Prevalence and risk factors for *Ascaris* and *Cryptosporidium* infestations in smallholder pigs in Ulanga district, Tanzania

E.G. Lyimo[1], H.A. Ngowi[2] and H.E. Nonga[2]

[1]Ulanga District Council, Department of Livestock Development and Fisheries, P.O.Box 22, Ulanga, Morogoro, Tanzania.
[2]Department of Veterinary Medicine and Public Health, Collage of Veterinary and Medical Sciences, Sokoine University of Agriculture, P.O.Box 3021, Chuo Kikuu, Morogoro, Tanzania
E-mail: emnanuel.lyimo@yahoo.com

SUMMARY

Diseases in particular parasitic infestation is among the drawbacks to profitable pig production since parasites compromise the production and reproduction performance of infested pigs. The objective of this study was to estimate the prevalence and associated risk factors for *Ascaris* and *Cryptosporidium* infestations in pigs reared under smallholder farming systems in Ulanga District, Tanzania. A total of 243 pigs were selected for faecal sample examination using floatation and Modified Ziehl – Neelsen techniques. Questionnaire survey was conducted to 48 smallholder pig farmers to assess knowledge, perceptions and practices (KPPs) in relation to GIT (GIT) parasite infestations in pigs. Results showed that prevalence of *Ascaris* infestation was 11.5% and that of *Cryptosporidium* was 11.9%. Factors such age, feeding system, housing and shairing of breeding boars were statistically significant ($p < 0.05$) as risk factors for *Ascaris* and *Cryptosporidium* infestation. The respondents had poor knowledge on GIT parasites and the pig farming practices predisposes pigs to GIT parasite infestations. Therefore, GIT parasites are common in intensively managed pigs in Ulanga district. Proper control measures of GIT parasites are recommended; which include good management system especially to young pigs, better feeding, housing, breeding systems and disposal of manure.

Keywords: *Ascaris*, *Cryptosporidium*, pigs, smallholder farmers, GIT parasites

INTRODUCTION

Pig farming is one among the livestock projects which is relatively growing at a fast rate in Tanzania. The current pig population in Tanzania is 2.67 million (URT, 2016) whereby, more than 60% of pigs are reared in the Southern Highlands regions of Iringa, Mbeya and Ruvuma (URT, 2012). Pig farming is an important enterprise which provides opportunity as an income generating activity to small-scale farmers, especially in developing countries. In Tanzania, pigs are kept for meat, dowry, and manure for fertilizing the soil (Karimuribo *et al.*, 2011; Braae *et al.*, 2013). There are several problems which constrain pig industry in Tanzania; among them are diseases in particular parasite infestations.

Common helminth parasites of pigs are *Ascaris, Trichuris, Oesophagostomum, Trichinella* and *Strongyles* (Nganga *et al.,* 2008). A pig infested with *Ascaris* has poor feed conversion, delay to achieve market weight and sometimes may die (Weng *et al.,* 2005; Mkupasi, 2008; Tomass *et al.*, 2013). Ascarid-associated lesions in pig livers (milk spots) may lead to condemnation or reduce the value of affected livers. A study by Nansen and Roepstorff (1999) reported that poor environmental hygiene coupled with extensive managements are the risk factors for GIT infestation in pigs. In addition, molecular evidence indicates *A. suum* to be zoonotic (Leles *et al.,* 2012).

Protozoan GIT parasites like *Eimeria, Isospora* and *Cryptosporidium* spp. are common in pig farms (Nosal *et al.,* 2005). Protozoan parasites of pigs cause different manifestations like diarrhoea, weight loss, reduced production and reproduction performance and mortality especially in young animals. Some of the protozoan parasites like C*ryptospodium* spp are also known to cause diseases in humans especially in paediatrics, geriatrics and people with HIV/AIDS (Leles *et al.*, 2012). Studies conducted in the small-scale and semi-intensive management systems in some areas of Morogoro region reported the prevalence of cryptosporidiosis to be 7.8% (Esrony *et al*., 1996).

Regardless of the importance of pig industry in Tanzania, GIT diseases like ascariosis and cryptosporidiosis are less researched. Pig keeping is an upcoming practice in Ulanga district with substantial number of households keeping pigsmainly as source of income (Akulumuka and

Madulu, 2006). Nevertheless, poor pig productivity has been observed in the district and studies elsewhere reported that GIT parasites play a big role to the observed poor performance of the industry (Esrony *et al*., 1996; Weng *et al.,* 2005; Mkupasi, 2008; Tomass *et al.,* 2013). Despite the fact that, the district's pig production has increased tremendously, no study has addressed GIT parasites as a drawback to pig production in Ulanga district. The current study estimated the prevalence and associated risk factors for *Ascaris* and *Cryptosporidium* infestations in pigs reared under smallholder farming systems in Ulanga District, Tanzania.

MATERIALS AND METHODS

Study area description

This study was conducted in Ulanga District, which is situated in the southwest of Morogoro region. The District headquarters is Mahenge located 312 km from Morogoro Municipality, 512 km from Dar es Salaam City. It borders with Kilombero District to the West and extends to the North, Liwale District to the East and Malinyi District to the South and West (Fig. 1). It is situated between latitude 9°00" South of equator and longitude 36°40" Eastern of Greenwich. According to the 2012 population and housing census, the district had human population of 265,203 with the growth rate of 2.9% per annum (NBS, 2013). Administratively, Ulanga District is divided into four divisions namely; Vigoi, Mwaya, Ruaha and Lupiro with 21 wards, 59 villages and 222 hamlets. The economic activities in the district include mining, livestock and crop agriculture, fishing, and game hunting and lumbering. The study was done in Ulanga because pig farming is newly upcoming economic activities in the district with potential of improving farmers' livelihood and many farmers have adopted it.

Study design

A cross-sectional study was conducted to estimate the prevalence of *Ascaris* and *Cryptosporidium* infestations in pigs and assess KPPs of smallholders pig farmers in relation to the GIT parasites in Ulanga district, Tanzania.

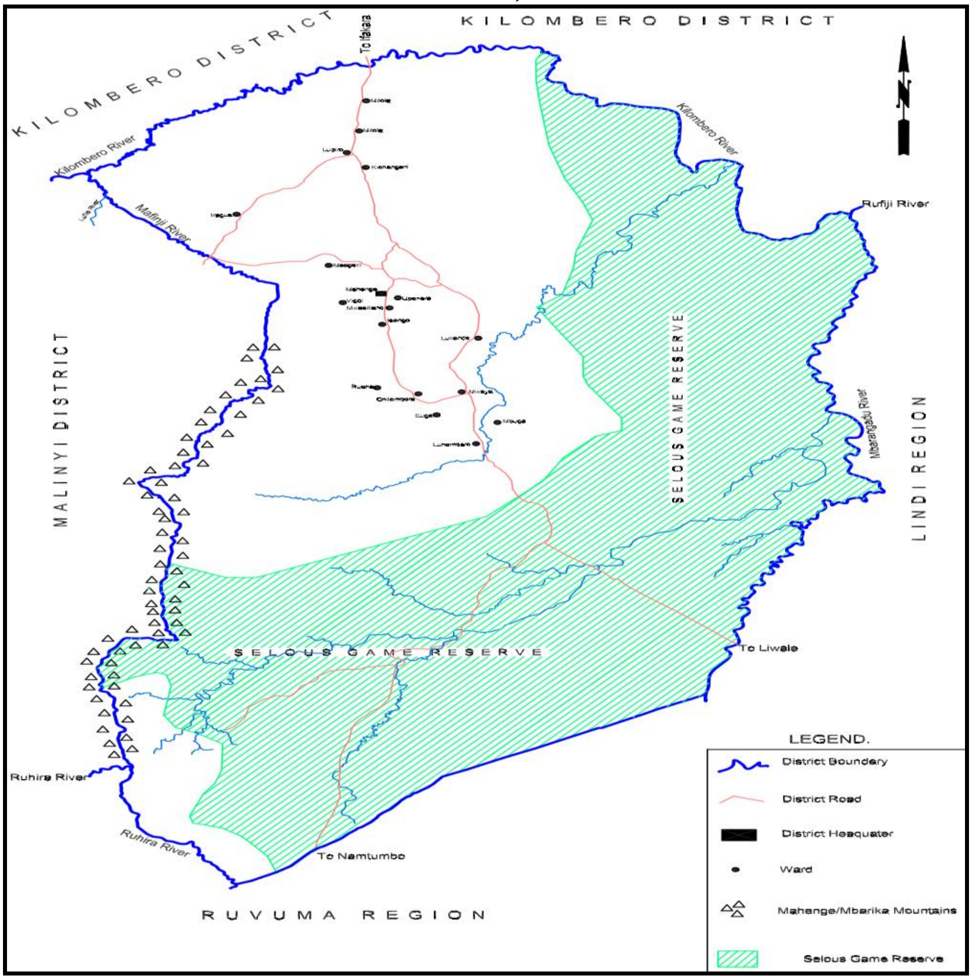

Figure 1 Map of Ulanga district showing boundaries, wards, district headquarters and Selous Game reserve.

Sample size determination

The sample size was calculated by using the formula as described by Martin *et al.* (1987).

$$n = \frac{Z^2_{alpha} \times p\,(1-p)}{d^2}$$

Where n= sample size, Z_{alpha} = standard normal deviate, set at 1.96 corresponding to 95% confidence level, p=proportion in the target population estimate; 50% is used if p is not known, q=1.0-p, d=degree of accuracy desired, set at p - value < 0.05 allowable error of estimation, 5% in this study. The estimated prevalence of *A. suum* of 12% was used as per studies conducted in Mgeta, Morogoro region (Esrony *et al.*, 1996).

Sampling technique

Multistage sampling procedure was adopted, and sample size rose by 50% to adjust for possible clustering of the infection (Martin *et al.,* 1987). Thus a total of 243 pigs were sampled. Pigs were sampled from 2 wards purposively selected out of 19 wards based on the number of pigs. In each study ward, 2 villages were selected also based on pig population. In each selected village, 12 households were randomly selected. In each village, the selected pig-keeping households were visited and a maximum of 5 pigs were sampled from each household until the desired sample size was attained. Inclusion criteria for the household were: smallholder pig farmers, willingness to participate in the study and their accessibility. Farms with ≤ 5 pigs, all the animals were sampled but for the farms with > 5 pigs, simple random sampling was performed to get five representative pigs.

Questionnaire survey

Before faecal samples were collected in pigs, a structured questionnaire was administered to the selected households to gather information on the possible factors contributing to GIT parasite infestation. A close ended interview questionnaire containing variables on pigs farming were administered to the heads of the selected households. In addition, check list was used to obtain information about production systems, feed and feeding equipments, ownership of breeding boars, disposal of pig manure and general condition of pig pens, water troughs and housing.

Sample collection and handling

Selected study pigs were restrained and faecal samples collected per rectum. Samples were stored in a cool box packed with ice packs during field work and thereafter stored at 4 – 8C^o in the refrigerator in Ulanga livestock office. Subsequently, samples were shipped to the helminthology laboratory at Sokoine University of Agriculture for analysis within 5 days after sampling.

Laboratory sample analysis

***Ascaris* eggs determination**

The floatation technique was used using Sodium chloride (NaCl) with specific gravity of 1.20 (1.20 S.G.) as a floatation solution (OIE, 2008). Three grams of faecal samples were mixed with NaCl solution into a beaker, then the suspension was poured into a test tube and left until a convex meniscus at the top was formed. A cover slip was carefully placed on top of the test tube and was left to stand for 20 minutes. The cover slip was carefully lifted from the tube and immediately placed on a glass slide for microscopic examination at 40 × magnifications (WHO, 1991). *Ascaris* eggs were identified by using standard identification keys based on their morphological features (Soulsby, 1982).

***Cryptosporidium* oocyst determination**

The modified Ziehl-Neelsen stain technique was used to analyse the presence of *Cryptosporidium* oocysts. The floatation technique used sucrose solution with specific gravity of 1.18 (1.18 S.G). One gram of faecal samples was mixed with sucrose solution in the beaker, then the suspension was poured into the test tube and left for 30 minutes until a convex meniscus at the top was formed. One drop of the sample mixture was used to make a smear on a glass slide, air-dried and fixed by using absolute methanol for 3 minutes. The slide was immersed in cold strong carbol-fuchsin and stained for 15 minutes before was rinsed with tap water. The slide was decolourised in 1% acid methanol for 10 seconds and rinsed again with tap water. A 0.4% malachite green solution was flooded on the slide as a counterstain for 30 seconds and rinsed again with tap water before was air-dried. Oil immersion was added on the smear and examined under the microscope at 100x magnification for detection of *Cryptosporidium* oocysts (WHO, 1991). *Cryptosporidium* oocysts were identified by using standard identification keys based on their morphological features as described by Soulsby (1982).

Data Analysis

Descriptive statistics was used to summarize the data and analysed for the prevalence of *Ascaris* and *Cryptosporidium* infestation in pigs. Chi-square test was analysed using SPSS version 16 to establish the differences in infestation rates of *Ascaris* and *Cryptosporidium* in pigs of different age and sex in different study sites. The differences was considered significant when $p<0.05$. Logistic regression analysis was used to assess the association between the prevalence of *Ascaris* and *Cryptosporidium* infestation and risk factors (age, sex, breeding, feeds and housing).

RESULTS

Socio-demographic characteristics of the respondents and pig management system

The wards and villages in which the study was conducted are shown in Table 1**.** A total of 48 respondents were interviewed. Out of the 48 respondents, 54.2% were from Vigoi ward and majority had a primary school education. All the respondents practised intensive pig management system and kept other animals like chickens, ducks, guinea fowl, cattle, goats and dogs.

Table 1. Socio-demographic characteristics of respondents and pig management system

Demographic information	Category	Number of respondents in wards		Percent of respondents	95% C.I
		Mahenge (n=24)	Vigoi (n=24)		
Gender	Male	12	13	25 (50.0)	38.0-66.2
	Female	10	13	23 (47.9)	33.8-62.0
Age range (years)	15-45	12	15	25 (52.1)	38.0-66.2
	> 45	12	11	23 (47.9)	33.8-62.0
Level of education	Non formal	5	2	7 (16.7)	4.6-24.6
	Primary	8	15	23 (47.9)	33.8-62.0
	Secondary	5	4	9 (18.8)	7.7-29.8
	Collage	6	3	9 (18.8)	7.7-29.8
Duration of keeping pigs (years)	1-10	15	9	24 (50.0)	35.9-64.1
	≥ 10	10	14	24 (50.0)	35.9-64.1
Management system	Intensive	24	24	48 (100.0)	1
Feeding	Presence of feed troughs	15	13	28 (58.3)	44.4-72.3
Manure disposal	Presence of disposal sites	14	16	30 (62.5)	48.8-76.2
Breeding	Ownership of boars	12	10	22 (45.8)	31.7-59.9
Keeping other animals other than pigs	Yes	19	21	40 (83.3)	72.8-93.9

Knowledge, practices and perceptions of smallholder pig farmers in relation to GIT parasites in pigs in Ulanga district, Morogoro

Knowledge, practices and perceptions of smallholder pig farmers in relation to GIT parasites in pigs were as presented in Table 2.

Table 2. Knowledge, practices and perceptions of smallholder pig farmers on GIT parasites in Ulanga, Morogoro

Variable	Question	Number of respondents	Number (%) of respondents with knowledge	95 % CI
Knowledge	Knowledge on pig GIT parasites	27	12 (44.4)	25.7 - 63.2
	Knowledge on how pigs infected with GIT parasites	27	12 (44.4)	25.7 - 63.2
	Knowledge on clinical signs of GIT parasites	27	7 (25.9)	9.4-42.5
	Knowledge on treatment	27	16 (59.3)	40.7 - 77.8
Perception	Knowing that pig gets infected with GIT parasites	48	27 (56.3)	42.2 - 70.3
Practices	Feeding	48	28 (58.3)	44.4-72.3
	Cleanliness	48	29 (60.4)	46.6-74.3
	Sites for manure disposal	48	30 (62.5)	48.8-76.2
	Rearing system	48	48 (100.0)	1
	Breeding	48	22 (45.8)	31.7-59.9
	Keeping other animals	48	40 (83.3)	72.8-93.9

Prevalence of *Ascaris* and *Cryptosporidium* infestation

A total of 243 pigs were sampled for determination of *Ascaris* and *Cryptosporidium* infestations. Out of the 243 pigs, 145 (59.7 %) were female and the age ranged between 2 and 36 months. The prevalence of *Ascaris* and *Cryptosporidium* infestation was 11.5 % (n=243; 95% CI= 7.5-15.5) and 11.9 % (n=243; 95%

CI=7.9-16.0), respectively. Prevalence of *Ascaris* and *Cryptosporidium* infestation in relation to different variables was as presented in Table 3.

Table 3. Prevalence of *Ascaris* and *Cryptosporidium* infestation by sex, age and location/sites

Infestation	Variable	Category	No. (%) of pigs infested	95% CI	p value
Ascaris	Age (months)	1-12	24 (9.9)	6.1-13.6	0.794 ns
		≥ 13	4 (1.6)	0.0-3.2	
	Sex:				
	Male	Male	8 (3.3)	1.0-5.5	0.12 ns
	Female	Female	20 (8.2)	4.8-11.7	
	Location:				
	Mahenge	125	8 (6.5)	2.1-10.7	0.01*
	Vigoi	100	20 (20.0)	12.2-27.8	
Cryptosporidium	Age (months)				
		1-12	23 (9.3)	5.8-13.1	0.145 ns
		≥ 13	6 (2.5)	0.5-4.4	
	Sex	Male	15 (6.2)	3.1-9.2	0.12 ns
		Female	14 (5.8)	2.8-8.7	
	Mahenge	110	13 (10.6)	5.8-17.9	0.5063 ns
	Vigoi	104	16 (13.3)	8.5-22.5	

***** *Statistically significant*

Various factors assessed as risks of *Ascaris* and *Cryptosporidium* infestation

The factors assessed as risk factors of *Ascaris* and *Cryptosporidium* infestation include age of the pig, sex, availability of the manure disposal pits, pig house, availability of feed troughs and keeping of other animals (Table 4). It was found that only age of the pig and breeding was statistically significant ($p<0.05$) as risk factors for *Ascaris* infestation whereas in *Cryptosporidium* all the assessed risk factor were not statistically significant ($p>0.05$).

Table 4. Various factors assessed as risks for *Ascaris* and *Cryptosporidium* infestation

Infestation	Variable	Number (%) of pig farms infested	95% CI	p value
Ascaris	Age (months): 1-12	14 (25.0)	16.3-42.0	0.000 **
	≥13	8 (16.7)	6.1-27.2	0.002**
	Sex: Male	9 (18.8)	7.7-29.8	0.456 ns
	Female	13 (27.1)	14.5-39.7	
	Feed	17 (35.4)	21.9-48.9	0.105 ns
	Housing	14 (29.2)	16.3-42.0	0.21 ns
	Breeding	5 (10.4)	1.8-19.1	0.001**
	Manure disposal pits	14 (29.2)	16.3-42.0	0.421 ns
	Keeping of other animals	11 (22.9)	11.0-34.8	0.048 ns
Cryptosporium	Age (months) 1-12	15 (31.3)	18.1-44.4	0.102
	≥ 13	5 (10.4)	1.8-19.1	0.496
	Sex: Male	8 (16.7)	6.1-27.2	0.379 ns
	Female	12 (25.0)	12.8-37.2	
	Feeding	15 (31.3)	18.1-44.4	0.322 ns
	Housing	13 (27.1)	14.5-39.7	0.137 ns
	Breeding	7 (14.6)	4.6-24.6	0.372 ns
	Manure disposal	12 (25.0)	12.8-37.2	0.294 ns
	Keeping of other animals	11 (22.9)	11.0-34.8	0.421 ns

****** *Statistically significant, ns not statistically significant*

Logistic regression analysis for *Ascaris* and *Cryptosporidium* infestation in relation to various factors assessed

Risk factors for pig infestation by *Ascaris* are shown on Table 5. The model of the predictors selected had a chi-square value of 54.6 and was statistically significant at p= 0.000 indicating that the predictors selected could explain the magnitude of *Ascaris* infestation in pigs raised in the study area and there was no multicollinearity problem between the predictors as all had standard error less than 2.0. Based on the findings age of pigs, presence of feed troughs and house with concrete floor were negatively associated with *Ascaris* infestation implying that younger pigs, poorly fed pigs and poorly housed pigs were more prone to *Ascaris* infestation although statistically were not significant. It was evident that relatively younger pigs were 78% more likely to suffer from *Ascaris* infestation compared to older pigs and poorly fed pigs were 31% more likely to suffer compared to better fed pigs (Table 5). Similarly, poorly housed pigs were 38% more likely to suffer from *Ascaris* infestation compared to properly housed pigs and the influence of age, housing and feeding was statistically significant at p< 0.05 (Table 5). Although female pigs suffered more from *Ascaris* infestation compared to male pigs and properly bred pigs suffered relatively low to *Ascaris* infestation, their influence was not statistically significant (p< 0.05). Again, pigs in the farms without proper manure disposal system such as manure pits were 92.2% more likely to suffer from *Ascaris* infestation than those in farms with good manure disposal system.

Risk factors for pig infestation by *Cryptosporidium* are shown on Table 5. The model of the predictors selected had a chi-square value of 21.49 and was statistically significant at p= 0.001 indicating that the predictors could explain the prevalence of *Cryptosporidium* infestation in pigs and there was no multicollinearity problem between the predictors as all had standard error less than 2.0. Based on the findings age, sex, breeding and housing were negatively associated with the prevalence of *Cryptosporidium* infestation. This implies that younger pigs, female pigs and improperly bred pigs and poorly housed pigs were more prone to *Cryptosporidium* infestation (Table 5). Age influence and breeding were statistically significant at p< 0.05 and it implies that relatively younger pigs were 75% more likely to suffer from cryptosporidiosis compared to their older counterparts. Female pigs were 71.2% more likely to suffer from *Cryptosporidium* infestation though this was not statistically significant at p< 0.05. Equally, poorly housed pigs were 71.2% more likely to suffer from *Cryptosporidium* infestation than better housed pigs although the difference was not significant (p< 0.05). Poorly bred pigs were approximately 57% more likely to suffer from *Cryptosporidium* infestation and the influence of breeding practice was statistically significant at p < 0.05. Pigs in a farm without proper manure disposal system were 47.9% more likely to get infected with *Cryptosporidium* infestation than the farm with good manure disposal system. The risk of *Cryptosporidium* infestation in pigs was also observed to the farms that keep other animals together with pigs which are 57.9% more likely to get infested although is not statistically significant.

Table 5. Logistic regression analysis for the prevalence of *Ascaris* and *Cryptosporidium* infestation in relation to various factors assessed

Infestation		B	S.E	Wald	Sig.	Exp(B)
Ascaris	Constant	-2.220	0.460	23.292	0.000	0.109
	Age	-0.243	0.158	2.364	0.124	0.784
	Sex	0.714	0.231	9.512	0.062	2.041
	Feeding	-1.174	0.253	21.567	0.000	0.309
	Breeding	0.595	0.253	5.524	0.059	1.813
	Housing	-0.979	0.255	14.719	0.000	0.376
	Manure disposal pits	-0.082	0.479	0.029	0.865	0.922
	Keeping other animals	-0.562	0.620	0.823	0.364	1.754
Cryptosporidium	Constant	-0.556	0.393	2.000	0.157	0.573
	Age	-0.291	0.153	3.639	0.046	0.747
	Sex	-0.339	0.231	2.151	0.142	0.712
	Feeding	0.527	0.243	4.712	0.030	1.695
	Breeding	-0.577	0.217	7.058	0.008	0.562
	Housing	-0.339	0.231	2.151	0.142	0.712
	Manure disposal pits	-0.736	0.462	2.531	0.112	0.479
	Keeping other animals	-0.546	0.572	0.911	0.340	0.579

DISCUSSION

This study aimed to estimate the prevalence and risk factors for *Ascaris* and *Cryptosporidium* infestation in smallholder pig production system in Ulanga district, Morogoro Tanzania. Generally, it was found that *Ascaris* and *Cryptosporidium* infestations were prevalent in Ulanga district and the associated risk factors were age of pigs, feeding system, housing and breeding type.

With these results, GIT parasites are among the setback to pig industry in Ulanga district. Proper control measures of GIT parasites in pigs are recommended which includes good management system especially to young pigs, better feeding, housing and breeding systems and disposal of manure. Otherwise, pig farmers are likely to continue with losses associated with GIT parasites in the district.

In the present study, out of 243 pigs examined for *Ascaris* infestations, 11.5% had eggs in their feacal samples. Nevertheless, this study found the prevalence of *Ascaris* infestations to be lower than 12.7% reported from Eastern Ghana (Tiwari *et al.*, 2009) and 54.6% from Bostwana (Nsoso *et al.*, 2000), but higher than 11.1% reported in Southwest Nigeria (Sowemimo *et al.*, 2012) and 4.2% in Turkey (Uysal *et al.*, 2009). High infection rate by *A. suum* was correlated with wetness, temperature and unhygienic environment as also reported elsewhere (Kagira 2010; Obonyo *et al.*, 2013). Ascariosis is a common infection of pigs and among the leading causes of liver condemnation during post-mortem meat inspection. *Ascaris suum* infection causes pathological effects to the liver and lungs, in the liver leads to a condition called milk spots due to larval migrations in liver tissues. A study carried out in the northern highlands of Tanzania recorded a prevalence of 44.3% of *A. suum* infection in pigs (Ngowi *et al.*, 2004), and a study conducted by Nonga and Paulo (2014) reported the prevalence of *Ascaris* infestations to be 37.0% at Sanawari slaughter slab in Arusha, Tanzania. However, Mkupasi *et al.* (2010) reported a prevalence of up to 8.1% in slaughtered pigs in Dar es Salaam, Tanzania. This implies that the parasite is prevalent in pigs in Tanzania and causes high economic losses to the farmers.

In fact, *A. suum* was previously considered to be a parasite of pigs only but current studies have reported it as among the causes of visceral larva migrans in humans (Sakakibara *et al.,* 2002). In addition, human eosinophilic pneumonia has been reported and *A. suum* specific antibodies were detected in these cases (Kakihara *et al.,* 2004). The potential of *A. suum* to infect human might be due to the fact that it shares similar protein molecules with *Ascaris lumbricoides* for which human is the natural host (Leles *et al.*, 2012). Therefore high prevalence of *A. suum* observed in Ulanga district in pigs is of great importance in public health perspective.

The present study established the prevalence of *Cryptosporidium* infection to be 11.9% (Table 3). This prevalence was higher than 7.8% reported by Esrony *et al.* (1996) in Mgeta Morogoro, 7.0% in Ethiopia (Haileyesus, 2010) and 6.7% in Turkey (Uysal *et al.*, 2009). However, higher positivity of *Cryptosporidium* spp. in intensively managed pigs in Lusaka, Zambia was reported (Siwila and Mwape, 2012). Cross infection of *Cryptosporidium* from animals to human has been reported. Studies elsewhere reported human infection with dog specific genotype of *Cryptosporidium canis* (found in dogs), C. *felis* (found in cats), *C. meleagridis* (birds), *C. muris* (rodents), corvine genotype (deer) and pig genotype have also been reported (Pieniazek *et al.*, 1999; Katsumata *et al.*, 2000; Morgan *et al.*, 2000; Pedraza-Diaz *et al.*, 2000 and Xiao *et al.*, 2002). Further studies are required to determine *Cryptosporidium* at species level so as to isolate several species which could provide basis for its management in the study area.

Based on wards, it was found that the prevalence of *Ascaris* infestations in Vigoi ward was three times higher than that of Mahenge (20%: 6.5%) and the difference was statistically significant (p = 0.01). This difference was probably due to the proximity of the Mahenge ward to the District Livestock and Fisheries Department where farmers can easily access the extension service as compared to Vigoi ward which is far and currently there is no livestock extension officer.

Both *Ascaris* and *Cryptosporidium* spp were common GIT parasites in all age categories of pigs examined in the present study although the magnitude of the infection was decreasing as the age increased (Table 3). This is in agreement with studies conducted in intensively managed pigs in Botswana where *A. suum* was found to be the most common endoparasite infesting both old and young pigs (Nsoso *et al.*, 2000). These are further evidences that *Ascaris* infestation in pig is a big problem in Tanzania and had been causing enormous losses to farmers and traders of pork.

Findings of questionnaire survey and observation during this study revealed that 56.3% of the respondents had poor knowledge on GIT parasites as a problem in pigs. Poor knowledge can be a factor for not doing proper pig management which are aimed at prevention and control of parasitic infestation. This implies that, the endemicity of GIT parasites in the study areas were also contributed by inadequate knowledge in pig management. In addition, most respondents had a wrong perception that rarely pig gets infested with GIT parasites. This makes farmers to be reluctant to plan prevention and control measures. So many of the daily practices in pig farms like type of feeding, hygiene, manure disposal, breeding systems and keeping other animals if not well managed may also be risk factors for parasite infestations.

The regression analysis has shown that; age, feeding, poor housing and breeding to be the risk factors for the prevalence of *Ascaris* and *Cryptosporidium* infestations in the study area (Table 5). More than 40% of the farms had no feed troughs and farmers feed their pigs by throwing the feeds on the floor. In addition, more than 80% of the pig houses had no concrete floor which made the cleaning work to become difficult. Shairing of boars for breeding was also among the practices done by more than 80% of the farmers, a practice that may have contributed to the results for the prevalence of the ascariosis and cryptosporidiosis in the study area. Housing and feeding were found to be associated with prevalence of *Ascaris* while feeding and breeding were found to be the risk factors for prevalence of *Cryptosporidium* in the study area.

Based on the findings from this study, it is concluded that *Ascaris suum* and *Cryptosporidium* spp) are prevalent in pigs managed under intensive system in Ulanga district, Morogoro, Tanzania. Some of the risk factors for infestations of *Ascaris suum* and *Cryptosporidium* spp were age, housing, feeding and breeding systems. The possibilities of *Ascaris* spp and *Cryptosporidium* species of pigs to infect human are high because of unhygienic environmental condition that exist in most of the pig farms. Further investigations are recommended for molecular characterization of *Ascaris* and *Cryptosporidium* isolates of pigs to clearly determine the species of the parasites responsible for swine ascariasis and cryptosporidiosis, respectively in the study areas.

ACKNOWLEDGEMENTS

The authors extend their gratitude to the One Health Central and Eastern Africa (OHCEA) Programme and Local Authorities Pensions Fund (LAPF) for funding this study. The cooperation shown by the pig farmers in Ulanga district, District Executive Director, Livestock Extension Officers and laboratory technicians at Sokoine University of Agriculture is highly appreciated.

REFERENCES

Akulumuka V, Madulu R. Report on the Assessment of Income and Social and Cultural Factors Affecting Technology Adoption in Ulanga District, report for Ulanga District Council.93pp., 2006.

Braae UC, Ngowi HA, Johansen MV. Smallholder pig production: Prevalence and risk factors of ectoparasites. *Vet Parasitol* 196 (1-2): 241-4, 2013.

Esrony K, Kambarage DM, Mtambo, MMA, Muhairwa AP, Kusiluka LJM. Intestinal Protozoan Parasites of Pigs Reared under Different Management Systems in Morogoro, Tanzania. *J App Anim Res* 10 (1): 25–31, 1996.

Haileyesus A. The prevalence of intestinal parasites and molecular characterization of *Cryptosporidium* species in Ethiopia. Ph.D. Thesis, Addis Ababa University, Ethiopia. pp.117, 2010.

Kagira JM. Characteristics of production system, epidemiology and control of pig parasites in Busia District, Kenya. Ph.D Thesis, University of Nairobi pp 59-80. 2010.

Kakihara D, Yoshimitsu K, Ishigami K, et al. Liver lesions of visceral larva migrans due to *Ascaris suum* Infection: CT findings. *Abdom Imag* 29: 598-602, 2004.

Karimuribo E, Chenyambuga, S, Makene V, Mathias S. Characteristics and production Constraints of Rural Based Small Scale Pig Farming in Iringa Region,Tanzania. *Lrrd* 23: 8, 2011.

Katsumata T, Hosea D, Ranuh IG, Uga S, Yonagi T, Kohno S. Short Report: possible *Cryptosporidium muris* infection in humans. *American J Trop Med Hyg* 62: 70-72, 2000.

Leles D, Scott L, Gardner KR, Alena I, Adauto A. Are *Ascaris Lumbricoides* and *Ascaris Suum* a single species?” *Parasite Vectors* 5 (1): 42, 2012.

Martin SW, Meek AH, Willeberg P. Veterinary Epidemiology, Principles and Methods. Iowa State University Press, Ames, Iowa, USA. University Press, Canada. 231 pp, 1987.

Mkupasi EM. “Prevalence of endoparasites of public health importance in pigs slaughtered in Dar Es Salaam City, Tanzania.” Unpublished dissertation for award of Master’s degree at Sokoine University of Agriculture, Tanzania. pp 1-73, 2008.

Mkupasi EM, Ngowi HA, Nonga HE. Slaughter Slab Survey for Extra-Intestinal Porcine Helminth Infections in Dar es salaam City, Tanzania. *Trop Anim Health Prod* 43(2): 417–423, 2010.

Morgan U, Weber R, Xiao L, et al. Molecular characterization of *Cryptosporidium* isolates obtained from human immunondeficiency virus-infected individuals living in Switzerland, Kenya and United States. *Clin Microb* 38: 1180-1183, 2000.

Nansen P, Roepstorff A. Parasitic helminths of the pig: factors influencing transmission and infection levels. *Int J Parasitol* 29: 877-89, 1999.

Nganga CJ, Karanja DN, Mutune MN.The prevalence of gastrointestinal helminth infections in pigs in Kenya. *Trop Anim Health Prod* 40(5):331- 334, 2008.

Ngowi HA, Kassuku AA, Maeda GE, Boa ME, Willingham III AL. A slaughter slab survey for extraintestinal porcine helminth infections in Northern Tanzania. *Trop Anim Health Prod* 36: 335-340, 2004.

Weng YB, Hu YJ, Li Y, Li BS, Lin RQ, Xie DH, Gasser RB, Zhu XQ. Survey of intestinal parasites in pigs from intensive farms in Guangdong Province, People’s Republic of China, *Vet Parasitol* 127: 333-336, 2005.

Nsoso SJ, Mosala KP, Ndebele RT, Ramabu SS. The prevalence of internal and external parasites in pigs of different ages and sexes in Southeast District, Botswana, Onderstepoort. *J Vet Res* 67: 217-220, 2000.

Nonga HE, Paulo N. Prevalence and intensity of GIT parasites in Pigs at Sanowari slaughter slab in Arusha, Tanzania. *Liv Res Rural Devel* 27:1, 2015.

Nosal P, Eckert R. GIT parasites of swine in relation to the age group and management system. *Medyc Weteryn* 61: 435-438. 13, 2005.

Obonyo FO, Maingi N, Githigia SM, Ng’ang’a CJ. Farming practices and risk factors for transmission of helminths of free range pigs in Homabay District, Kenya. *Livest Res Rural Dev* 25(36): 78-83, 2013.

OIE AHS. Manual of Diagnostic Tests and Vaccines for Terrestrial Animals. *Office Int Epiz Paris France* 1092–1106, 2008.

Pedraza-Diaz S, Amar C, McLauchlin J. The identification and characterisation of an unusual genotype of Cryptosporidium from human faeces as *Cryptosporidium meleagridis*. *FEMS Microbiology Lett* 189: 189-194, 2000.

Pieniazek NJ, Bornay-Llinares FJ, Slemenda SB, Da Silva AJ, Moura IN, Arrowood MJ, Ditrich O, Addiss DG. New Cryptosporidium genotypes in HIV- infected persons. *Emerg Inf Dis* 5: 444-449. 1999.

NBS. 2012 Population and Housing Census of Tanzania. General report, Dar es Salaam, 264pp, 2013.

Sakakibara A, Baba K, Niwa S, et al. Visceral larva migrans due to *Ascaris suum* which presented with eosinophilic pneumonia and multiple intra-hepatic lesions with severe eosinophil infiltration-outbreak in a Japanese area other than Kyushu, *J Int Med* 1: 574-579. 2002.

Siwila J, Mwape KE. Prevalence of Cryptosporidium spp. and Giardia duodenalis in pigs in Lusaka, Zambia. *Onderstepoort J Vet Res* 79(1):1-5, 2012.

Sowemimo OA, Asaolu SO, Adegoke FO, Ayanniyi OO. Epidemiological survey of GIT parasites of pigs in Ibadan, Southwest Nigeria. *J Pub Healt Epi* 4(10): 294-298, 2012.

Soulsby EJL. Helminths, Arthropods and Protozoa of domesticated animals. 7th edition, Lea Febiger, Philadelphia, 136-328. 1982.

Tiwari KP, Chikweto A, Belot G, Vanpee G, Deallie C, Stratton G, Sharma RN. Prevalence of intestinal parasites in pigs in Grenada, West Indies. *West Indian Vet J* 9 (1): 22-27, 2009.

Tomass Z, Imam E, Kifleyohannes T, Tekle Y, Weldu K. Prevalence of GIT parasites and *Cryptosporidium* spp. In extensively managed pigs in Mekelle and urban areas of southern zone of Tigray region, Northern Ethiopia. *Veterinary World*, 6: 433-439, 2013.

URT (United Republic of Tanzania). Budget report for the Ministry of Agriculture, Livestock and Fisheries, 2016/2017. pp 1-153, 2016.

URT (United Republic of Tanzania). National Sample Census of Agriculture 2007/2008 Small Holder Agriculture - National Report. Tanzania Government.pp12-89, 2012.

Uysal H, Kirkoyun O, Boral KM, Atilla I. Investigation of Intestinal Parasites in Pig Feces That Are Also Human Pathogens.” *Turkiye Parazitol Derg* 33 (33): 218–221, 2012.

WHO. Basic laboratory methods in medical parasitology. World Health Organization, Geneva. pp 1-114, 1991.

Xiao L, Bern C, Arrowood M, Sulaiman I, Zhau L, Kawai V, Vivar A, Lal AA, Gilman RH. Identification of the *Cryptosporidium* pig genotype in a human patient. *J Inf Dis* 185: 1846-1848, 2002.