini sample of farms was considered a fair representation of the population in the district. In Mukurweini district, all cattle that were above three months of age on the selected farms were sampled for the study. In Nakuru District, where some farms were larger, a systematic random selection method was used to ensure that no more than 10 animals were sampled per farm. A total of 419 head of cattle were selected in the two districts (202 in Nakuru and 217 in Mukurweini).

Faecal samples from each animal on the selected farms were collected and analyzed for faecal egg counts (FEC) using a Modified McMasters technique (Ministry of Agriculture, Fisheries and Food, 1986), with a lower detection limit of 50 eggs per gram (epg).

A questionnaire on farm management was administered on every farm, in addition to individual data that were collected for every animal recruited. The potential risk factors studied included: age of the animal, parity (if a cow), body condition score (BCS - using a 1 to 5 scale, with 1 being thin and 5 being fat), bodyweight (using a heart girth tape), government or private veterinary service availability, frequency of deworming, timing and type of dewormers used last, availability of shelter, type of floor, type of bedding, manure removal frequency, and the grazing system practiced at the farm.

Statistical analysis

An animal was considered to have a GIN infection if the faecal egg count was 100 epg or higher (Hansen and Perry, 1994). This cutoff was selected because the McMasters egg counting method gave an output in multiples of 50 (each egg seen represented 50 eggs, and so one egg seen (representing 50 egg) could be a false positive due to the passing through of ingested eggs, or a very light level of parasitism.

Frequency tables showing the GIN infection status versus the risk factors were generated, and the percentage of the infected animals in each level of the risk factor (using the Pearson's chi square) was calculated to ascertain the univariable association between GIN infection and the potential risk factors.

A logistic regression model was fitted to determine significant factors associated with GIN infection (the outcome variable), while controlling for the effects of other factors and confounders, such as animal age (Dohoo *et al.*, 2009). Factors that were significant ($p < 0.10$) in the univariable analyses were eligible to be entered into the model. The logistic regression analysis used a backward elimination procedure and variables were considered significant and remained in the final model at $P<0.05$. The fitted model was examined for goodness of fit by plotting half normal plot with both rough and smooth envelopes to act as confidence intervals, and to examining Cook's statistics for influential observations (Collet, 1991). A mixed logistic regression model analysis with the herd and the district as random effects, controlled for clustering of animals within herds and herds within districts, respectively, was used to confirm the results of the logistic regression model.

Results

Univariable analysis of factors associated with gastrointestinal nematode infections

Breed, age, gender, district, source of forage, frequency of deworming, time of last deworming, and product used at last deworming were univariably significantly associated ($p<0.10$) with cattle GIN infections, as described in Table 1. These variables were eligible for entering into the final models used to predict GIN infections.

There was a higher prevalence of GIN infection among animals on the farms that got forage from sources where many other cattle could graze, either by cutting from roadsides and carrying to the animals, or by communal grazing, compared with other sources of forages with limited or no other cattle exposure ($p = 0.009$).

Table 1: Univariable results of factors associated with gastrointestinal nematode infection from 419 dairy cattle in Nakuru and Mukurweini districts between June 16th 2010 and August 30th 2010.

Explanatory variables	Levels	Totals	Proportions infected (%)	χ^2	p value
Animal breed	Friesian	305	19	7.8	0.02
	Ayshire	88	11		
	Guernsey	26	27		
Animal age	3- 12 months	146	22	12.2	0.001
	>12 months	273	10		
Animal gender	Female	401	13	5.99	0.014
	Male	18	33		
Body condition1	Poor	143	18	3.43	0.064
	Good	276	12		
District	Nakuru	202	20	11.6	0.001
	Mukurweini	217	8		
Time of last dewormer	>6 months	38	29	9.44	0.001
	3 -6 months	82	13		
	< 3 months	299	9		
Frequency of deworming	>6 months	63	29	18.7	0.002
	3 -6 months	193	13		
	< 3 months	163	9		
Source of forage	Cut from farm	125	11	13.6	0.009
	Cut from other farms	176	11		
	Cut on roadside	12	25		
	Grazing on farm	34	9		
	Communal grazing	72	26		
Product used at last deworming	Albendazole	74	18	11.0	0.012
	Ivermectin	65	12		
	Levamisole	107	21		
	Unknown	173	8		

Multivariable analysis of factor for gastrointestinal nematode infection

The final multivariable logistic regression model indicated that animal age, district the animals were in, time to last deworming, and product used at last deworming were associated with GIN infections in cattle, controlling for clustering within herds, and the confounding effects of other variables. A mixed logistic regression model analysis with the herd and the district as random effects, controlling for clustering of animals within herds and herds within districts, respectively, confirmed these findings. Based on this final model, a higher odds of GIN infection was found in younger versus animals > 12 months of age, and in animals in Nakuru versus Mukurweini district. The odds of an animal having a GIN infection increased as the time to last deworming increased, although > 6 months ago was not greater than 5 months ago, and the odds of an animal having a GIN infection increased if it was on a farm with deworming frequencies less often than every 6 months versus a quicker frequency of deworming. Animals last treated with albendazole or levamisole had a higher odds of GIN infection versus animals last treated with ivermectin or an unknown dewormer. Source of forage, body condition, breed and gender did not remain significant in the final models.

The half normal plot and Cook's statistic plots demonstrated good fit of the final model to the data.

Discussion

The results of this study showed that animal age, district, and deworming management were significantly associated with the prevalence of GIN infections in dairy cattle. The results agree with those of a previous study carried out on smallholder mixed farming systems in Central Kenya highlands, which identified animal age, farmer's education, and deworming and grazing system as the main factors associated with nematode infections (Odoi *et al.,* 2007). A study carried in Kiambu District of Kenya also showed that cattle between weaning and one year of age were more prone to GIN infections, and that the highest prevalence of infection was found among this group (Waruiru *et al.,* 2001). Older animals have more developed innate and adaptive immune systems to counter GIN infections (Male *et al.,* 2006).

The nematode infection risk was shown to be higher in male animals; however there was a confounding effect with the age of animals, where all the male animals encountered in both districts were calves, as the farmers did not prefer to keep older males. Therefore, gender was not significant in the final model.

In the univariable analysis, cattle with poor BCSs had higher GIN infection prevalences compared with those with higher scores. However, there was a possibility of a reverse causation bias, not uncommon with cross-sectional studies (Dohoo *et al.,* 2009).

Table 2: Multivariable results of factors associated with gastrointestinal nematode infections from 419 dairy cattle in Nakuru and Mukurweini districts between June 16th 2010 and August 30th 2010.

Factor	Odds Ratio	P value
Age		
Aged < 12 months (referent category)	1	-
Aged above 12 months	0.3172	<.001
District		
Nakuru (referent category)	1	-
Mukurweini	0.3384	0.001
Time to last deworming		
Last deworming < 1 month ago (referent category)	1	-
Last deworming 2 months ago	1.737	0.362
Last deworming 3 months ago	2.166	0.136
Last deworming 4 months ago	4.848	0.023
Last deworming 5 months ago	9.901	0.002
Last deworming > 6 months ago	7.081	0.001
Frequency of deworming		
Dewormed less often than every 6 months (referent category)	1	-
Dewormed every 3 -6 months	0.3541	0.056
Dewormed every 0-3 months	0.3247	0.025
Product used at last deworming		
Albendazole (referent category)	1	-
Ivermectin	0.6890	0.481
Levamisole	1.064	0.868
Last dewormer unknown	0.2058	0.001

It would be hard to conclude whether poor body condition was a clinical sign of the GIN infection or a predisposing factor using this kind of study, because the duration of the infection is unknown. Also, newborn calves are born in lean body condition for calving ease, and age was a significant factor in the final model, therefore, age would confound the relationship between BCS and GIN infection, hence BCS was not significant in the final model.

Time to last deworming was an important factor for nematode infection, with the infection prevalence being highest among dairy animals that had not been dewormed in the last 5 to 6 months compared with animals dewormed within the previous five months. While pre-patent periods of GINs can be less than a month (Georgi & Georgi, 1997), re-infection can take substantially longer, even up to 6 months, because the nematode lifecycle involves environmental contamination, ingestion, infection and deworming animals breaks this lifecycle, reducing the adult worms that shed eggs, thereby reducing egg counts in manure, and pasture contamination of infective larvae.

Cattle on farms that dewormed at a frequency interval greater than six months also recorded a higher risk of GIN infections. Most farmers in this study practiced a deworming frequency of less than 3 months, which explained the overall low prevalence of nematodes (Kabaka *et al.*, 2012). This finding is in agreement with reports from other authors, that under traditional free-range grazing systems there is continuous infection and re-infection from heavily contaminated pastures, rendering anthelmintic treatment of short-term value compared with the situation under zero-grazing (Waller, 2004).

An interesting observation was that cattle of farmers who could not recollect the last dewormer used recorded lower prevalence of nematode infections. This was probably because this group of farmers used the veterinary service providers and that is why they did not know which drug had been used on their animals. The veterinary service providers would likely know which dewormers would be most effective against GIN infections, leading to a lower prevalence of GIN infection.

The significantly higher GIN infection in animals on farms that sourced forages from the roadside or by communal grazing could be explained by the contamination of roadside and communal pastures with infective larvae from animals from multiple sources. Minimization of faecal contamination on forage sources can be an effective measure for the control of GIN infections.

Conclusion

The significant factors associated with GIN infection in cattle were the age of the animal, the district in which they lived, the time from last deworming, the frequency of deworming, and the kind of dewormer used last. A regular deworming interval of three to four months should be encouraged among the young stock which is the most vulnerable group, especially in high risk areas.

The overall GIN infection prevalence was lower in Mukurweini as compared with Nakuru district. The most salient difference in the two districts is the grazing system used, where farms in the former practice zero-grazing systems almost entirely, and thus housing with zero-grazing should be advocated as a long-term control strategy for nematodes.

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