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TAENIASIS PREVALENCE AND ASSOCIATED FACTORS IN BORRONG COMMUNE, DEMSA LGA, ADAMAWA STATE, NIGERIA

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ABSTRACT

Taeniasis represents a human parasitic infection originating from three distinct tapeworm species: *Taenia saginata*, commonly known as the beef tapeworm, *Taenia solium*, referred to as the pork tapeworm, and *Taenia asiatica*, identified as the Asian tapeworm. The primary transmission of these parasitic organisms occurs when individuals consume poorly cooked meat, specifically raw or insufficiently cooked beef for *T. saginata*, or pork for both *T. solium* and *T. asiatica*. This research aims to understand how common a particular health issue is in the Borrong Community and explore what factors might be related to its occurrence in this specific area of Adamawa State, Nigeria. 376 people were picked by chance to participate in the research, which covers three villages: Borrong, Dilli, and Gwamba. Data analysis was conducted using SPSS Statistics Version 20. The 376 people studied, 129 were carriers of taeniasis infection with 34.3% infection rate. The highest infection occurred in age group 30-39 years in both males 18(51.4%) and females 16(43.3%), and is lower in ages 1-9 years in both males 1(11.1%) and females 1(9.1%). The source of water supply, hand washing habit after defecation, educational level, and pigs roaming freely, were significantly associated with taeniasis infections. Due to scarce feed resources, pigs in Africa are commonly allowed to move around freely, using waste as their primary food source. Increasing awareness about local risk factors such as pig management, education, and personal hygiene is crucial. This will play a great role in suppressing the taeniasis prevalence.

Keywords: Taeniasis, Infection, Tapeworm, Pigs, Risk factors

INTRODUCTION

Taeniasis, an intestinal infection, is caused by three species of tapeworm: *T. solium* (pork tapeworm), *T. saginata* (beef tapeworm), and *T. asiatica*. People get infected by ingesting contaminated beef or pig liver tissue, Out of the 32 known species of taenia, only *T. solium* and *T. saginata* are of medical significance. Recent Southeast Asian studies have found a new tapeworm species, *T. asiatica*, that can infect humans (Ito *et al*., 2006).

T. solium represents a zoonotic parasitic organism demonstrating complex inter-species transmission dynamics, manifesting as taeniasis (in humans) and cysticercosis (in both humans and pigs), pigs act as temporary hosts, while humans are the final hosts of the infection.

Humans can unexpectedly serve as temporary hosts when *T. solium* larvae invade muscular, subcutaneous, or organ tissues, resulting in human cysticercosis, a complex parasitic manifestation. If found in the central nervous system (CNS), including the brain and the spinal cord, the disease is termed neurocysticercosis (NCC) (Sotelo *et al*., 2002). A person may also have parasitic cysts in the brain and other body parts, which is known as (neuro) cysticercosis. The tapeworm *T. saginata* is one of three taenia species that infect humans as their final host, with bovines serving as the temporary host. *T. saginata* spreads to humans through undercooked beef. The tapeworm then develops in the small intestine, becoming fully established in approximately ten weeks. At this stage, the strobila can grow up to three meters long (Craig and Ito, 2007), and gravid proglottids may hold as many as 100,000 taeniid eggs. Cattle become infected through contaminated pastures, water, or feed. After ingestion, oncospheres hatch, and hexacanth larvae migrate via the lymphatic and blood systems to muscle tissue, maturing into the metacestode phase known as cysticerci (Symeonidou, 2018). Unlike *T. solium*, which can cause neurocysticercosis in humans as a dead-end intermediate host, *T. saginata* infects humans only at the adult tapeworm stage, with minimal public health impact. While progress has been made in understanding taeniasis, research gaps persist. Thorough studies on transmission patterns, risk factors, and control measures are vital for making well-informed decisions. This study aims to determine the taeniasis prevalence and associated factors in Borrong commune, Demsa LGA, Adamawa State, Nigeria. This study will benefit every dweller of Borrong community and everyone who consumes meat without the necessary precautions.

MATERIALS AND METHODS

Overview of Study Site

The study focused on the people who live in the Borrong community of Demsa LGA of Adamawa State. Demsa has a latitude of 9° 27'19.95°N and a longitude of 12°9'9.19°E. Temperature ranges from 34°C in April and 27°C in August (Google map). Demsa covers a total area of 1,213.30km^2; the region experiences a typical tropical climate characterized by distinct dry and rainy seasons. Rainfall begins in May and continues until late October, totaling approximately 1,113 mm per year. August and September are the wettest months, contributing around 25% of the annual precipitation (National Population Commission, 2006). Altered vegetation and human activities in Demsa create favorable conditions for parasitic disease transmission. The community's economic activities include government work, farming, fishing, and trading. Demsa LGA is home to several local languages, including Bacama, Bali, Bata, Bille, and Mbula-Bwazza.

Population Size

The study focused on the population of Demsa LGA of Adamawa State, which comprises the following zones in Borrong community: Borrong zone, Dilli zone, and Gwamba zone respectively. The research included a diverse group of people aged 1-70, selected without any specific restrictions. According to NPC Adamawa State, the current projected population of Borrong as of 2023 is 3,298.4.

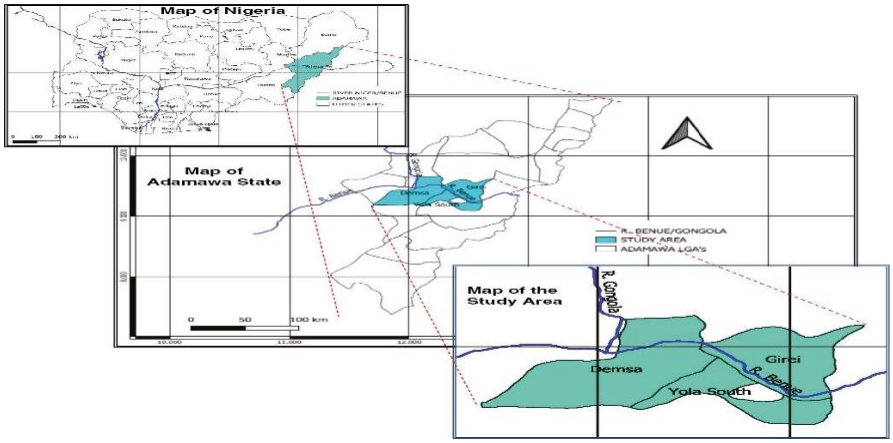

Figure 1: Map of Adamawa state showing focus sites

Sampling Methods

Without existing prevalence data, we applied the standard 50% estimate to calculate our sample size due to the lack of prior epidemiological data on taeniasis in this region (Naing *et al*., 2007). It was obtained by applying the formula below (Araoye, 2004);

$n_0 = \frac{Z^2P(1-P)}{d^2}$

Where

N = Sample size; Z = Score for a given confidence interval usually 1.96 for 95%

P = Prevalence value of 50% (0.50); d = Permissible error of the estimate is 0.05 (5%)

Since our actual population is finite, we can use the Cochran formula for a finite population (Cochran, 1946), thus;

$n = \frac{n_0}{1+\frac{n_0}{N}}$

Therefore, 376 participants were chosen from Borrong to participate in the study.

Sample Collection

An English questionnaire was employed to collect research data. Participants provided detailed insights through interviews, encompassing personal background, washing practices, water sources, and sanitation-related information. A pilot survey was conducted with 5% of Sangere, Girei LGA population seven days before the starting date of the collection, for reliability clarity. Participants were provided with labeled cups and applicator sticks for stool collection. About 2g of fresh stool was collected, along with details like sampling date, name, age, sex, and education level. Samples were preserved in 10% formalin and sent to the Zoology Laboratory at Modibbo Adama University. One gram of each sample was processed and examined microscopically using direct wet mount and formal-ether concentration techniques as per WHO guidelines (WHO, 1992).

Laboratory Procedures (Parasitological Examination)

Formalin-ether Concentration Method

Stool samples were processed using the formol-ether method by Garcia (2010). A stool sample, approximately walnut-sized, was homogenized in 10ml saline, filtered through fine mesh gauze, and centrifuged at 2,500 rpm for 5 minutes. The supernatant was discarded, and the sediment was resuspended in 10ml saline for a second centrifugation. The process was repeated until the supernatant cleared. Then, 10ml of 7% formal saline was added, followed by 3ml of ether. The mixture was shaken and centrifuged again at 2,500g for 5 minutes. Using an applicator stick, the debris plug was removed, and the supernatant decanted. A drop of the sediment was placed on a slide, iodine added, and covered with a cover slip. The slide was then examined at x10 magnification for *Taenia solium* ova (Garcia, 2010).

Data Analysis

Data entry and verification were completed in Excel 2016, and comprehensive statistical analysis was conducted using SPSS Version 20. Prevalence was cross-tabulated with demographics, and associations were tested using Pearson's Chi-square (X^2) at $P \leq 0.05$. The percentage of taeniasis cases was determined by proportional analysis of sample results.

RESULTS AND DISCUSSION

Comprehensive Taeniasis Prevalence of the Study Population

Table 1 provides a comprehensive overview of taeniasis infection prevalence across the study area. The study area comprises three villages: Borrong, Dilli, and Gwamba. Out of the 376 individuals selected for the study (comprising both the aged, young and children), out of the study population, 34.3% (129 subjects) tested positive for taeniasis. Taeniasis prevalence varied across study locations: Borrong Community showed the highest rate at 39.5%, followed by Dilli Community at 32.5%, and Gwamba Community at 20.0%. Statistical analysis using chi-squared test revealed no significant variation in taeniasis prevalence among communities ($p > 0.05$).

Taeniasis Infection Rates to Age

Table 2 shows the infection rate of taeniasis to age. Taeniasis infection peaked in the 30-39 years age group, with 18(51.4%) of males and 16(43.3%) of females affected, while being lowest in the 1-9 years age group at 1(11.1%) for males and 1(9.1%) for females. Statistical analysis indicates a significant association between age group and gender in terms of infection rates of human taeniasis p-value (0.015).

Prevalence of taeniasis Infection with associated risks

The risks for taeniasis are highlighted in table 3. Among the three hundred and seventy-six individuals (376) used for the studies, one hundred and twenty-nine (129) individuals were infected generally and in various factors. The major source of water that the people subscribed to was the river/stream with the highest number 206, 82(21.8%) were infected. Seventy-seven 77(20.5%) individuals were examined, and 26(6.9%) were infected of whom the water source was well water. Only 21(5.6%) individuals attributed to borehole water sources were infected, making them the lowest in that category. the prevalence was significantly different (P>0.05).

The prevalence of types of toilets used by various individuals, open defecation seems to be the day-to-day practice of the people, and it has the highest number of infected individuals 66(17.6%) followed by pit latrine 54(14.4%), individuals using water closets have the lowest infection 9(2.3%). No significant variation was observed (P>0.05).

Concerning hand washing, table 3 shows that out of 376 individuals who said "Yes" they do wash their hands after defecation, 34(9.0%) individuals were infected, while people who said "No" were the highest number of infected persons 69(18.4%) while the least was individuals who said "they were not too sure" had the prevalence of 26(6.9%). No significant variation was observed (P>0.05).

The infection rate of taeniasis is higher 98(26.1%) in individuals whose education level stopped at primary education than in those whose education level stopped at secondary education 25(6.7%) and the lowest prevalence of 6(1.5%) in individuals who attained the tertiary level of education. No significant variation was observed (P>0.05).

The infection rate of taeniasis is higher 66(17.6%) in individuals who practiced both closed and open systems of rearing pigs than those who practiced closed systems only 42(11.1%) and the lowest prevalence of 21(5.6%) in individuals who practiced roam freely. No significant variation was observed (P>0.05).

Prevalence in individuals who eat undercooked meat is higher in individuals who can't say where they stand 68(18.1%), followed by individuals who are certain they don't 40(10.6%) and the least are those who are certain they eat undercooked meat 21(5.6%). No significant variation was observed (P>0.05).

Most individuals, 89 (23.7%), frequently consume pork tongue, compared to 40 (22.3%) who rarely do. No significant variation was observed between taeniasis infection and individuals who consume pork tongue (P<0.05).

The majority of the pigs are slaughtered in various slaughterhouses 57(15.2%), followed by anywhere available with a prevalence of 48(12.8%), and in individual homes with 24(6.4%) prevalence. No significant variation was observed between taeniasis infection rate and places where pigs are slaughtered (P>0.05).

The majority of the pork meat is purchased in the market 84(22.3%), followed by any available source outlet 25(6.7%), and any other means of getting it 20(5.3%). No significant variation was observed (P>0.05).

Prevalence in individuals who deworm often is higher in individuals who don't deworm 84(22.3%), followed by individuals who are not certain they deworm often 36(9.6%) and the least are those that are certain they deworm 9(2.4%). No significant variation was observed (P>0.05).

Table 1: Overall Prevalence of Taeniasis Infection in the Study Population

Borrong Village	Number Examined	Number Infected	Prevalence (%)
Borrong	195	77	39.5
Dilli	126	41	32.5
Gwamba	55	11	20.0
Total	376	129	34.3%

$\chi 2 = 6.000$ (Calculated); df = 4; p = 0.199

Where: $\chi 2$ is Chi-squared statistic, df is degrees of freedom, and P is p-value

Discussion

Determination of the prevalence of taeniasis among residents of Borrong Communities

In most developing countries, livestock including pigs and cows are of great economic value as they are good protein sources, vitamins, minerals, and fat (Joshi *et al.,* 2004). With a prevalence of 34.3%, taeniasis in Borrong, Dilli, and Gwamba surpasses reports from other states in Nigeria. Weka *et al.* (2013) documented a 9.6% *Taenia solium* prevalence among pig farmers in Jos North Local Government Area, Nigeria. Epidemiological research by Biu and Hena (2008) identified a 4.2% taeniasis prevalence in Borno State.

Our study on overall taeniasis prevalence of 34.3% falls within a comparable range(moderate or low) when looking at the previous studies reports which varied: 40.9% by Mogaji *et al.* (2016) in Ogun State, 47.7% by Udensi *et al.* (2015) in Imo State, and 38.0% by Prasad *et al.* (2007) in India.

Table 2: Prevalence of taeniasis in relation with age

Age group (year)	Male			Female			Total		
	Number Examined	Number Infected	Prevalence (%)	Number Examined	Number Infected	Prevalence (%)	Number Examined	Number Infected	Prevalence (%)
1 – 9	9	1	11.1	11	1	9.1	20	2	10.0
10 – 19	17	5	29.4	29	9	31.0	46	14	30.4
20 – 29	29	14	48.3	57	23	40.4	86	37	43.0
30 – 39	35	18	51.4	37	16	43.3	72	34	46.0
40 – 49	11	5	45.5	42	12	28.6	53	17	32.1
50 – 59	13	2	15.4	36	13	36.1	49	15	30.6
60 – above	19	3	15.8	31	7	22.6	50	10	20.0
Total	133	48	36.1	243	81	33.3	376	129	34.3%

$\chi 2 = 15.724$ (Calculated); df = 6; p = 0.0915

Where: $\chi 2$ = Chi-squared statistic, df = degrees of freedom, and P = p-value

Table 3: Prevalence of taeniasis infection with associated risk factors

Parameter	Risk Factors	No. Examined %	No. Infected %	P-value
Source of water supply	Well	77(20.5)	26(6.9)	
	River/Stream	206(54.8)	82(21.8)	
	Borehole	93(24.7)	21(5.6)	P> 0.05(0.159)
	Total	376 (100)	129(34.3)	
Toilet used at home	Pit latrine	143(38.0)	54(14.4)	
	Water closet	30(8.0)	9(2.3)	
	Open defaecation	203(54.0)	66(17.6)	P> 0.05(0.132)
	Total	376(100)	129(34.3)	
Hands wash after defaecation	Yes	112(29.8)	34(9.0)	
	No	205(54.5)	69(18.4)	
	Not always	59(15.7)	26(6.9)	P> 0.05(0.083)
	Total	376(100)	129(34.3)	
Educational Level	Primary education	230	98(26.1)	
	Secondary education	127	25(6.7)	
	Tertiary education	19	6(1.5)	P> 0.05(0.265)
	Total	376(100)	129(34.3)	
Pigs roam freely	Closed system only	150(31.9)	42(11.1)	
	Roam freely,settle anywhere	57(23.1)	21(5.6)	
	Both are practiced	169(45.0)	66(17.6)	P> 0.05(0.068)
	Total	376(100)	129(34.3)	
Do you eat undercooked meat	Yes	65(17.3)	21(5.6)	
	No	187(49.7)	40(10.6)	
	I can't say	124(33.0)	68(18.1)	P> 0.05(0.088)
	Total	376(100)	129(34.3)	
Pork tongue consumed	Often	220(58.5)	89(23.7)	
	Rarely	156(41.5)	40(10.6)	P< 0.05(0.044)
	Total	376(100)	129(34.3)	
Where you buy pork meat	Market	201(53.5)	84(22.3)	
	Any available source	126(33.5)	25(6.7)	
	Others	49(13.0)	20(5.3)	P> 0.05(0.171)
	Total	376(100)	129(34.3)	
Where do you slaughter pig	Slaughter house	92(24.5)	57(15.2)	
	Home	156(41.5)	24(6.4)	
	Others (Anywhere)	128(34.0)	48(12.8)	P< 0.05(0.049)
	Total	376(100)	129(34.3)	
Do you deworm yourself often	Yes	59(15.7)	9(2.4)	
	No	212(56.4)	84(22.3)	
	Not always	105(27.9)	36(9.6)	P> 0.05(0.189)
	Total	376(100)	129(34.3)	

Epidemiological investigations demonstrate that intestinal parasitic infections are determined by complex interactions between human behavior, socio-economic dynamics, and environmental contexts (Suriptiastuti and Manan, 2011; Abah and Arene, 2015). Borrong dwellers are known for pig rearing and most of the pigs that are reared are majorly for trade and not necessary for their consumption, although few rearers do consume them when there is a major event (like Borrong day, coronation) within their environment and for family gatherings (like meetings).

The low to moderate prevalence could be explained by existing provisions of improperly cooked pork on exposed trays outside school premises after learning hours and also within communities by food vendors at night which is a common practice in most rural communities in Nigeria (Ekpo *et al.*, 2008). Infections therefore could have been acquired from consumption of this locally made available pork, especially when roasted, grilled or fried with minimal heat (OIE, 2004).

Secondly, the price of pork meat seems to be the most expensive meat consumed by the dwellers of Borrong, the high cost has deprived many residents of buying and consuming pork as often as they desire it, notwithstanding some still purchase pork meat but in one way or the other have reduced the number of people consuming pork, this has also helped many to develop more likeness for fish because it's much more available and less expensive compared to pork.

Furthermore, the free-roaming of pigs to scavenge for food could be a major cause of the high prevalence in this study. Some practices regarding pigs' well-being are not the best. The pig's stools are all around the study area, and there is no law as to where the pig should be slaughtered, sometimes, when pigs are slaughtered, the viscera of the pig are thrown inside the river, and the pig itself is also been washed in the river, this could in turn influence the prevalence of porcine or human taeniasis in the community since the major water source is the river.

Association between taeniasis and age among residents of Borrong Communities

The study found higher taeniasis infection rates among 10-39-year-olds compared to 1-9-year-olds, consistent with Biu and Hena's (2008) findings of greater adult infection prevalence. Taeniasis infection can occur from age 2 onwards, with higher prevalence in individuals under 40 years old (Enekwechi and Azubike, 1994; Garcia *et al*., 2003).

Risk factors associated with taeniasis among residents of Borrong Communities

In this study, the infection was strongly associated ($p \leq 0:008$) with 8 out of 10 risk factors considered. Parasitic infection was highest (21.8%) among individuals relying on river or stream water as their source of supply. This may be attributed to open defecation near water sources, where rain can wash fecal matter into drinking water supplies (Mbae *et al*. 2013). This suggests that using drinking water from improved sources, such as boreholes or tap water, acts as a protective measure against taeniasis infections. A similar result was observed for *H. nana* in Al-Fayoum in Egpty (El-Mohamady *et al*, 2006).

The prevalence of taeniasis was higher (17.6%) among those practicing open defecation, consistent with Karunaithas *et al*. (2011), though not statistically significant ($P > 0.05$). However, the study revealed a significant link between handwashing after toilet use and intestinal parasite prevalence. Handwashing after defecation was linked to lower rates of intestinal infection, with a higher prevalence (18.4%) observed among those who did not practice it, consistent with Sah *et al.* (2013). The washing of hands include: washing with water only, soap, hand wash gel. Handwashing has been shown to significantly lower intestinal parasite infections in a recent cluster-based study (Mahmud *et al.* 2015). Studies show that contaminated hands are a major source of faecal-oral transmission in developing countries, and handwashing before eating or after defecation is a critical secondary prevention measure (Anuar *et al.*, 2012).

Awareness plays a significant role in controlling and preventing diseases, and that is why the issue of education cut's across every other risk factor and other issues associated with taeniasis. The higher the educational level, the lower the infection, this is the relationship between taeniasis and educational level. The earlier the awareness program kick started in various communities, the better informed residents become.

In the study area, semi-intensive management of pigs allowed them to roam freely during the day, giving them direct access to human feces, during the resting hours, they look for available shelter or the ones built for them and are mostly made of mud. There is a well-established link between taeniasis and pigs' access to human feces. In many parts of Africa, pigs are allowed to roam freely because they can utilize waste products to convert into meat, and the practice is cheaper in areas of poverty compared to maintaining pigs in closed shelters.

Eating undercooked pork is something the majority of the study population agreed that they "could not say" whether the pork they eat was properly cooked or not, the level of education is a factor in that, many of the people were not conscious of what they eat (whether cooked or not) and it had the highest prevalence of 18.1%, people couldn't say, and so there might be a possibility that some of the pork purchased by the study population might not have been properly cooked, if that is the case, the likelihood of contamination with taeniasis is high when fed undercooked pork.

Eating pork tongue is as normal as eating the other parts of the pig, this is the people's belief which might not be true completely particularly when it is not properly cooked. Different traditional cultural practices bring people together to drink and merry in Borrong, which pork is part of their delicacy, men drink and merry with the pork meat. People who often eat pork tongues have the highest prevalence (23.7%), and people who rarely consume pork tongues have 10.6% prevalence. The tongue palpation method for porcine cysticercosis detection has shown that the pork tongue is more likely to harbor a heavy infection compared to other areas of the pig. Reports from Falake *et al.* (2003), in Ibadan south-west Nigeria and of Onah *et al.* (1995) Enugu south-east Nigeria, and other countries like Phiri *et al.* (2002) 43% in Zambia buttress the possibilities of high infection from pork tongue and other pork offal.

The majority of the pigs are slaughtered in various slaughterhouses 57(15.2%), followed by anywhere available with a prevalence of 48(12.8%), and in individual homes with 24(6.4%) prevalence. No significant variation was observed between taeniasis infection and places where pigs are slaughtered ($P>0.05$). The absence of pipe-borne water aligns with findings from Zuru, Nigeria, where wells and rivers were primary water sources (Gweba *et al.*, 2010), potentially increasing contamination risk due to environmental exposure. Epidemiological analysis reveals that biannual deworming programs provide partial protection against parasitic infections, but systemic environmental and behavioral determinants significantly compromise intervention outcomes.

CONCLUSION

The overall epidemiological assessment of human taeniasis in the focused location (Borrong, Dilli, and Gwamba zones) was moderately high 34.3% considering cognizant findings from other states in Nigeria. The prevalence reported for taeniasis in this study portrays a serious public health challenge that requires an urgent approach. Developing effective and pioneering tools to drive social adjustments is essential for controlling and preventing this disease. The high prevalence of taeniasis among villagers unveils a critical public health challenge rooted in complex environmental and behavioral factors. The infection's widespread occurrence strongly suggests systemic deficiencies in sanitation infrastructure, characterized by: environmental contamination, sanitation limitations, and limited transmission knowledge. Seasonal variations, specifically the dry season's environmental conditions, can significantly impact parasite survival, potentially modulating infection transmission dynamics and reducing re-infestation risks.

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