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ORIGINAL ARTICLE

Prevalence and determinants of gastrointestinal parasite infection in intensively managed pigs in Nsukka agricultural zone, Southeast, Nigeria

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Abstract Gastrointestinal parasite (GIP) infection in pigs constrains swine production and enhances dissemination of zoonotic parasites, especially in the tropics. Therefore, an epidemiological study to determine prevalence and risk factors of GIP infection in intensively managed pigs in Nsukka, was conducted. Faecal samples from 1400 pigs, randomly collected from 40 farms, were examined for GIP eggs following standard protocol. Data on involvement of pig farmers in risk practices that enhance endoparasitic infection in piggeries were obtained using structured questionnaire. Overall prevalence of 80% (32/40) and 28.6% (400/1400) were recorded at farm and individual pig levels, respectively. Prevalence of 25.3% (138/546), 30.7% (262/854), 30.4% (310/1020) and 23.7% (90/380) were obtained for male, female, young (< 1 year) and adult (≥ 1 year) pigs, respectively. Epidemiological factors (sex, age, season, farm location and flock size) were significantly ($p < 0.05$) associated with worm infestations. Worm eggs identified and their prevalence were: Strongyles 25.7% (360/1400), *Trichuris* 11.4% (160/1400), *Ascaris* 0.7% (10/1400) and mixed infections (Strongyles and *Trichuris)* 9.3% (130/1400). Major risk factors found were feeding of self-compounded on-farm feed, non-disinfection of pen and equipment, rearing pigs of different ages together, infrequent removal of dungs, early weaning at less than 6 weeks and non-availability of routine deworming programme. The overall prevalence at farm and individual pig levels were high; and involvement of farmers in the risk practices was massive. Therefore, cost-effective control of GIP infestations in pig in the study area is imperative; to boost pig production and minimize risk of transmission of zoonotic parasites.

Keywords Swine · Pork · Prevalence · Gastrointestinal parasites · Risk factors · Zoonotic parasites

Introduction

The domestic pig, *Sus scrofa,* is a prominent member of the *Suidae* family reared in most parts of the world. Pig farming is extensively practiced as a family business in Southeast Nigeria (Onunkwo et al. 2011). Ownership of livestock is a measure of financial and social status, and a form of cash reserve for solving financial problems in rural African settings (Ekere et al. 2018). Pig keeping has therefore become an indispensible component of the rural economy; contributing significantly to job creation, poverty alleviation and meat production (Akanni et al. 2017).

Pigs contribute about 40% of meat consumed globally (Karaye et al. 2016). In Nigeria, pigs are reared exclusively for pork production, to satisfy high demand for meat occasioned by the nation's fast growing human population (Njoga et al. 2018a), currently estimated at 200 million at 2.6% annual growth rate (Worldometers 2019). Nigeria's average per capita daily protein intake (45.4 g) is lower than the FAO minimum recommendation of 65 g per day

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(FAO 2002; Abonyi et al. 2012; Abiodun et al. 2017) due to insufficiency and high cost of animal protein.

Although pigs and pig farming have the capacity to rapidly bridge the wide gap between demand and supply of animal protein in Nigeria, this has not been achieved due to high burden of gastrointestinal parasites (GIP) that frustrate productivity and profitability in pig farming businesses. Gastrointestinal parasite infection has been a major drawback in pig production in Nigeria due to multiplicity of factors that facilitate pathogen survival and proliferation in the tropics (Njoga et al. 2018b; Okoli et al. 2018). Following infection with GIP, the commonest clinical manifestations in pigs are in-appetence and diarrhoea. As the infection advances, the worms usually out-compete their hosts for available nutrients, resulting in emaciation, unthriftiness, anaemia, infertility problems and eosinophilia.

Heavy worm infection can result in irritation of the upper gastrointestinal tract or complete blockage of small intestine and bile duct; leading to emesis, icterus in young pigs and even death on eventual rupture of the intestine. Sometimes, immunosuppression ensues, thereby worsening the health condition of the infested pigs by predisposing them to plethora of other infections and possible deaths (Jufare et al. 2015). GIPs therefore contribute significantly to diminution in pork production in the tropics.

In addition, some GIPs of pig are zoonotic. *Ascaris suum, Taenia solium* cysticerci and *Trichinella spiralis* are zoonotic GIPs of pigs, causing enormous public health problems especially in areas where environmental or personal hygienic standard are compromised. Of these parasites, *A. suum* appears to be the most essential from public health perspective, causing stunted growth and impaired cognitive function in children and young adults (Vlaminck et al. 2014). Subsistent pig farming, in which piggeries are sited within residential areas to prevent animal theft, makes for close association between pigs and humans; especially children, and exacerbates transmission of zoonotic parasites (Agustina et al. 2017). Humans may acquire *A. suum* infection via ingestion of food or water contaminated with viable egg of the parasite (Idika et al. 2017). The infection in man may cause serious health challenges and financial loses in medical treatment.

Besides the aforementioned problems, GIP infection causes substantial negative effects in the econometrics and profitability of pig farming enterprises. The economic losses accruing from the worm infection can be significant, but farmers usually do not realize it as early warnings of the infection seem to proceed sub-clinically. Infested pigs usually manifest anorexia and poor feed conversion efficiency; hence delay in maturity or attainment of market weight. Additionally, high morbidity and disease conditions associated with the parasitic infection cause substantial economic wastage due to costs of anthelmintics and veterinary services during treatment. Un-thriftiness noted among infested pigs (Jatfa et al. 2019) translates to economic loses as the animals are reared and fed longer than usual. Furthermore, the worms may damage visceral organs, resulting in financial losses due to condemnation of damaged organs or carcasses during meat inspection.

Despite profuse reports on prevalence of GIP infection in pigs in other parts of Nigeria (Nwoha and Ekwurike 2011; Sowemimo et al. 2012; Okorafor et al. 2014; Karaye et al. 2016; Akanni et al. 2017; Obisike et al. 2018; Lekko et al. 2018; Jatfa et al. 2019), there is dearth of published data on GIP infection in pigs in Nsukka agricultural zone; notwithstanding widespread pig farming activities and large scale consumption of pork. Although Wosu (2015) reported on the prevalence of internal parasites of pigs in the study area, there is paucity of information on farmers' involvement in farm practices that could aggravate acquisition and dissemination of GIP infection in piggeries. Additionally, there is need to determine the current status of GIP of pig in the study area. The study was therefore undertaken to determine the prevalence and determinants of GIP infection in intensively managed pigs in study area. This will guide policy formulation on cost-effective control measures against the worm infection, to boost pork production, limit economic loses and risk of transmission of zoonotic parasites of pigs in the study area.

Materials and methods

Study site

The study was carried out in Nsukka agricultural zone, Enugu State, Southeast, Nigeria. Nsukka is situated in the derived savannah ecological zone of Enugu State at latitude 6°51′24″N and longitude 7°23′45″E; and elevation of 1810 ft. above sea level (Nwanta et al. 2011). Enugu State consists of three agricultural zones, 17 Local Government Areas (LGA) and is bounded to the North, West, South and East by Benue, Anambra, Abia and Ebonyi States respectively. Nsukka agricultural zone is the largest of the 3 zones, consisting of 7 out of the 17 LGAs. The study area has a population of about 2.5 million people, total land area of 5545.38 km^2, relative humidity of 14%, annual rainfall range of 1520–2030 mm and temperature range of 20–46 °C (Nwanta et al. 2011; Njoga et al. 2018a). Moreover, the study area experiences rainy/wet (winter) and dry (summer) seasons each year.

Sample collection

Weekly research visits for samples collection were made for 8 months; covering 4 months each for dry (December–

March) and wet (June–September) seasons. Multi-stage sampling technique was used to select five LGAs, 10 towns and 20 villages for the study. Forty piggeries were purposively selected from 68 available farms. The selection was based on the consent of the owners/managers to partake in the survey and accessibility of the farms. At the farm level, 10–25% of the pigs were selected by simple random sampling method and sampled. Stool samples were collected per rectum in clean sterile containers, packaged, labeled and transported in cold condition to the laboratory for parasitological examination. About 0.5 ml of blood was humanely and aseptically collected from the ear vein for determination of packed cell volume (PCV). For each sampled pig, the age was determined from farm records and the animal categorized as young (< 12 months) or adults ($\geq$ 12 months). Other epidemiological parameters such as sex, breed, season, farm location, flock size and availability of routine deworming programme in the farm were also determined and documented.

Sample analysis

Analysis of the faecal samples for GIP eggs was performed using tube floatation technique in saturated $NaCl_2$ solution as described by Hansen and Perry (1990). Faecal egg count was then expressed as eggs per gram (EPG) of faeces using McMaster counting chamber and classified as low (< 200 EPG), mild (200–499 EPG) and high ($\geq$ 500 EPG) infection. The PCV was determined by centrifugation method as described by Jones (1961).

Questionnaire survey

Structured and pretested closed-ended-questionnaire was used to elicit data on pattern of anthelmintic administration to pigs and involvement of pig farmers in certain farm practices that could enhance acquisition and spread of GIP of pigs in intensive management system. Informed consent was sought and obtained from 40 pig farm owners or managers surveyed. Respondents who were not proficient in use of the English language were interviewed in native language. Afterwards, completed copies of the questionnaire were collected and the responses collated for statistical ana-lysis.

Data analysis

Fisher's exact or Chi square test, as appropriate, was used to test for significant association ($p < 0.05$) between GIP infection in pigs and epidemiological factors and farm practices that may influence the dynamics of the worm infection in piggeries. The analysis was done at 5% probability level using GraphPad Prism® software, version 6.04 (GraphPad® Inc., San Diego, California, USA). Casual association between the worm infection and farm practices or epidemiological factors was established at $p \leq 0.05$ and or odds ratio values greater than one.

Results

Prevalence of gastrointestinal parasites

The overall prevalence of GIP infestations were 80% (32/40) and 28.6% (400/1400) at farm and individual pig, levels respectively. The prevalence was higher in females (30.7%, 262/854) than in males (25.3%, 138/546); young (30.4%, 310/1020) than in adult pigs (23.7%, 90/380); and during the wet season (31.2%, 223/714) than in dry season (25.8%, 177/686). Prevalence of 31.9% (197/618) and 26.5% (207/782) were recorded in farms located in rural and urban areas respectively (Table 1). Similarly, prevalence of 30.5% (196/643) and 26.9%, (204/757) were documented in farms that had flock size of less than 100 pigs and $\geq$ 100 pigs respectively (Table 1). There were significant associations ($p < 0.05$) between GIP infection and sex, age, season, farm location and availability of routine deworming programme. No significant association was found between the worm infection and breed of pigs and flock size at p-values of 0.534 and, 0.154 respectively.

Results on the types and prevalence of gastrointestinal parasites found in faecal samples examined were presented in Table 2. Worm eggs identified and their individual prevalence were: Strongyles 25.7% (360/1400), *Trichuris* 11.4% (160/1400), *Ascaris* 0.7% (10/1400) and mixed infection (Strongyles and *Trichuris)* 9.3% (130/1400). Majority of the worm burden were of low (14.7%, 206/1400) and mild (9.8%, 137/1400) infections (Table 2).

Mean packed cell volume

Table 3 contains information on mean PCV of intensively managed pigs surveyed, according to age groups, sex, breed and GIP infection status. Mean PCV values of 36.1 ± 0.83 and 38.4 ± 0.77 were recorded in young and adults pigs, respectively. Similarly, mean PCV values of 36.8 ± 0.78, 36.1 ± 0.68, 35.3 ± 1.03 and 38.7 ± 0.98 were document for male, female, infested and un-infested pigs correspondingly. Exotic breeds had slightly higher mean PCV value of 37.6 ± 0.73 than 36.4 ± 0.85 recorded in indigenous breed.

Table 1 Prevalence of gastrointestinal parasites in intensively managed pigs in Nsukka agricultural zones, Southeast Nigeria, according to various epidemiological factors

Epidemiological factors	Number of pigs screened	Number of pigs infected	Prevalence	Relative risk	95% CI	Odds ratio	95% CI	*p* value
Sex								
Male	546	138	25.3	0.82	0.69–0.98	0.76	0.6–0.97	0.029*
Female	854	262	30.7					
Breed								
Indigenous (local)	83	21	25.3	0.88	0.60–1.28	0.84	0.50–1.39	0.534
Exotic	1317	379	28.8					
Age								
Young (< 1 year)	1020	310	30.4	1.3	1.05–1.57	1.4	1.07–1.85	0.014*
Adults (≥ 1 year)	380	90	23.7					
Season								
Wet (winter)	714	223	31.2	1.2	1.02–1.43	1.3	1.03–1.65	0.025*
Dry (summer)	686	177	25.8					
Farm location								
Urban	782	207	26.5	0.83	0.71–0.98	0.77	0.61–0.97	0.028*
Rural	618	197	31.9					
Flock size								
< 100 pigs	643	196	30.5	1.1	0.96–1.33	1.2	0.94–1.5	0.154
≥ 100 pigs	757	204	26.9					
Availability of routine deworming programme								
Not available	573	183	31.9	1.2	1.03–1.44	1.3	1.04–1.67	0.022*
Available	827	217	26.2					

CI confidence interval

*Denotes statistically significant *p* value, Fishers' exact test

Table 2 Types and prevalence of gastrointestinal parasite found in intensively managed pigs in Nsukka agricultural zone, Southeast, Nigeria

Variables	Number of pigs screened	Number of pigs infested	Prevalence (%)	*p* value
Types of parasite found				
Strongyles	1400	360	25.7	0.0001*
Trichuris	1400	160	11.4	
Ascaris	1400	10	0.7	
Mixed infections (*Strongyles and Trichuris)*	1400	130	9.3	
Extent of parasite infection				
Low (< 200 EPG)	1400	206	14.7	0.0001*
Mild (200–499 EPG)	1400	137	9.8	
High (≥ 500 EPG)	1400	57	4.1	

*Denotes statistically significant *p* value, Chi square statistic

Pattern of administration of anthelmintics in pig farms

Albendazole, ivermectin, levamisole and piparazine were the anthelmintics used in pigs farms surveyed (Table 4). The frequency of deworming with these anthelmintics was: never 10% (4/40), monthly 15% (6/40), quarterly 40% (16/40) and yearly 20% (8/40). Fifteen percent of the farmers (6/40) did not respond to the question on the frequency of anthelmintic administration in pigs. Fifty-five percent (22/40) of the farmers sourced the drugs from veterinary pharmacy while only 20% (4/40) of the farms utilized the

Table 3 Mean PCV of intensively managed pigs surveyed in Nsukka agricultural zone according to some epidemiological variables

Epidemiological variables	Number of pigs sampled	Minimum PCV (%)	Maximum PCV (%)	Mean PCV ± SEM
Age groups				
Young (< 1 year)	1020	29.4	38.8	36.1 ± 0.83
Adult (≥ 1 year)	380	34.8	42.6	38.4 ± 0.77
Sex				
Male	546	35	42.4	36.8 ± 0.78
Female	854	34.6	40.8	36.1 ± 0.68
Worm infestation status				
Infected	400	29.4	41.2	35.3 ± 1.03
Uninfected	1000	31.2	43.8	38.7 ± 0.98
Breed				
Local (indigenous)	83	33.8	40.2	36.4 ± 0.85
Exotic	1317	34.7	43.8	37.6 ± 0.73

SEM standard error of mean

Table 4 Pattern of anthelmintic administration in piggeries (n = 40) surveyed in Nsukka agricultural zone, Southeast, Nigeria

Information required	Variables	Number of respondents (%)
Anthelmintics administered[a]	Albendazole	20 (50)
	Ivermectin	23 (57.5)
	Levamisole	10 (25)
	Piperazine	6 (15)
Frequency of deworming	Never	4 (10)
	Monthly	6 (15)
	Quarterly	16 (40)
	Yearly	8 (20)
	No response	6 (15)
Source of anthelmintics used	Veterinary pharmacy	22 (55)
	Others	14 (35)
	No response	6 (15)
Administration status of the drugs used	Vet doctors	8 (20)
	Auxiliary veterinarians	14 (35)
	Self/farmers	18 (45)

[a]Farms administered more than one anthelmintic

services of veterinarians for the drug administration (Table 4).

Risk factors of gastrointestinal parasite infection in pig farms

Detailed information on involvement of pig farmers in farm practices that can influence the dynamics of GIP infection in piggeries are presented in Table 5. Some prominent risk factors found and proportion of farms involved were: feeding of self-formulated on-farm feed, 85.7% (35/40); rearing pigs of different ages together, 85% (34/40); infrequent removal of dungs, 80% (32/40); non-disinfection of pen and equipment, 90% (36/40); early weaning at less than 6 weeks of age, 75% (30/40) and non-availability of routine deworming programme, 55% (22/40). Casual association between the farm practices/epidemiological factors and occurrence of the worm infection was established at $p < 0.05$ and or odds ratio values greater than one.

Table 5 Risk factors for gastrointestinal parasite infestation in intensively managed piggeries (n = 40) surveyed in Nsukka agricultural zone, Southeast, Nigeria

Risk/farm practices	Number of respondents	Number of farms infested	Prevalence	Odds ratio	95% CI	*p* value
Infrequent removal of dungs						
Yes	32	28	80% (32/40)	7	1.23–39.8	0.037*
No	8	4				
Rearing pigs of different ages together						
Yes	34	30	85% (34/40)	15	2.04–110	0.009*
No	6	2				
Non-disinfection of pen and equipment						
Yes	36	30	90% (36/40)	5	0.24–104	0.368
No	4	2				
Non-availability of routine deworming programme						
Yes	22	22	55% (22/40)	19	0.853–415	0.026*
No	18	10				
Early weaning at less than 6 weeks of age						
Yes	30	28	75% (30/40)	9	1.56–52.0	0.012*
No	10	4				
Non-quarantine of newly procured or exposed pigs						
Yes	22	20	55% (22/40)	5	0.42–59.7	0.285
No	18	12				
Feeding of self-formulated on-farm feed						
Yes	35	30	85.7% (35/40)	9	1.19–68.2	0.046*
No	5	2				
Presence of bushes within and around piggery						
Yes	8	8	20% (8/40)	3	0.144–73	0.538
No	32	24				

CI confidence interval

*Statistically significant *p* value, Fisher's exact test

Discussion

The prevalence recorded in this study (28.6%) is higher than a previous one (24.1%) reported by Wosu (2015) for intensively managed pigs in the same study area. This signifies 4.5% increase in GIP infection in less than half a decade; and unmistakably shows that the infection has continued to rise unabatedly. Farmers' involvement in farm practices, as well as availability of epidemiological and climatic factors that favour the endemicity and proliferation of the parasites; may be contributory to the increase in worm burden. This increase is also suggestive of defective control measures against the parasites or development of anthelmintic-resistance by the parasites. This calls for a holistic review of the preventive and control measures against the worn infections; to boost pig production, preserve therapeutic efficacy of anthelmictics, and mitigate negative public health consequences thereof.

The overall prevalence of 80% and 28.6% recorded for GIP infestations at farm and individual animal levels, respectively are high for intensively managed pigs. Intensive production management system limits parasitic and microbial infections (Nwoha and Ekwurike 2011) but our findings seem to negate this due to massive involvement of the farmers in risk farm practices that facilitates GIP infection in piggeries. For instance, infrequent removal of dungs, presence of bushes around piggeries and early weaning at less than 6 weeks of age encourages coprophagia, build-up of invertebrate intermediate hosts and predisposes immunologically naive young pigs to endoparasitism, respectively. It is therefore obvious from our findings, that farmers' involvement in the risk practices counteracted the benefit of low pathogen infectivity of intensive management system; and predisposed pigs to worm infestations, hence the high prevalence recorded.

Additionally, the omnivorous feeding habit and voracious appetite of pigs helplessly predispose them to GIP infection. Moreover, the phenomenon of "self-cure", a hypersensitivity reactions to an adult worm burden in which the worms are expelled and the host get cured as a result of exposure to a second larval infection has not been reported in pigs. Rather, this phenomenon is largely restricted to small ruminants infected with *Haemonchus or Trichostrongylus* species. Furthermore, GIPs are capable of cryptobiosis, which is a reversible physiological state of extreme hibernation to evade adverse environmental conditions in the tropics. The hibernating parasites usually infect pigs during feeding and subsequently regain viability post infection. The interplay of these factors may have been responsible for the higher prevalence recorded.

Although the 28.6% prevalence is high, it is lower than the findings of Sowemimo et al. (2012), Nwoha and Ekwurike (2011), Jatfa et al. (2019), Okorafor et al. (2014), Karaye et al. (2016), Obisike et al. (2018) and Akanni et al. (2017) who reported prevalent rates of 35.8%, 100%, 53.7%, 32.7%, 61.5%, 50% and 31% respectively. However, the prevalence is higher than 5.8% and 24.1% reported by Lekko et al. (2018) and Wosu (2015) respectively. At the international level, the reported prevalence is higher than 25% documented in Ethiopia by Jufare et al. (2015) and 28% reported in Ghana by Atawalna et al. (2016) but however lower than 61.4% documented by Roesel et al. (2017) in Uganda.

The discrepancies in the findings could be attributed to disparity in epidemiological and climatic factors capable of influencing gastrointestinal helminth infection dynamics; such as husbandry systems, breed, season, nutrition status, availability of veterinary services, health status of breeders or replacement stocks, individual differences in interpretation of test observation/results and total number of samples examined. Moreover, some of the findings emanated from abattoir surveys which are naturally biased, because most sick or unproductive animals culled from the farms are salvaged at the abattoirs; hence higher chances of pathogen recovery from abattoir-based than farm-based studies.

The preponderance of the worm infestation in female and young pigs may have immunological undertone. Young animals are immunologically naive and hence highly susceptible to parasitic infections. Stress and hormonal changes associated with gestation, farrowing and lactation in sows tend to lower their general immune status and resistance to GIP infection, resulting in higher worm burdens than in males. Additionally, sows are reared for longer period than the boars and this extended period of rearing exposes them to the worm infestation much more than the males.

Similarly, high prevalence recorded in farms sited in rural areas and those having flock size of less than 100 pigs may be attributed to availability and provision of veterinary services. Livestock farming inputs such as veterinary drugs or the services of Veterinarians are not readily available in rural settings. Government veterinarians who offer veterinary extension services free of charge are most times difficult to assess in rural areas due to their limited number. Most small-scale (flock size of < 100 pig) pig farmers may not ready afford the cost of veterinary services or do not consider payment for such services worthwhile. Consequently, pathogens such as GIPs thrive and disease conditions set in; leading to financial losses due to decreased productivity.

The dominance of Strongyles (25.7%) in the infected pigs may be attributed to its high rates of paedogenesis and fecundity that are pivotal for their propagation and survival in the tropics. Additionally, improper use of anthelmintics, as evidenced in this study, has been associated with development and spread of anthelmintic-resistance parasites in pig farms (Kaigara et al. 2013). Majority of the farmers used ivermectin repeatedly probably because of its advantage of treating both over other antiparasitics in treatment of both GIPs and ectoparasites. Such repeated administration of antiparasitic drugs, especially by non-professionals, facilitates the development of anthelmintic-resistant parasites. These may explain the dominance of Strongles and *Trichuris* species in the farms surveyed. In growing pigs, helminthosis have been shown to reduced growth rates by at least 33% due to poor feed utilization and causes production of heavier plucks and less lean meat in pigs of all ages (Roesel et al. 2017).

The 0.7% prevalence recorded for *A. suum*, a well-known zoonotic parasite, is significant from public health and food safety points of view. Humans may acquire *Ascaris* infection via consumption of food or water contaminated with the viable eggs voided in faeces by infected pigs. Close human contact with pig, as obtains in occupationally exposed individuals (pig farmers and pig carcass processors) and in rural settings where cohabitation with animals still exist (Onunkwo et al. 2018), facilitates transmission of *Ascaris* infection to humans. Use of pig dung as manure in fruit and vegetable gardens may exacerbate dissemination of the infection. Considering large scale consumption of pork in the study area (Nwanta et al. 2011), humans are at risk of the zoonosis unless the “farm to fork” method of zoonotic pathogen control is adopted. This method includes strict farm-level biosecurity, proper cooking (heating at 80 °C and above for about 30 min) of meat before consumption and hygienic processing and preparation of edible tissues.

The mean PCV values recorded in this study were close to the basal values but within the normal range (32–47%) for pigs as reported by Eze et al. (2010). Although excessive blood loss or iron deficiency anemia may result as GIPs attach and feed on the mucosa of the small intestine, out findings show that low (less than 200 EPG) and mild (200–499 EPG) infections did not elicit clinical anaemia as corroborated by Kaigara et al. (2013) and Perri et al.

(2016). However, the parasites are known to damage vital organs responsible for physiological process and hence decreased body function and productivity.

The overall prevalence at farm and individual pig levels are high for intensively managed pig; and involvement of farmers in the risk practices was massive. The GIP infestation were wide spread but of low or mild infection and hence did not cause clinical anaemia. In view of the health problems (stunted growth and impaired cognitive function in children and young adults) caused by *A. suum* (Vlaminck et al. 2014); there is need for adoption of cost-effective control measures against the infection. This includes good farm management practices, strict farm biosecurity measures, routine prophylactic deworming programme and good environmental and personal hygiene; to boost pig production and curb transmission of zoonotic parasites in the study area.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Ethical clearance for inclusion of 1400 pigs in this study and blood collection from the animals, via ear venapucture was granted by Institutional Animal Care and Use Committee (IACUC) of the Faculty of Veterinary Medicine, University of Nigeria, Nsukka.

Human and animal rights All applicable international, national, and/or institutional guideline for care and use of animals, as contained in the IACUC protocol, were followed.

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