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## Identification of predisposing and risk factors associated with gastric lesions in pigs

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## ABSTRACT

**Objective:** To identify some predisposing and risk factors of gastric lesions in pigs in Southwestern Nigeria.

**Methods:** Pre-slaughter animal assessment and post-slaughter stomach evaluation were conducted on pigs presented for slaughter in three major abattoirs in Southwestern Nigeria. The factors assessed included animal characteristics, environmental and management factors and infection. The gross lesions encountered in 480 stomachs were graded using standard technique. Stomach contents were assessed and subjected to parasitological studies while stomach tissue sections were used for histopathology evaluation. The data obtained were analyzed using *Chi*-square, One-way ANOVA and percentages. Significance was determined at  $P < 0.05$ .

**Results:** There was no significant association between breed, weight at slaughter, location of the farm of origin and occurrence of gastric lesions in pigs. Sex and stomach content volume were identified as associated risk factors while abattoir findings and evidence of stomach infection suggests that unhygienic feeds, stressful husbandry practices, stressful pre-slaughter handling, internal parasites and *Helicobacter* species infection are important predisposing factors.

**Conclusions:** This study documents some factors that are contributory to the occurrence of gastric lesions in pigs in Southwestern Nigeria and identifies the need for improved animal welfare.

## 1. Introduction

The pig stomach is prone to lesions, of which ulceration is frequently encountered[1]. The causation of gastric lesions in pigs is multifactorial and the condition may affect the non-glandular (pars oesophagea) or the glandular (cardia, fundus and antrum) region[2]. More studies have reported the occurrence of lesions in the pars oesophagea[3] as lesions in glandular regions tend to be uncommon[1].

Gastric lesions may result in significant economic losses due to sudden death, decreased feed intake and reduced daily weight gain of pigs[4]. Its occurrence has been reported for many years in different continents of the world spanning across North America, South America, Europe, Oceania and Africa[3,5,6].

The available reports are either experimental studies evaluating the association of certain variables such as nutritional factors[3,7], stress factors[1], helminthosis[8] with gastric lesions, or observational studies at slaughter houses focused on quantifying its frequency of occurrence[9]. There are also a number of studies in recent years on the role of infectious agents in the formation of gastric lesions in pigs[5].

This study was therefore designed to identify some predisposing and risk factors of gastric lesions in pigs in Southwestern Nigeria.

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## 2. Materials and methods

### 2.1. Study location and population

The study was conducted on three abattoirs in states of Oyo (Bodija, Ibadan, 7.4208050° N, 3.9237550° E), Ogun (Okearo, Akute, 6.6896910° N, 3.3325720° E) and Lagos (Oko-oba, Agege, 6.6646080° N, 3.6914060° E) in Southwestern Nigeria between the months of July and September. A total of 480 pigs (Lagos: 180, Ogun: 150, Oyo: 150) presented for slaughter within a continuous two-week period of activities in each abattoir were randomly evaluated for gastric lesions. The castrated males were excluded from the study. The three abattoirs handle an average of 3500 pigs monthly. Consent of the abattoir authorities and workers were obtained before collection of data.

### 2.2. Data collection

Pre-slaughter practices (transportation, handling and lairaging) and animal characteristics including sex, breed, weight and general health of the pigs were noted. The stomachs were harvested, cut open along the minor curvature, and the stomach content (volume and type) were assessed and samples of it were collected for parasitological investigation using sedimentation and flotation methods[10]. The stomachs were inverted and the mucosa surface was washed gently with water. The different regions (pars oesophagea, cardia, fundus and antrum) of the stomachs were carefully examined for gross lesions which were scored based on presence and severity of lesions. Tissue samples from the fundus and antrum of 10% of the stomachs randomly selected were stained with Warthin-Starry silver stain for evidence of the presence of organisms[11].

The gastric lesions were scored using a six-point ordinal scoring system (0–5) which is a modification of the visual morphological scoring guide for oesophagogastric ulcers[12]. The scores are: 0 indicating no lesion; 1 indicating slight keratosis; 2 indicating severe keratosis and thickened epithelium; 3 indicating erosions; 4 indicating mucosa damage (lacerations, scars and puncture wounds); and 5 indicating ulceration. The summation of scores for each stomach was used to group the stomachs into Grade 1 (score 1–5), Grade 2 (score 6–10), Grade 3 (score 11–15), and Grade 4 (score 16–20).

### 2.3. Statistical analysis

The association between identified variables and gastric lesion occurrence were analyzed using *Chi*-square test. The mean of gastric lesions scores in each region of stomach in different variable groups were subjected to One-way ANOVA. Significance was determined at  $P < 0.05$ . Data on evidence of infection were

presented as percentages.

## 3. Results

### 3.1. Predisposing and risk factors

#### 3.1.1. Animal characteristics

There was no significant association between the breed of pig and the occurrence/grade of gastric lesions (Table 1). There was also no significant association between weight at slaughter and the occurrence/grade of gastric lesions (Table 2). Pigs of both sexes were affected with gastric lesions (Table 3) while further analysis of the severity of gastric lesions in each stomach region reveals that males have a risk of having more severe lesions than females (Table 4).

**Table 1**

Association between breed and occurrence/grade of gastric lesions in pigs in Southwestern Nigeria.

Breeds	Grade of lesion					Total	Pearson Chi-square value	P-value
	Non	1	2	3	4			
Large white	89	68	32	3	4	196	20.761	0.835
Landrace	6	5	3	0	0	14		
Duroc	14	9	6	0	0	29		
Hampshire	16	12	6	2	0	36		
Large white/Hampshire cross	47	35	26	3	0	111		
Large white/Duroc cross	13	19	10	2	0	44		
Duroc/Hampshire cross	12	15	8	0	0	35		
Undetermined cross	8	3	4	0	0	15		
Total	205	166	95	10	4	480		

**Table 2**

Association between body weight at slaughter and occurrence/grade of gastric lesions in pigs in Southwestern Nigeria.

Weight (kg)	Grade of lesion					Total	Pearson Chi-square value	P-value
	Non	1	2	3	4			
30–40	11	12	5	1	0	29	17.444	0.829
41–50	31	26	10	2	1	70		
51–60	57	54	28	1	1	141		
61–70	76	46	37	3	1	163		
71–80	22	21	10	1	1	55		
81–90	7	7	4	2	0	20		
101–110	1	0	1	0	0	2		
Total	205	166	95	10	4	480		

**Table 3**

Association between sex and occurrence/grade of gastric lesions in pigs in Southwestern Nigeria.

Sex	Grade of lesion					Total	Pearson Chi-square value	P-value
	Non	1	2	3	4			
Male	92	75	50	9	2	228	9.179	0.057
Female	113	91	45	1	2	252		
Total	205	166	95	10	4	480		

**Table 4**

Analysis of variance of the lesion score/severity in the different regions of the pig stomach in both sexes.

Sex	PO	Cardia	Fundus	Antrum	Total
Male	0.73 ± 1.19 <sup>b</sup>	0.65 ± 1.50 <sup>b</sup>	1.73 ± 2.20 <sup>a</sup>	0.47 ± 1.37 <sup>a</sup>	3.58 ± 3.96 <sup>b</sup>
Female	0.71 ± 1.25 <sup>b</sup>	0.65 ± 1.46 <sup>b</sup>	1.19 ± 1.98 <sup>b</sup>	0.24 ± 0.97 <sup>b</sup>	2.79 ± 3.34 <sup>b</sup>

Data were expressed as mean ± SD. In the same column, values with superscript “a” are significantly greater than those with superscript “b” ( $P < 0.05$ ). PO: Pars oesophagea.

### 3.1.2. Environmental and management factors

There was no significant association between the state of origin of the pigs and occurrence of gastric lesions (Table 5) although the severity of gastric lesions in pigs from Ogun State was significantly higher (Table 6). There was a significant association between the volume of stomach content and the occurrence/grade of gastric lesions in pigs (Table 7). The stomachs that were empty at slaughter had a significantly higher lesion severity. This shows that pigs with stomachs that are empty or with sparse content had a high risk of developing gastric lesions (Table 8).

**Table 5**

Association between state of origin and occurrence/grade of gastric lesions in pigs in Southwestern Nigeria.

States	Grade of lesion					Total	Pearson Chi-square value	P-value
	Non	1	2	3	4			
Oyo	70	52	25	3	0	150	8.844	0.356
Ogun	58	51	33	6	2	150		
Lagos	77	63	37	1	2	180		
Total	205	166	95	10	4	480		

**Table 6**

Analysis of variance of the lesion score/severity in the pig stomach in Southwestern Nigeria.

States	PO	Cardia	Fundus	Antrum	Total
Oyo	0.57 ± 1.02 <sup>b</sup>	0.36 ± 1.11 <sup>b</sup>	1.44 ± 2.12 <sup>b</sup>	0.31 ± 1.09 <sup>b</sup>	2.69 ± 3.16 <sup>b</sup>
Ogun	0.74 ± 1.27 <sup>b</sup>	0.97 ± 1.79 <sup>a</sup>	1.65 ± 2.20 <sup>b</sup>	0.47 ± 1.38 <sup>b</sup>	3.83 ± 4.14 <sup>a</sup>
Lagos	0.83 ± 1.32 <sup>b</sup>	0.63 ± 1.42 <sup>b</sup>	1.28 ± 2.01 <sup>b</sup>	0.28 ± 1.06 <sup>b</sup>	3.02 ± 3.58 <sup>b</sup>

Data were expressed by mean ± SD. In the same column, values with superscript “a” are significantly greater than those with superscript “b” (P < 0.05). PO: Pars oesophagea.

**Table 7**

Association between stomach content volume and occurrence/grade of gastric lesion in pigs in Southwestern Nigeria.

Volume	Grade of lesion					Total	Pearson Chi-square value	P-value
	Non	1	2	3	4			
Empty	2	20	14	0	0	36	50.701	0.000
Sparse	23	28	14	6	1	72		
Moderate	23	20	13	2	1	59		
Full	157	98	54	2	2	313		
Total	205	166	95	10	4	480		

**Table 8**

Analysis of variance of the lesion scores in different regions of the pig stomach with various content volumes.

Volume	PO	Cardia	Fundus	Antrum	Total
Empty	2.00 ± 1.29 <sup>a</sup>	0.78 ± 1.51 <sup>b</sup>	2.00 ± 2.43 <sup>b</sup>	0.00 ± 0.00 <sup>b</sup>	4.78 ± 3.15 <sup>a</sup>
Sparse	0.90 ± 1.27 <sup>b</sup>	0.71 ± 1.63 <sup>b</sup>	1.58 ± 2.07 <sup>b</sup>	0.79 ± 1.65 <sup>a</sup>	3.99 ± 4.34 <sup>b</sup>
Moderate	0.78 ± 1.25 <sup>b</sup>	1.00 ± 1.71 <sup>b</sup>	1.63 ± 2.20 <sup>b</sup>	0.25 ± 1.11 <sup>b</sup>	3.66 ± 3.88 <sup>b</sup>
Full	0.52 ± 1.10 <sup>b</sup>	0.56 ± 1.38 <sup>b</sup>	1.32 ± 2.05 <sup>b</sup>	0.30 ± 1.10 <sup>b</sup>	3.70 ± 3.42 <sup>b</sup>

Data were expressed by mean ± SD. In the same column, values with superscript “a” are significantly greater than those with superscript “b” (P < 0.05). PO: Pars oesophagea.

### 3.1.3. Evidence of infection

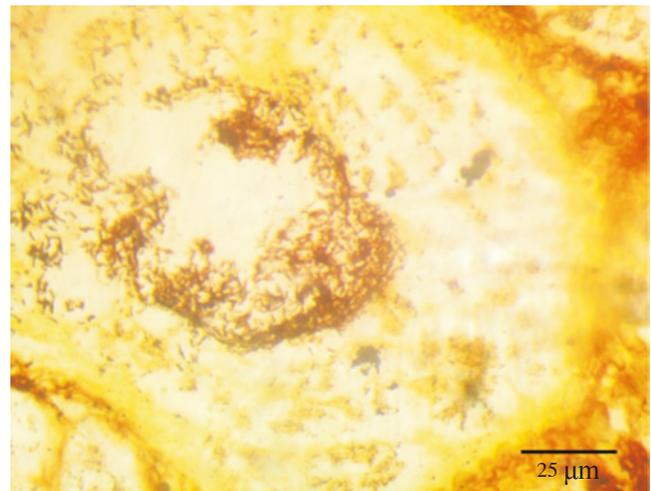
Parasitological investigation of the intestinal contents reveals the presence of helminth parasites as shown in Table 9. The accumulation of *Helicobacter* sp. was observed in the gastric mucosa of some of the pigs surveyed (Figure 1). Out of 48 stomachs (10% of sample size) randomly selected (24 with gross lesions and 24 without lesions), 17 (71%) of the stomachs with lesions and 9 (37.5%) of

the stomachs without lesion were positive for *Helicobacter* sp. in the mucosa of the fundus or antrum, showing a higher frequency of *Helicobacter* species infection in stomachs with gastric lesions.

**Table 9**

Evidence of helminth parasites in the stomach contents.

Parasite	Frequency	Incidence (%)
<i>Hyostromylus</i> sp.	18	3.8
<i>Ascaris suum</i>	4	0.8
<i>Taenia solium</i>	5	1.0
<i>Metastrongylus</i> sp.	2	0.4
<i>Oesophagostomum</i> sp.	15	3.1
<i>Fasciola</i> sp.	1	0.2
<i>Hymenolepis</i> sp.	1	0.2
Total	480	9.5



**Figure 1.** Numerous silver staining spiral microorganisms in gastric glands of the fundic region.

## 3.2. Previous environment and management

Information on previous environment and management of the pigs was obtained from findings at the abattoir. The pre-slaughter practices observed contributed to excessive stress and poor animal welfare.

### 3.2.1. Restraint and transportation

The pigs presented to the abattoir were often restrained with ropes and transported to the abattoir with bikes, cars, buses or trucks. This cruel practice seems widely accepted and approved by the farmers, transporters and butchers, thereby reflecting the general poor attitude of pig handlers to animal welfare.

### 3.2.2. Poor lairaging

The provided facilities were without feeders and often overcrowded. They were provided basically to hold the animals, often without food until slaughter.

### 3.2.3. Stomach content

The stomach content revealed much on poor management and unhygienic feeding practices on the farms of origin. Various foreign

materials observed in the stomachs included: 1) bristles which were observed in significant quantity in the stomach content of 135 (28.15%) pigs, out of which 5 (1.00%) had formed trichobezoars; 2) sharp metals which were observed in 6 (1.25%) stomachs. Two stomachs were found to have metal piercing through the antral muscular layer.

#### 4. Discussion

This report highlights an array of predisposing and risk factors of gastric lesions in pigs in Southwestern Nigeria. The study of pigs included thorough breeds and cross breeds of different combinations. All the breeds represented were affected with gastric lesions. In this study, breed was not established as a predisposing factor as there was no significant association between the breed of pigs and gastric lesions. Previous reports on the association of genetic origin with gastric lesions were also not able to prove a significant association[2]. Pigs were presented for slaughter at different body weights but no significant association existed between weight at slaughter and gastric lesions. Further study on the association of age, growth rate or growth phase with gastric lesions may provide more information as this was not possible in the current study due to unavailable farm records of the individual pigs. Both sexes had the occurrence of gastric lesions, but the males had more severe lesions. This shows that male pigs are at a higher risk of developing more severe gastric lesions than female pigs. This is similar to a previous research[13] where the workers found a higher tendency in barrows to have oesophagogastric ulcer than females. Tendency for lower severity in females may also be attributable to the protective effect of estrogens, as demonstrated in previous study[14].

There was no significant association between the geographical location/state of origin of the pigs and the occurrence of gastric lesions although the pigs raised in Ogun State were observed to have a significantly higher severity. This observation may be due to the higher intensity of production and the wide spread use of finely ground feed on the government-owned pig farm scheme where most of the slaughtered pigs surveyed in Ogun State were raised. Historically, the incidence of gastric lesions in pigs is known to have increased dramatically with the intensification of pig production and the concomitant changes in pigs' diet and housing[2]. In previous experiments, researchers have examined stomach morphology following feeding of coarsely and finely ground diets and found that finely ground meal was associated with higher incidence of gastric lesions[1].

Empty stomach was identified as a risk factor of gastric lesions in this study as there was a significant association between the volume of stomach content and occurrence of gastric lesions. The most severe lesions were observed in the empty stomachs. Previous

reports have also shown that any factor that will cause increase in speed of passage of ingesta or empty stomach increases the prevalence of gastric lesions in pigs[1]. The method of restraint and transportation adopted by farmers and other pig handlers puts extra stress on the pigs which is aggravated by mixing and poor lairaging procedures. Stress in husbandry and pre-slaughter handling was identified as a predisposing factor. It is well recognized that stress is implicated in the formation of gastric lesions[9]. A significant number (28.15%) of the stomach materials examined had a high content of bristles, out of which 1.00% had formed trichobezoars showing a chronic accumulation in the stomach. The presence of bristles in large quantity in stomach content is abnormal and may be due to uncontrolled external parasitism, poor nutrition or poor feed hygiene. Trichobezoars are known to pose a clinical problem and severe cases that may lead to complications such as obstruction, intussusception, or gastric perforation and hemorrhage[15].

Sharp metals were also observed in some of the stomachs examined while few were observed to have lodged in the muscular layer of the antral region and pierced into the peritoneal cavity. This may predispose to peritonitis and sepsis. Pigs are heteropagus and therefore, when starved, they will attempt to feed on any item available, it is hence important that their housing is kept free of foreign objects. Unhygienic feed production and husbandry practices predispose pigs to gastric lesions.

Stomach infection is also a known predisposing factor of gastric lesions in pigs. The presence of pathogens in the stomach may cause initial local inflammatory response and/or direct damage to the gastric epithelium. Gastric lesions may also arise as signs of other systemic diseases. Our findings on helminthes infestation reveal the presence of a known gastric helminth and other aberrant parasitic organisms in the stomach. *Hyostrogylus rubidus* which we observed in a few cases has been associated with gastric lesions in pigs[8]. The relatively low prevalence of aberrant helminthes in this study may be due to improved deworming practices by farmers; however, the presence of these organisms is a pointer to their role as a potential risk factor especially when their multiplication goes unchecked.

The colonization of pig stomach by different species of bacteria has been reported by researchers for many years[1], but none of these microorganisms was established as a primary pathogen causing gastric lesions in swine until recently when *Helicobacter suis* was associated with ulcers of the non-glandular part of the stomach in pigs[16].

Our findings from the histology of some pig gastric tissues using Warthin-Starry silver stain revealed the accumulation of *Helicobacter* sp. in the fundic or antral gastric mucosa. The evidence of infection with this organism was observed to be more frequent in stomachs with lesions than those without lesions. Other

authors have reported the prevalence of infection with *Helicobacter* sp. to be above 60% in the stomachs of pigs at the age of slaughter [17,18] and it has been associated with gastric ulceration and decreased daily weight gain [19,20].

Our observation of the colonization of *Helicobacter* sp. at gastric mucosa of pigs, to the best of our knowledge, is the first report in Nigeria. Therefore, further studies on the strains of this organism and host-pathogen interaction may enrich our understanding of its role in formation of gastric lesions in pigs and possibly in humans due to its zoonotic potentials.

Gastric lesions are an ongoing problem affecting the swine industry in Nigeria which in the past had been rarely reported. This study documents its occurrence, some predisposing and risk factors. It is therefore important that conscious and consistent efforts should be made to manage or eliminate these identified factors in order to enhance the productivity and profitability of the Nigerian swine industry. Future routine checks should be made at postmortem inspection by veterinarians in order to keep track of this condition in pigs and further studies on non-invasive biomarkers of this condition should be carried out to aid early diagnosis and control of the condition.

### Conflict of interest statement

We declare that we have no conflict of interest.

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