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Prevalence, intensity and spectrum of helminths of free range pigs in Homabay District, Kenya.

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Abstract

A cross-sectional study was conducted to determine the prevalence, intensity and spectrum of helminths of free range pigs in Homabay District, Kenya. Faecal samples from 372 pigs were examined using the modified McMaster technique and post-mortem examination of 30 pigs carried out.

Out of the 372 pigs examined, 308 (83%) were excreting nematode eggs. The nematode eggs encountered were those of Strongyles (75%), *Strongyloides* spp (26.6%), *Trichuris* spp (7.8%), *Ascaris* spp (5.4%) and *Metastrongylus* spp (0.3%). Coproculture of Strongyle-type nematode egg positive faecal samples revealed the presence of *Oesophagostomum* spp (74%), *Hyostrongylus rubidus* (22%) and *Trichostrongylus* spp (4%). The post-mortem examination revealed presence of *Hyostrongylus rubidus, Physocephalus sexalatus, Trichostrongylus axei, Ascaris suum, Oesophagostomun dentatum, Trichuris suis* and *Metastrongylus pudendodectus*. The highest prevalence of helminth infections was recorded in finishers (88%) and the lowest in adults (79%). The highest mean helminth egg per gram of faeces (epg) was recorded in adults (1,175) and the lowest was in piglets (526). Pigs from Riana division had the highest prevalence (91%) of infection and mean epg (1,109), while those from Asego Division had the lowest prevalence (50%) and mean epg (100). Female pigs recorded a higher mean epg (567) compared to males (416). Age had significant influence on infection with Strongyles (p = 0.04) with growers and finishers recording higher levels of infection than adults. Sex had significant effect on the prevalence of infections with Strongyles (p = 0.028) and *Ascaris suum* (p = 0.012) with females recording higher levels of infection than males. Division of origin of pigs had significant influence on the prevalence of infection with *Ascaris suum* (p = 0.000) and Strongyles (p = 0.000) with the mean epgs for Riana and Ndhiwa divisions being significantly higher than those of Pala Division. This study indicates that helminths are highly prevalent in the study area with low to moderate levels of infections and may be one of the contributing factors to low productivity. Therefore, there is need to formulate appropriate control measures for the parasites in order to increase livestock productivity.

Key words: endoparasites, free range, Homabay, non-descript pigs, production

Introduction

Free range pig keeping is still common in the rural set-up of many developing countries inspite of its shortcomings such as poor feed conversion, high mortality rates, poor final products (Lekule and Kyvsgaard 2003) and the risk of spreading zoonotic diseases such as cysticercosis (Githigia et al 2005; Kagira 2010). Under this type of production system, pigs are mainly kept for generation of income and provision of protein. Besides constraints associated with pig production such as scarcity of feed and viral infections

such as African swine fever, helminthosis has been reported to be a major hindrance to profitable pig production in Africa (Permin et al 1999; Lekule and Kyvsgaard 2003; Nissen et al 2011). Internal parasitism in pigs can result in loss of appetite, poor growth rate, poor feed conversion efficiency and potentiation of other pathogens or even death (Stewart and Hoyt 2006). The effects arising from direct losses may be visible but of economic importance are indirect losses that arise from sub-clinical infections such as decreased litter sizes, poor growth rates, reduced weight gains and visceral organ condemnation at slaughter (Stewart and Hale 1988; Ng'ang'a et al 2008).

In Kenya, pigs are produced under two main systems; the indoor and the outdoor production systems. The indoor production system is common in Central, Rift Valley and Nairobi provinces and accounts for 80% of the total production (Githigia et al 2005; Ng'ang'a et al 2008). Out of these, small holder production accounts for 60%. The free range system is common in Nyanza and Western provinces. Studies on the prevalence and intensity of pig helminths in the country have mainly been focused on pigs kept under the indoor production system (Kagira et al 2002; Wabacha et al 2004; Ng'ang'a et al 2008). Knowledge on the prevalence and intensity of helminths infections in pigs reared under the free range system is limited to studies by Githigia et al (2005), Mutua et al (2007) and Kagira (2010). Githigia et al (2005) studied the prevalence of *Cysticercus cellulosae* and the risk factors by lingual examination while Mutua et al (2007) estimate the prevalence of palpable lingual cysts from 316 randomly selected small scale pig farmers in Western Kenya as a possible indicator of Cysticercosis. The study by Kagira (2010) was done to determine the prevalence and intensity of gastrointestinal and ectoparasites and *Cysticercus cellulosae* at both slaughter slab and farm level in Busia District. No study on the prevalence and intensity of helminth infection has previously been carried out in Homabay District where outdoor rearing of pigs is common. Such knowledge of the spectra of parasites and their epidemiology is important in the formulation of effective parasite control measures.

Materials and methods

Study area

The study was conducted in Homabay District, Nyanza Province which has a geographical coverage of 1,160 Km^2 with a latitude of 0° 54' 08"S and a longitude of 34° 18' 00"E. The district has seven administrative divisions; Rangwe, Asego, Ndhiwa, Pala, Riana, Nyarongi and Kobama (Figure 1). Pala Division was curved out of Ndhiwa Division before the study started (2007) but at the time of this study, its' administrative boundaries had not been included on the map. The climate of the district is inland equatorial with two distinct features, the Lakeshore lowlands and the Uplands plateau. The lakeshore lowland lies between 1,143 to 1,220m above sea level and mainly comprise a narrow stretch bordering Lake Victoria on the Northern part of the District. At the end of the Lakeshore is a bay from which the district derives its name. The upland plateau rises from 1,220 m to 1,560m and has undulating terrain. The rainfall pattern is bimodal with the long rain season extending from March to June while the short rain

season occurs from August to November. Heavy rain of between 500-1000mm is experienced in the uplands plateau especially of Rangwe and Ndhiwa divisions while the lowlands (Asego, Nyarongi and Western parts of Ndhiwa) receive low rainfall varying from 250 to 700mm (FAO 2007). Temperature varies with altitude and proximity to the lake and tends to increase towards the lowland with an average of 17.1-34.8°C.

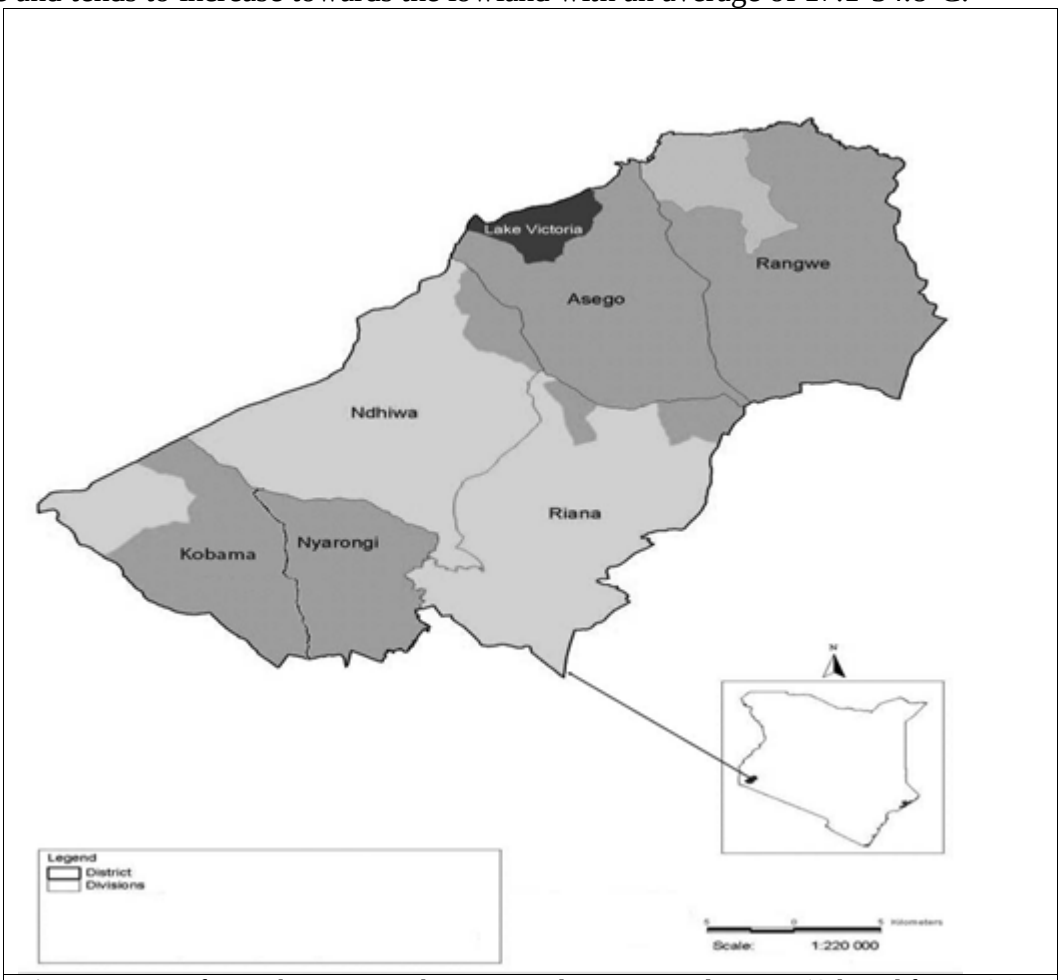

Figure 1: Map of Homabay District showing its administrative divisions (Adapted from FAO 2007)

Selection of study farms

This study was conducted between September, 2009 and December, 2010 and the study population consisted of 372 pigs of non-descript and cross-breed type from 297 households selected randomly from 44 villages. The study area had an estimated pig population of 20,800 as determined by the Ministry of Livestock Development and Marketing (2007). Most of the pigs in the study area were either tethered or kept in a mixed system characterized by free range during the dry season and tethered during the rainy season except in Rangwe division where pigs were permanently kept indoors. The pigs were mainly fed on different kinds of kitchen leftovers, grass and sweet potato vines without commercial feed supplementation. Housing was not provided by most of the farmers with pigs staying under a tree or next to the homestead. Deworming by use of regular antihelmintics was performed only in a few farms. Farmers in the study area did

not keep breeding records but majority of the pigs could be considered as non-descript. Most of the farmers reared pigs up to when they reach the market weight for slaughter with a few pigs being slaughtered in local butchers within the district while majority were transported to the main slaughter house in Nairobi. An estimation of the sample size of the pigs required for the study was done using the formula $n=Z\alpha^2pq/L^2$ (Martin et al 1987), where n is the required number of individuals to be examined (sample size), $Z\alpha$ is the standard normal deviate (1.96) at 5% level of significance, p is a known or estimated prevalence, q = (1-p) and L is the allowable error (precision) of estimation. The sample size was based on estimated prevalence of 14% of *Cysticercus cellulosae* in Busia District, Western Kenya (Githigia et al 2005). Therefore, the minimum number of pigs to be sampled was 185. Sampling was aimed at pigs in every division and the number of samples was allocated to the overall total of seven divisions. Depending on the pig population of the division, sampling was proportionally allocated to each division so that divisions with more pigs had a higher proportion of samples. The study farms were selected with the assistance of field extension officers of the Ministry of Livestock Development and Marketing (MLOD) and local administration officials. The sampling unit of interest was individual small holder farms. In the cross sectional survey, a list of locations with the highest population of pigs in the seven divisions was made and two locations from each division randomly selected. Subsequently, a list of small scale farmers in the selected locations was established. In Kobama and Nyarongi divisions where there were few pig farmers, the sampling frame consisted of only villages with pigs. In Rangwe Division where the management system was semi-intensive, all the farmers with the semi-intensive system were included in the study. At the village level, households with pigs were established with the help of Extension Officers and other farmers until all the selected farmers were covered.

Animal categories and sampling

Pigs were grouped into 4 categories: pigs under 3 months of age were classed as piglets (n = 16), those in the range of 3-5 months were classed as growers (n = 96), those between 5-7 months were classed as finishers (n = 50) and those above 7 months were classed as adults (n = 210). Pigs were further classified as males (n = 124) and females (n = 248). Faecal samples were collected per rectum from individual pigs using clean, unused gloves. All the samples were labeled individually and kept in a cool box containing ice packs during transportation to the laboratory where faecal samples were immediately processed or kept at 4°C for a maximum of one day before processing.

Faecal sample analysis

The number of nematode eggs in the faeces was determined using the modified McMaster Method (MAFF 1986). The type of helminths eggs and the number of eggs per gramme of faeces (e.p.g) were recorded. The presence of coccidian oocyts was noted but quantification was not done. All Strongyle type-eggs positive faecal samples were pooled per farm and thoroughly mixed. They were cultured at 27°C for 14-21 days and larvae were harvested by the use of the Baerman apparatus as described in the MAFF (1986) manual. One hundred nematode larvae were examined and identified according to the criteria described by Thiepont et al (1986) in order to differentiate between

Oesophagostomum spp, *Hyostrongylus rubidus*, *Trichostrongylus axei* and *Globocephalus urosubulatus.*

Post-mortem examination for helminth parasites

In order to determine the species of worms in Homabay District, post-mortem examinations were carried out on gastro-intestinal tracts of pigs which were at least seven months old. Due to logistic considerations, gastrointestinal tracts were obtained from thirty pigs only. The lungs, livers and gastrointestinal tracts (stomach, small and large intestines) were obtained from five pigs from two local slaughter houses in Homabay District; two from Riana Division and three from Asego Division. The rest of the gastro-intestinal tracts, liver and lungs were obtained from twenty five pigs purchased from different parts of Homabay District and transported for slaughter to Ndumbuini slaughter house on the outskirts of Nairobi.

Post-mortem examination was carried out as per the procedure described by Roepstorff and Nansen (1998) with some modifications. Briefly, the trachea, bronchi and bronchioles were cut open using a pair of scissors and examined for lungworms. The liver surfaces were examined for milk spot lesions associated with larval Ascarid migration. The stomach was cut open along the major curvature using a pair of scissors and the contents transferred to a bucket, sieved using a mesh (250µm) and macroscopically examined for stomach worms. The stomach wall was also inspected for worms attached to the gastric mucosa. The small intestines were sliced longitudinally using a pair of scissors, their contents sieved using a mesh (250µm) and examined macroscopically. The mucosa was inspected for worms attached to the intestinal wall. The large intestines was sliced longitudinally, its contents emptied in a bucket and intestinal wall washed with water. The sample was examined macroscopically for the presence of worms and the intestinal wall inspected for worms attached on the mucosa. The number of worms was estimated using the total count method. The isolated worms were preserved in 70% ethanol, cleared with the use of lactic acid and identified using a light microscope according to Soulsby (1982) and Kauffman (1996).

Statistical analysis

The data collected were entered into Microsoft Excel and exported to SPSS version 12.0 (Statistical package for Social Scientists 2003) for statistical analysis. Descriptive statistics were calculated and presented as tables. The prevalence (p) of the animal harboring each parasite was calculated as $p = d/n$ where d is the number of animals diagnosed as having a given parasite at that point in time and n is the number of animals at risk (examined) at that point in time (Thrushfeld 1995). The EPG was described in terms of mean, minimum, maximum and standard deviation. The differences in the mean epgs for different ages, sex and divisions were tested using One-way analysis of variance (ANOVA) based on logarithmically transformed egg counts i.e. log10 (epg+1). The results were considered to be significantly different when $p< 0.05$.

Results

Faecal examination (from farm survey)

Out of the 372 animals sampled, 83% (308) were shedding nematode eggs. The nematode eggs were; Strongyles (75%), *Strongyloides* spp (26.6%), *Trichuris* spp (7.8%), *Ascaris* spp (5.4%) and *Metastrongylus* spp (0.3%). From coprocultures of Strongyle positive faecal samples, *Oesophagostomum* spp comprised 74%, *Hyostrongylus rubidus* 22% and *Trichostrongylus s*pp 4% of the larvae. Coccidian oocysts were detected in 34.8% of the animals.

The highest prevalence of helminth infection was recorded in finishers (88%) and the lowest prevalence recorded in adults (79%). Growers recorded the highest level of infection with Strongyles (84.4%), *Strongyloides* spp (55.2%), *Trichuris* spp (50%) and *Ascaris* spp (51%). No *Ascaris* spp was recorded in piglets. The highest mean epg of infection with helminths was recorded in adults (1,175) while the lowest mean epg was recorded in piglets (526). Growers recorded the highest mean epg of infection with Strongyles 584± (69) while the least mean epg of infection with Strongyles was recorded in piglets 43± (38.7). The highest mean epg of infection with *Trichuris* spp was recorded in adults146± (8.9) Table 1. The epg ranges for various age groups were; adults (0-12,000), growers (0-15,000), finishers (0-2,900) and piglets (0-4,700). Females recorded a higher overall mean epg (567) than males (416). Also females recorded a higher mean epg of infection with Strongyles 362± (39.4), *Trichuris* spp 32± (10.3) and *Ascaris* spp 37± (19.7) than males.

Table 1: Prevalence and mean eggs per gram of faeces for different age categories of pigs in Homabay District

Age group	Parasite	Prevalence (%)	Mean epg	SE
Adults (n =210)	Strongyles	72.4	229	49.0
	Strongyloides spp	33.3	766	13.5
	Trichuris spp	10.0	146	8.9
	Ascaris spp	9.1	34	23.0
Finishers (n =96)	Strongyles	70.0	506	89.0
	Strongyloides spp	14.0	147	74.5
	Trichuris spp	4.0	57	13.5
	Ascaris spp	6.0	24	14.5
Growers (n =50)	Strongyles	84.4	584	64.0
	Strongyloides spp	55.2	480	183.0
	Trichuris spp	50.0	20	16.7
	Ascaris spp	51.0	22	10.2
Piglets (n =16)	Strongyles	81.3	43	38.7
	Strongyloides spp	12.5	473	200.0
	Trichuris spp	6.3	10	5.4
	Ascaris spp	0.0	0	0

The prevalence of helminth infection varied from division to division. The highest prevalence (91%) was recorded in pigs from Riana division and the lowest (50%) prevalence was recorded in pigs from Asego division. Only three pigs were sampled from Kobama division. Coccidian Oocysts were detected 34.8% of the animals examined. Pigs

from Riana division recorded the highest prevalence of infection with Strongyles (84.9%), *Strongyloides* (30.1%) spp and *Trichuris* spp (10.2%). Pigs from Rangwe division recorded the highest prevalence of infection with *Ascaris* spp (42.6%) but no infection with *Strongyloides* spp while Asego and Kobama divisions did not record infections with *Strongyloides* spp, *Trichuris* spp and *Ascaris* spp. One adult pig was infected with *Metastrongylus* spp in Riana Division. The highest mean epg of infection with helminths was recorded in pigs from Riana Division (1,109) while the lowest mean epg was recorded in pigs from Asego Division (100). Pigs from Riana division recorded the highest mean epg of infection with Strongyles 623± (327) while pigs form Rangwe division recorded the highest mean epgs of infection with *Ascaris* spp 492± (346).

Table 2: The prevalence and mean epgs of various nematodes eggs in pigs according to the division

Division	Parasite	Prevalence (%)	Mean epg	SE
Riana (n = 167)	Strongyles	84.9	623	327.0
	Strongyloides ssp	30.1	428	38.6
	Trichuris spp	10.2	40	3.1
	Ascaris spp	4.8	18	5.5
Pala (n = 123)	Strongyles	67.5	317	69.0
	Strongyloides ssp	28.5	153	23.6
	Trichuris spp	4.1	141	2.3
	Ascaris spp	2.4	10	9.2
Ndhiwa(n = 45)	Strongyles	80.0	570	113.0
	Strongyloides ssp	22.2	104	38.0
	Trichuris spp	6.7	13	8.1
	Ascaris spp	2.2	2	1.3
Nyarongi (n = 15)	Strongyles	73.3	207	55.0
	Strongyloides ssp	13.3	33	23.0
	Trichuris spp	6.7	7	6.6
	Ascaris spp	0	0	0
Rangwe (n = 13)	Strongyles	15.4	62	59.0
	Strongyloides ssp	0	0	0
	Trichuris spp	7.7	139	7.2
	Ascaris spp	42.6	492	346.0
Asego (n = 6)	Strongyles	50.0	100	64.5
	Strongyloides ssp	0	0	0
	Trichuris spp	0	0	0
	Ascaris spp	0	0	0
Kobama (n = 3)	Strongyles	33.3	333	91.0
	Strongyloides ssp	0	0	0
	Trichuris spp	0	0	0
	Ascaris spp	0	0	0

Age had significant influence on infection with Strongyles with significantly higher levels of infection being recorded in finishers than in adults ($p = 0.04$). Also, growers recorded significantly higher levels of infection with Strongyles than adults ($p = 0.036$). Sex had significant influence on the prevalence of infection with Strongyles ($p = 0.028$)

and *Ascaris suum* (p = 0.012) with females recording higher levels of infection than males.

Division of origin of pigs had significant influence on the intensity of infection with *Ascaris* spp (p = 0.000) and Strongyles (p = 0.000). The mean epgs for pigs from Riana Division were significantly higher than pigs from Pala Division (p = 0.000). Similarly, pigs from Ndhiwa Division recorded significantly higher mean epgs than those from Pala Division (p = 0.04). Asego, Rangwe, Nyarongi and Kobama divisions had few pigs and were therefore not included in the statistical analysis (ANOVA) due to small sample size to avoid bias.

A higher proportion (68%) of the animals was found to have low levels of infection (< 500 epg), 29% had moderate (500-2000 epg) and 3% had high (2000-5000) levels of infections with Strongyles (Figure. 2).

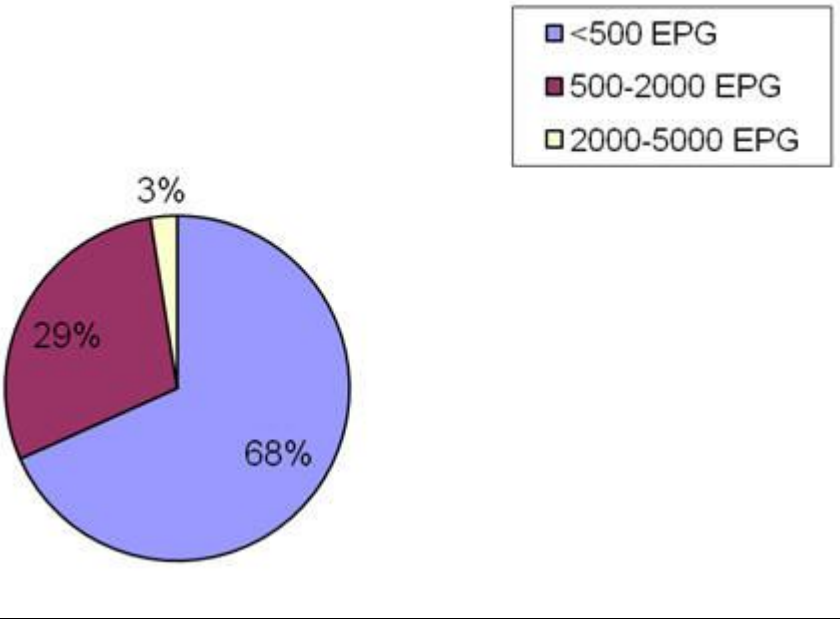

Figure 2: Levels of infection with Strongyle-type nematode eggs in pigs in Homabay District expressed as percentage.

Post-mortem examination for helminth parasites (Slaughter-house survey)

Out of the 30 pigs examined, 26 (86.7%) had one or more helminth parasites. *Hyostrongylus rubidus* was isolated from the stomachs of 12 pigs while *Physocephalus sexalatus* was recovered from the stomachs of 10 pigs. *Trichostrongylus axei* was isolated from the stomach of one pig while the small intestines of 3 pigs harboured *Ascaris suum*. *Oesophagostomum dentatum* was isolated from the large intestines of 23 pigs while 4 pigs harboured *Trichuris suis* in their large intestines. *Metastrongylus pudendodectus* was recovered from the lungs of 13 pigs. The highest mean burden of worms was recorded for *Physocephalus sexalatus* (85.06) while the lowest mean burden was recorded for *Ascaris suum* (0.13) (Table 3). Postmortem examination revealed the presence of *Trichostrongylus axei* and *Physocephalus sexalatus* whose eggs were not

detected through faecal examination. Also, *Metastrongylus pudendodectus* was recovered from the lungs of 13 pigs through post-mortem examination as compared to the faecal examination which detected the presence of *Metastrongylus* spp in one pig only. No infections of *Ascaris suum* were detected from examination of the liver.

Table 3: Genus and species of worms recovered from pigs at post-mortem in Homabay District

Location	Parasite	Number infected (%)	Mean burden	Range
Stomach	*H. rubidus*	12 (40.0%)	60.73	0-587
	P. sexalatus	10 (33.3%)	85.06	0-460
	T. axei	1 (3.3%)	26.27	0-788
Small intestines	*A. suum*	3 (10.0%)	0.13	0-2
Large intestines	*O. dentatum*	23 (76.7%)	74.37	0-559
	T. suis	2 (6.7%)	1.33	0-18
Lungs	*M. pudendodectus*	13 (43.3%)	16.50	0-126

H-Hyostrongylus; A- Ascaris; M- Metastrongylus; P- Physocephalus; O- Oesophagostomum; *T-Trichostrongylus; T- Trichuris*

Discussion

This study indicated a high prevalence and low to moderate levels of infections with helminths of pigs in Homabay District. The overall prevalence (83%) reported in this study is comparable to the 84.2% reported by Kagira (2010) in free range pigs in Busia District, Western Kenya which neighbours Nyanza Province. However, the prevalence recorded in the present study is higher than that reported previously in Kenya by Ng'ang'a et al (2008) on the outskirts of Nairobi, Wabacha et al (2004) in Kiambu District and Kagira et al (2002) in Thika District who reported prevalence's of 67.8%, 43.5% and 39% respectively. The higher prevalence recorded in this study may be due to the fact that it was based on outdoor pigs in which poor management and husbandry is associated with higher prevalence of helminths as compared to the previous studies which were mainly based on indoor pigs in which improved management is associated with lower helminth prevalence (Roepstorff and Nansen 1998). The high prevalence recorded in this study is in agreement with reports from outdoor pigs in Nigeria (Ajayi et al 1988), Ghana (Permin et al 1999), China (Boes et al 2000), Burkina Faso (Tamboura et al 2006) and Uganda (Nissen et al 2011) in which prevalence's of 97%, 91%, 95.9%, 93% and 91% were respectively reported. In outdoor pigs kept in India (Yadav and Tandon 1989), Botswana (Nsoso et al 2000) and Zimbabwe (Marufu et al 2008) and indoor pigs kept in Tanzania (Esrony et al 1997), lower prevalence's of 68.4%, 52%, 58.7% and 53% were respectively reported. The differences in the prevalence's may be due to the differences in climatic conditions, management systems, breeds and inherent characteristics such as host immunity in the study regions. Results from the present study and those of Kagira (2010) indicate that helminths are prevalent in pigs kept under the free range system in Kenya.

The species spectrum of worms identified in this study has been reported before in indoor and outdoor reared pigs in Kenya (Langat 1999; Kagira et al 2002; Wabacha et al 2004; Ng'ang'a et al 2008) and Kagira (2010). However, *Oesophagostomum quadrispinalatum*, *Trichostrongylus colubriformis* and *Ascarops strongylina* which were reported by Ng'ang'a et al (2008) and *Globocephalus urosubulatus* reported by Kagira (2010) were

not identified in this study. This may be attributed to differences in the fecundity of adult worms and pre-patent periods of these helminth species.

All the animals examined were found to excrete low to moderate numbers of nematode eggs. This indicates sub-clinical infections which are the most important form of infection since they are associated with economic losses such as decreased litter sizes, poor growth rates and reduced weight gain (Adebisi 2008; Marufu et al 2008). The results therefore mean that nematode infections may be one of the contributing factors to low productivity of pigs in the study area.

Most of the pigs examined were infected with Strongyles (Family *Trichostrongylidae*) of which 74% were infected with *Oesophagostomum* spp. This finding is in agreement with other reports which have found *Oesophagostomum* spp to be the most common in most pig farms (Esrony et al 1997; Boes et al 2000; Marufu et al 2008; Ng'ang'a et al 2008; Kagira 2010; Nissen et al 2011). The prevalence of *Oesophagostomum* spp reported in this study is comparable to 74.8% reported by Kagira (2010) in Busia District, Western Kenya but higher than 70% reported in outdoor reared pigs in Nigeria (Ajayi et al 1988), 60.6 % in Ghana (Permin et al 1999) and 54.6% in Zimbabwe (Marufu et al 2008). This prevalence is lower than 86.7% reported in outdoor reared pigs in China (Boes et al 2000). The variations in the prevalence in these studies may be attributed to the differences in the production systems which has significant influence on the environment and hence the development and survival of the free living stages of this helminth spp. The high prevalence of *Oesophagostomum* spp is attributed to the fact that its transmission is favoured by the high egg excretion rate of the parasite and humid and unhygienic conditions which are common under the outdoor production system (Nansen and Roepstorff 1999; Ng'ang'a et al 2008; Nissen et al 2011).

Ascaris suum had a prevalence of 5.4% with the highest prevalence of infection being recorded in Rangwe Division. The high prevalence recorded in Rangwe Division may be due to the high rainfall in this area compared to other parts of the district since re-infection levels of *Ascaris* spp have been found to be strongly correlated with the amount of rainfall, temperature as well as the number of wet days (Gunawardena et al 2004; Kagira 2010). Another probable reason for the high prevalence in this division is that most of the pigs sampled were growers and *A. suum* is known to mostly affect growers (Roepstorff and Nansen 1998). In this study, growers recorded the highest prevalence of infection with *A. suum* and piglets did not record any infections with this parasite. This is contrary to the report by Kagira (2010) in which piglets recorded the highest prevalence of infection with *A. suum* while growers recorded the least prevalence. A possible explanation to this scenario could not be established.

Trichuris suis was observed to have a prevalence of 7.8%. This is comparable to 7% reported in outdoor reared pigs by Kagira (2010) in Busia district, Kenya but higher than 4.6% reported in Ghana (Permin et al 1999) and 4.2% in Zimbabwe (Marufu et al 2008). A higher prevalence of 15.8% and 17% were reported by Boes et al (2000) and Nissen et al (2011) in outdoor reared pigs in China and Uganda respectively. This variability in the prevalence may be explained by the effect of environmental conditions on the

development of *T. suis* eggs since part of sampling was done during the dry period of the year. The eggs are more susceptible to dehydration and high temperature thus many eggs are killed during the dry period (Pitman et al 2010).

Strongyloides ransomi recorded a prevalence of 26.6% which is lower than 36.6% reported in outdoor reared pigs in Busia district, Western Kenya (Kagira 2010). This prevalence is higher than 9% reported in indoor reared pigs in Tanzania (Esrony et al 1997) and 2.3% in Kenya (Kagira 2001) and 1.7% in outdoor reared pigs in Ghana (Permin et al 1999). The differences in the prevalence may be attributed to the differences in climatic conditions of the study areas since the survival of *Strongyloides* larvae depends on the environmental temperature and moisture. The larvae of these species are susceptible to desiccation with the dry areas providing unfavourable environment for survival of *S. ransomi* larvae (Esrony et al 1997; Marufu et al 2008). Even though *S. ransomi* was reported in faecal examination, it was not recovered during post mortem examination. This could be attributed to the fact that *S. ransomi* mostly affects piglets (Roepstorff and Nansen 1994) and post-mortem examination was done in adult pigs.

The prevalence of *Metastrongylus* spp in this study was 0.3%. This is lower than 9.8% prevalence reported in outdoor reared pigs in Kenya (Kagira 2010), 19.3% in Ghana (Permin et al 1999) and 65.7% (Ajayi et al 1988) in Nigeria. Although only one pig was found to excrete *Metastrongylus* spp eggs, most of the pigs were found to be infected with this parasite at post-mortem. Lungworms have low fecundity and it may be difficult to find the eggs in faeces when using the regular detection methods (Roepstorff and Nansen 1994; Stewart and Hoyt 2006; Kagira 2010).

Postmortem examination revealed the presence of *Trichostrongylus axei* and *Physocephalus sexalatus* whose eggs were not detected through faecal examination. This may be attributed to the low sensitivity of coprological examination compared to post-mortem examination since some parasites may produce only a small number of eggs (Roepstorff and Nansen 1998; Permin et al 1999; Ng'ang'a et al 2008). Also, the correlations between egg output and worm burdens may not be clear (Ng'ang'a et al 2008).

A higher percentage of pigs (68%) were excreting low Strongyle-type epg and 29% were excreting moderate epg. Only 3% of the pigs were found to excrete high epg indicating that the high prevalence of nematode infection was not related to high mean epg. This concurs with the findings of studies conducted in outdoor reared pigs in Ghana (Permin et al 1999) and Burkina Faso (Tamboura et al 2006) and rein forces the fact that helminthosis in pigs is usually sub-clinical (Esrony et al 1997). In the current study, the highest level of infections with helminths was recorded in adults and the lowest level of infection recorded in piglets. The higher prevalence in adults than in piglets could be due to prolonged exposure of adults to infective stages of nematodes. Piglets recorded the least mean epg of infections with Strongyles which could be explained by the fact that infections with *Oesophagostomum* spp and *Hyostrongylus rubidus* are greatest in the breeding stock which is probably a manifestation of the lower immunogenicity of these

two parasites (Nansen and Roepstorff 1999). Similarly, adults recorded the highest intensity of infection with *A. suum. Ascaris suum* has been shown to be the most prevalent in growing pigs but adult pigs have the highest intensity of infection (Nansen and Roepstorff 1999).

The effect of sex on the prevalence of helminth infections in this study was evident for Strongyles and *A. suum* with female pigs recording a higher prevalence than the males. Females are generally more prone to helminth infections than males during late pregnancy and lactation. This may be attributed to hormonal changes at this time that lower their resistance to nematodes resulting in the establishment of higher worm burdens than in males(Kusiluka and Kambarage 1996; Swai et al 2010). The results of this study contrasts with those of Yadov and Tandon (1989) in which no sex related incidence on the prevalence of parasites was observed. It also contrast with Kagira (2010), where male pigs had higher prevalence's than females.
In conclusion, this study has demonstrated that helminths are highly prevalent in free range pigs in the study area with low to moderate levels of infections and may be one of the contributing factors to low productivity in the study area. Therefore, there is need to institute appropriate control measures for these parasites in order to increase livestock productivity.

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