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Epidemiology of Taeniasis in Some Communities of Borrong, Demsa Local Government, Adamawa State, Nigeria

[1]Ogundipe Olayinka Ibukunoluwa, [2]Chessed Godly, and [3]Onyia Emmanuel C.
Department of Zoology, Faculty of Life Sciences, Modibbo Adama University, P. M. B. 2076, Yola, Adamawa State, Nigeria
***Corresponding author Email**:
Olayinka_ogundipe@yahoo.com
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ABSTRACT

Background: Taeniasis in humans is a parasitic infection caused by the tapeworm species *Taenia saginata* (beef tapeworm), *Taenia solium* (pork tapeworm), and *Taenia asiatica* (Asian tapeworm). Humans can become infected with these tapeworms by eating raw or undercooked beef (*T. saginata*) or pork (*T. solium and T. asiatica*).
Objective: This is a community-based descriptive cross-sectional research designed to determine the epidemiology of taeniasis among the people of Borrong Community, Demsa Local Government Area, Adamawa State.
Methods: A total number of 376 individuals were randomly selected for the study sites, from three villages which are Borrong, Dilli, and Gwamba. The data was collected using a well-structured questionnaire alongside their stool samples. Statistical analyses were done using IBM, SPSS Statistics Version 20 (IBM. Somers, NY).
Result: Out of the 376 individuals selected for the study, 129 subjects were positive for taeniasis infection with a prevalence of 34.3%. Other parasites found alongside taeniasis were: Hookworm was the highest 172 (45.8%), followed by *A. lumbricoides* 148 (39.4%), *Taenia spp* 129 (34.3%), *T. Trichuria* 45 (12%), *E. coli* 9 (2.4%), and the least being *S. stercolaris* 3 (0.8%). Out of the 129 persons infected, 19 (5.1%) had double infection while no triple was reported. Majority of the study population had light-intensity infection 90 (69.8%), followed by moderate-intensity infection 11 (8.5%) and the least intensity was among those who had heavy 2 (1.6%).

Keywords: Taeniasis, Infection, Tapeworm, Borrong, Prevalence

1. Introduction

Taeniasis in humans is a parasitic infection caused by the tapeworm species *Taenia saginata* (beef tapeworm), *Taenia solium* (pork tapeworm), and *Taenia asiatica* (Asian tapeworm). Humans are infected with these tapeworms by eating raw or undercooked beef (*T. saginata*) or pork (*T. solium and T. asiatica*) (Symeonidou *et al*., 2018). Taeniasis is an emerging infectious zoonotic disease caused by segmented parasitic tapeworms belonging to the family taeniidae, and subclass cestoda. Certain identified Taenia spp. Includes *Taenia solium, Taenia saginata, Taenia crassiceps, Taenia ovis, Taenia taeniaeformis, Taenia hydatigena, Taenia multiceps, Taenia serialis, Taenia asiatica, and Taenia brauni* (Mogaji *et al.,* 2016).

T. solium is a tapeworm that causes Taeniasis in humans and cysticercosis in humans and pigs. The life cycle of *T. solium* involves pigs as intermediate hosts (cysticercosis), while humans are definitive hosts (taeniasis). Humans may also act as accidental intermediate hosts when larvae of the parasite settle in muscles, subcutaneous or organ tissues causing human cysticercosis (HC) (Sotelo and Del Brutto, 2002; WHO, 2005). If they lodge in the central nervous system (CNS), the disease is called neurocysticercosis (NCC) (Sotelo *et al*., 2002). An individual may also have cysticerci in the CNS as well as in other parts of the body, which is referred to as (neuro) cysticercosis. The tapeworm *T. saginata* is one of three taenia species that infect humans as their definitive host, with bovines serving as the intermediate host. Humans acquire *T. saginata* infection after consuming undercooked beef containing viable cysticerci. The adult tapeworm resides in the small intestine, where it becomes patent within approximately ten weeks (Carabin, *et al.,* 2015; Winkler and Richter, 2015; Stelzle, *et al.,* 2022). At that moment, the strobila may have reached a length of up to three meters (Craig and Ito, 2007), and gravid proglottids can contain up to 100,000 taeniid eggs. These eggs are voided during and between defecation

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(Tembo, 2015), and have the potential to survive for a long time without hatching. Eggs found in faecal material and eggs within soil have been documented to remain viable for up to 9.5 months (Hendrickx *et al*., 2019). Contaminated pastures, water and feed are a source of infection for cattle. Following ingestion, the early larval stages (oncospheres) hatch, and the hexacanth larvae migrate, utilizing the lymphatic and blood system, to the muscle tissue. Here the larvae mature into the metacestode stage, called cysticerci (Symeonidou, 2018).

Unlike *T. solium*, for which humans can also act as a dead-end intermediate host leading to the debilitating and stigmatizing disease neurocysticercosis, human *T. saginata* infections are restricted to the definitive (adult tapeworm) stage, which has a more limited public health burden. *T. saginata* taeniasis is generally asymptomatic or associated with mild abdominal discomfort, although more serious complications, including appendicitis, intestinal obstruction, and gall bladder perforation have occasionally been documented (Hendrickx *et al*., 2019). While progress has been made in understanding taeniasis, gaps in research persist. Comprehensive studies on transmission dynamics, risk factors, and the impact of control measures are essential for informed decision-making (Braae *et al*., 2015). This study is aimed to determine the epidemiology of taeniasis in Borrong community, Demsa LGA, Adamawa State. This study will benefit every dweller of Borrong community and everyone who consumes meat without the necessary precautions.

2. Materials and Methods

2.1 Description of Study Area

This study was conducted among the dwellers of Borrong community, 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 area has a tropical climate, marked by dry and rainy seasons. The rainy season commences in May and ends in the middle or late October, the rainfall has a mean total of 1113.3mm, with August and September being the wettest months with about 25% of the total annual rainfall (National Population Commission, 2006). The Demsa environment is a secondary type due to human activities going on consistently through construction, farming, and wood gathering for fuel and grazing have altered the natural vegetation. Most indigenes of Demsa are civil servants, farmers, fishermen and women, and petty traders. The languages spoken in Demsa LGA are Bacama, Bali, Bata, Bille, and Mbula-Bwazza.

2.2 Study Population

The study population is composed of individuals living in Demsa LGA, Borrong community: Borrong zone, Dilli zone, and Gwamba zone, of Adamawa State. Individuals aged between 1-70 years were selected randomly irrespective of age, sex, health status, or tribe during the study period. According to NPC Adamawa State, the current projected population of Borrong as of 2023 was 3,298.4.

2.3 Sample Size and Sampling Procedure

The sample size of this study was estimated by taking the prevalence as 50% because there was no published report on the prevalence nor epidemiology of taeniasis so far in the study area. Hence, the sample size was calculated using the formula (Naing *et al*., 2007). It was determined using the following formula (Araoye, 2004);

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

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 taken as 0.05 (5%)

$$n_0 = \frac{(1.96)^2 X\ 0.50\ X\ 0.50}{(0.05)^2}$$

$n_0 = 384$

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

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

$$n = \frac{384}{1+\frac{384}{N}} =$$

$$n = \frac{384}{1+\frac{384}{3,298.2}} = 376$$

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

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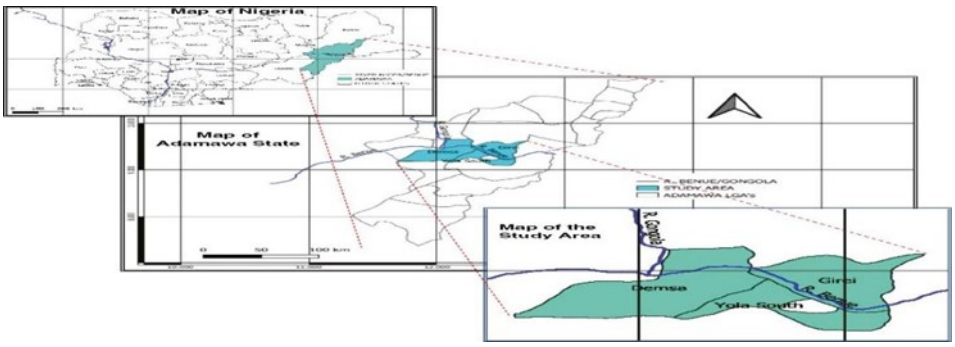

Fig 1: Map of Adamawa state showing study areas

2.4 Ethical Consideration

The permission to explore the community was obtained using a letter of introduction from the Head of the Department of Zoology, Modibbo Adama University, Yola. Ethical clearance was obtained from Adamawa State Ministry of Health, and the permission/approved letter was taken to Demsa Local Government for further clearance while the informed consent of the leaders of the community was obtained after explaining the objectives of the study to the leaders of the community. Study participants were at will to withdraw from the study at any moment they so wish. Participants who tested positive were recommended for deworming before the infection became chronic.

2.5 Pre Survey

In the community, a pre-survey meeting was conducted to explain the purpose of the study to the District Head and other local authorities. Eligibility and selection of members was based on age (1-70 years). Among all eligible household members who consent to participate in the study, a member was selected by a simple random sampling technique. A short, structured questionnaire was administered to all participants to collect information on biodata such as age, sex, occupation hygiene and sanitary practices, pig keeping, and pork consumption among other information.

2.6 Sample Collection

The data was collected using a well-structured questionnaire prepared in English language. The study participants were interviewed to obtain gender, age, educational level, washing habits before and after meals, hand washing after defecation, source of water for bathing, source of water for drinking, latrine availability, latrine usage, and many more. The questionnaire was pre-tested on 5% of the population in Sangere, Girei Local Government Area, one week before starting the actual data collection time to evaluate the reliability before the study began. The participants were instructed properly and were given clean labeled collection cups along with applicator sticks and from each participant about 2g of fresh stool was collected. At the time of collection, the name of the participant, age, sex, and educational level of the participant was recorded for each subject. The stool samples were preserved in 10% formalin before being transported to the Zoology laboratory- at Modibbo Adama University. A gram of each sample was processed and examined microscopically using direct wet mount and formal-ether concentration techniques following the procedures according to WHO guidelines (WHO, 1992).

2.7.0 Laboratory Procedures (Parasitological Examination)

2.7.1 Formalin-ether Concentration Method

Stool samples were processed using the formol-ether sedimentation technique, as described by Garcia (2010). A small portion of stool specimen about the size of a walnut was mixed thoroughly in 10mls of saline solution. The emulsion was filtered through fine mesh gauze into a conical centrifuge tube, and the suspension was centrifuged at 2,500 for 5 minutes. The supernatant was decanted, and the sediment was suspended in 10ml of normal saline solution and centrifuged again. This process was repeated until the supernatant is clear. The supernatant was then poured out and 10ml of 7% formal saline added. To the mixture, 3ml of ether was added and shaken vigorously before centrifuging again at 2500g for 5 minutes. Using an applicator stick, the top plug of the debris formed was freed and the supernatant was decanted. A small amount (1 drop) of the sediment was placed on a glass slide and a drop

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of iodine added and covered with a cover slip. The slide prepared was examined microscopically at x10 magnification for the presence of *Taenia solium* ova (Garcia, 2010).

2.8 Data Analysis

Data obtained were entered into a Microsoft Office Excel spreadsheet 2016 and verified for accuracy. Statistical analyses were done using IBM, SPSS Statistics Version 20 (IBM. Somers, NY). Prevalence and intensity estimates were cross-tabulated with demographic data, and associations were determined using the Pearson Chi-square test (X^2). Analysis of Variance (ANOVA) was used for comparing intensity estimates among surveyed communities. Significances will be set at $P \leq 0.05$. The prevalence of taeniasis was calculated by dividing the number of positive (infected) samples by the total number of the samples collected and multiplied by one hundred to obtain the percentage of positivity.

3. Results

3.1 Prevalence of Taeniasis Infection in the Study Population

Table 1 shows the overall prevalence of taeniasis infections examined in the study area. The study area comprises of three villages which are Borrong, Dilli and Gwamba. Out of the 376 individuals selected for the study (comprising both the aged, young and children), 129 subjects were positive for taeniasis infection with an overall prevalence of 34.3%. In the three study locations, the highest prevalence of 77(39.5%) was observed at Borrong Community, followed by 41 (32.5%) in Dilli Community, and the least 11 (20.0%)) was in Gwamba Community. Based on the chi-squared test results and p-values > 0.05, results show that there was no variation in the prevalence of taeniasis infection across the different communities.

3.1.2 Prevalence of Taeniasis and other Parasites Identified in Various Locations

Table 2 show the prevalence of taeniasis and other parasites identified. Parasitic infections that were found include Hookworms, *Ascaris lumbricoides*, *Trichuris trichiura*, *Entamoeba coli* and *Stongyloides stercoralis*, and not all the volunteers were positive for taeniasis but almost all were positive of one parasitic infections. There were volunteers who had multiple infections but no greater multiples than double was witnessed or recorded (table 3).

The parasite with highest prevalence was Hookworm 172(45.8%), followed by *A. lumbricoides* 148(39.4%), *Taenia spp* 129 (34.3%), *T. Trichuria* 45(12%), *E. coli* 9 (2.4%), and the least being *S. stercolaris* 3 (0.8%). With respect to Borrong Community, Hookworm 106(54.4%) had the highest prevalence, coming second was *A. lumbricoides* 78(40%), followed by *Taenia spp* 77(39.5%), *T. trichuria* 27(13.9%), *E. coli* 8 (4.1%), and the least encountered parasite was *S. stercoralis* 3(1.5%). The margin is similar for Dilli and Gwamba.

3.2 Intensity of Taeniasis With Respect to Location

The intensity of taeniasis (light, moderate and heavy intensity) identified is shown in Table 4. Out of the total number of 129 infected individuals, only 103 were afflicted with one parasite or the other at varying intensity. The remaining 26 individuals were either not clear/ visible or had no intensity attributed to them, nothing visible was found on their slides. Generally, majority of the study population had light infection 90(69.8%), followed by moderate infection 11(8.5%) and the least intensity was among those who had heavy 2 (1.6%).

3.3 Prevalence of Human Taeniasis in Relation to Gender

Table 5 show the prevalence of taeniasis in relation to gender. More females 81(33.3%) were infected than male counter parts 48 (36.1%). With respect to males, Borrong recorded the highest prevalence 31(43.1%) followed by Dilli 14(31.1%) and the least community was Gwamba 3(18.8%). For the females, Borrong also had the highest prevalence 46(37.4%) followed by Dilli 27 (33.3%), and the least community was Gwamba 8(20.5%).

4. Discussion

The overall prevalence of human taeniasis in the study areas of Borrong, Dilli, and Gwamba was relatively high 34.3% when compared with similar reports from other states in Nigeria. Weka *et al*. (2013) also reported an overall prevalence of 9.6% *Taenia solium* among pig rearers in Jos North Local Government Area of Plateau State, Nigeria. Biu and Hena (2008) reported a prevalence of 4.2% human taeniasis in Maiduguri, Borno State, Nigeria.

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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

$\chi 2 = 6.000$ (Tabulated);

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

Table 2: Prevalence of Taeniasis and other Parasites Identified in Various Locations

Borrong Villages	Number Examined	Taenia spp	Hookworm spp	*Lumbricoides*	*T. trichuria*	*E. coli*	*S. stercoralis*
Borrong	195	77(39.5)	106(54.4)	78(40.0)	27(13.9)	8 (4.1)	3(1.5)
Dilli	126	41(32.5)	47(37.3)	56(44.4)	15(12.0)	1 (0.8)	0(0.0)
Gwamba	55	11(20.0)	19(34.6)	14(25.5)	3(5.5)	0 (0.0)	0(0.0)
Total	**376**	**129(34.3)**	**172(45.8)**	**148(39.4)**	**45(12.0)**	**9**	**3(0.8)**

Hookworms spp $\chi 2 = 14.36$; df = 2; p = 0.05

Stongyloides stercoralis $\chi 2 = 3.69$; df = 2; p = **0.158**

A. lumbricoides spp $\chi 2 = 5.52$; df = 2; p = **0.063**

T. trichuria $\chi 2 = 7.59$; df = 2; p = 0.022

E. coli $\chi 2 = 8.15$; df = 2; p = 0.01

The same overall prevalence results could be termed as moderate or low prevalence (34.3%) when compared with Mogaji *et al.* (2016) in a related study who reported an overall prevalence of 40.9% human taeniasis in Odeda Area of Ogun State, Udensi *et al*. (2015) in Imo State, where they reported prevalence of 47.7%, Prasad *et al*. (2007) in India, with prevalence rates of 38.0%. Epidemiological studies have revealed that the prevalence and distribution of intestinal parasitic infections (human tianaesis) are governed by behavior, socio-economic and environmental characteristics of the people (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 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).

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Table 3: Prevalence of Co-infection Among the Study Population

Number Exam-	**No. Infected**	**Co-infection**	**Types of Parasites Co-infected**			
			A. lumbricoides + *Taenia spp*	*Hookworm* + *T. trichuria*	*Hookworm* + *A. lumbricoides*	*A. lumbricoides* + *T. trichuria*
		No.(%)	No.(%)	No.(%)	No.(%)	No.(%)
376	**129**	**19(5.1%)**	**2(10.5%)**	**5(26.3%)**	**8(42.1%)**	**4(21.1%)**

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Table 4: Intensity of Taeniasis With Respect to Location

Borrong District	Number Examined	Number Infected (%)	Intensity (EPG)		
			L+(%)	M++(%)	H++(%)
Borrong	195	77(39.5)	53(68.8)	9(11.7)	2(2.6)
Dilli	126	41(32.5)	33(80.5)	2(4.9)	0(0.0)
Gwamba	55	11(20.0)	4(36.4)	0(0.0)	0(0.0)
Total	**376**	**129(34.3)**	**90(69.8%)**	**11(8.5%)**	**2(1.6%)**

$\chi 2 = 3.000$; df = 2; p = 0.223

Intensity Egg Per Gram(EPG): Light (L+): 1-5 EPG

Moderate (M++):6-10 EPG

Heavy (H++): 11…, EPG

Where: χ^2 Chi-squared statistic,
df degrees of freedom, and
P p-value

The low/moderate prevalence obtained in this study could be a result of provision 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 its much more available and less expensive compared to pork.

Suboptimal pig management practices, particularly allowing pigs to roam freely for food, significantly contribute to the elevated infection rates observed in this study. 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 is 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.

Multiple infections co-existed in the study subjects and the prevalence was 5.1%, which is moderately low. A similar prevalence of double infections has also been reported by Simon-Oke *et al*. (2014) and Tulu *et al*. (2014). These are evidences that the occurrence of polyparasitism is a norm in developing countries. The low prevalence of polyparasitism could be attributed to the recent developments in the community such as the provision of portable water systems and modern toilet facilities by the State Government/community leaders.

Light infections were dominant for all the district 90(69.8%). However, Borrong had the highest light infection intensity 53(66.8%), the highest moderate intensity 9(11.7%) and the highest heavy infection intensity 2(2.6%). Light intensity predominated in various specific helminth infections. This could explain why

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Table 5: Prevalence of Human Taeniasis in Relation to Gender in the Studied Communities

Borrong District	Male			Female			Total		
	Number Examined (%)	Number Infected	Prevalence	Number Examined	Number Infected	Prevalence (%)	Number Examined	Number Infected	Prevalence (%)
Borrong	72	31	43.1	123	46	37.4	195	77	39.5
Dilli	45	14	31.1	81	27	33.3	126	41	32.5
Gwamba	16	3	18.8	39	8	20.5	55	11	20.0
Total	**133**	**48**	**36.1**	**243**	**81**	**33.3**	**376**	**129**	**34.3%**

For Male: $\chi2 = 6.000$; df = 4; p = 0.199

For Female: $\chi2 = 6.000$; df = 4; p = 0.159

Where: $\chi2$ = Chi-squared statistic,
df = degrees of freedom, and
P = p-value

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there was no relationship between anthropometric measurements and prevalence of intestinal parasitic infection. That being said, the occurrence of taeniasis infection at high prevalence among the villagers could be indicative of faecal pollution of soil and domestic water supply around homes due to poor sanitation, ignorance of the mode of transmission of these worms and improper sewage disposal which has been found to be a predisposing factor to infection. The intensity of taeniasis infection varied from one district to another (P>0.05). This disagrees with the finding of Mogaji *et al* (2016) in Odeda Area of Ogun State.

Generally, the majority of the individuals who came out for the test were more of female. This high margin between the gender didn't stop there, the female 81(33.3%) were more infected compared to their male counterpart 48(36.1%). However, there were significant differences in the parasitic infection between both genders. Although, this high margin should have been expected that the female overall prevalence of 33.3% should be more than this when compare to the male overall prevalence of 36.1%, but the result was not so.

This is in agreement with the findings of Mogaji *et al* (2016) in Odeda Area of Ogun State and Eke *et al* (2014) in Bosso area of Minna State, but in contrast with that of Usip *et al* (2011) in Uyo area of Akwa Ibom State, where females prevailed the more than male subjects.

Males cravings for half grilled or roasted beef and pork is more pronounced than that of females and this might be a probable reason why they were more infected than females in the study. The gender difference can be due to the fact that males are continuously exposed to pork, as males were handlers and male traditional chefs, who habit of tasting raw pork for salt and spice combinations. The males are more dominant compared to the females, they are the providers, they work more compared to the females, they eat more than females, and they are everywhere within the study population. In Borrong, males commonly consume undercooked pork, or pork visceral organs, alongside alcohol as part of cultural practices. Thus, educating the community on appropriate consumption of meat, targeting male members of the community is expected to have a substantial impact on the prevalence of taeniasis, although altering cultural dietary practices is recognized as a challenging approach to successful intervention.

Previous works have made it clear that sex distribution is not a confounding factor in intestinal infection as both sexes are equally susceptible even though the work done by Mogaji *et al* (2016) in South West, Ogun State revealed that males were more infected with taeniasis than that of females. Male or female individuals could be both infected if proper care is not taken, most of the previous studies revealed that males were more susceptible majorly because of their practices. The prevailing circumstance of high prevalence will continue to appreciate if crucial steps are not taken to curb the recurrence. However, further studies are recommended on the association of gender with respect to taeniasis.

5. Conclusion

The overall prevalence of human Taeniasis in the study areas of Borrong community (Borrong, Dilli, and Gwamba zones) was moderately high 34.3% when compared with similar reports from other states in Nigeria. The prevalence reported for taeniasis in this study portrays a serious public health challenge that requires urgent approach. There is a need to develop effective and innovative tools for behavioural changes in the control and prevention of this disease. The occurrence of taeniasis infection at high rates among the villagers could be indicative of faecal pollution of soil and domestic water supply around homes due to poor sanitation, ignorance of the mode of transmission of these worms and improper sewage disposal has been found to be a predisposing factor to infection.

Sometime, the timing of the study period (in the dry season), which affects the viability of eggs and larvae, could be one of the major factors that alter the infection rate. Such conditions might considerably reduce the chances of transmission and infestation.

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