Prevalence and Risk Factors of *Helicobacter pylori* Infection among Secondary School Adolescents in Port Harcourt Metropolis, Nigeria

ABSTRACT

Introduction: *Helicobacter pylori* is an infectious organism affecting man which occurs worldwide, more prevalent in developing countries including Nigeria. It is the most frequent cause of peptic ulcers in children and is linked to the emergence of gastric cancers in adults. *H. pylori* is usually acquired in childhood and may persistent into adulthood without treatment. The aim of this study is to determine the prevalence and risk factors of *Helicobacter pylori* infection among secondary school adolescents in Port Harcourt Metropolis, Nigeria

Methods: It was a cross-sectional descriptive study carried out using 402 adolescents aged 10 to 18 years attending secondary schools in randomly selected two public and twenty-two private schools in Obio/Akpor Local Government Area, Port Harcourt Metropolis, from May 2021 to July 2021. The adolescents' sociodemographic, household characteristics and hygiene practices were entered into a proforma. Stool antigen test was carried out on each subject's stool. A mixture of dilution buffer and stool was centrifuged to obtain the supernatant. *H. pylori* Stool Antigen dipstick was dipped into the supernatant and results read within 5-10 minutes. This colored line shows a positive result when it appears in the test region, but a negative result when it does not. If no line appears in the control region, the test result was interpreted as being invalid.

Results: Infection with *H. pylori* was prevalent in 59.7% of adolescents aged 10 to 18 years. Statistically significant difference was found with increasing age, poor hand washing practice after toilet use and poor hygiene practice in washing of vegetables before eating and lower mother's education with ($p < 0.05$). Predictors of *H. pylori* infection were lower mother's educational level (OR-1.744, 95%CI=1.066; 2.853, p=0.027), poor handwashing practices after toilet use (OR-1.668, 95%CI=1.073; 2.594, p=0.023), and poor hygiene practice in washing of vegetables before consumption (OR-8.781, 95%CI=1.102; 60.972, p=0.040) respectively.

Conclusion: The high prevalence of *H. pylori* infection could be attributed to the poor hygiene practices of the adolescents and the low educational level of their mothers.There is need to strengthen school health programs through quality health education on good hand hygiene practices and consumption of properly washed vegetables. There should be provision of adequate clean water in schools and improvement in the education of the girl child.

Keywords: Helicobacter pylori; infection; stool antigen test; adolescents

1.INTRODUCTION

Helicobacter pylori is a gram negative bacillus that inhabits the gastrointestinal tract of man.[1] When ingested, it first inhabits the gastric mucous layer and induces an immune response that results in infection.[2] *Helicobacter pylori (H. pylori)* weakens the protective mucous coating of the stomach and duodenum thus allowing acid to get to the sensitive lining beneath. Both the bacteria and acid irritate the lining and cause peptic ulcer disease (PUD).[2] In 1983, Robin Warren, a pathologist in Perth, reported the presence of "curved bacterium" in the mucosal layer of the gastric biopsy specimen[3] while Barry Marshall showed evidence suggesting that chronic colonization with H. *pylori* led to the development of PUD.[4] Robin Warren and Barry Marshall were later awarded the Nobel Prize for the discovery of *H. pylori* and its ability to cause gastritis and peptic ulcer disease in 2005.[5] The discovery of *H. pylori* was a great development in medicine as it was formerly believed that psychological stress and peppery foods were the cause of gastritis and ulcers.[6] In the paediatric population it is the most important underlying cause of stomach ulcers and may present with recurrent abdominal pain, nausea, anorexia, and gastrointestinal bleeding.[7,8] The International Agency for Research on Cancers (IARC), an arm of the World Health Organisation (WHO) has classified *H. pylori* as a class 1 carcinogen for gastric cancer.[9] About 50% of the global population is infected with *H. pylori* and children make up to one third of this population.[10,11] In developed countries the rate of infection with *H. pylori* in childhood range from 0.5-1% per year compared to a prevalence rate of 3-10% in developing countries.[12] Several African studies[13,14.15,16] have shown increase in *H. pylori* infection with increasing age with the lowest prevalence in younger ages. Hence carrying out a study among adolescents to identify those who are actively infected and also to study the risk factors that can predispose them to the infection is important. The fecoprevalence of *H. pylori* and the risk factors among adolescents is not known in the study area. Therefore, the study was carried out to determine the prevalence of *H. pylori* using stool antigen test and the risk factors among adolescents attending private and public secondary schools in South-South Nigeria.

2. METHODOLOGY

2.1 Study Design

A cross-sectional descriptive study was conducted with 402 adolescents. The adolescents were aged 10 to 18 years attending two public and 22 private randomly selected secondary schools in Port Harcourt Metropolis, Nigeria.

2.2 Study Population

A multi-stage, stratified sampling method was employed in recruiting subjects in this study. Sampling was done in four stages. Stage 1 consists of selection of the local government area (LGA) by balloting and Obio/Akpor LGA was picked. Stage 2 involved selection of the secondary schools using a list of schools provided by Ministry of Education representatives. The secondary schools in Obio/Akpor LGA were divided into public and private institutions which is made up of 25 public and 263 private schools.

The ratio of public-private secondary schools in Obio/Akpor LGA is 1:11. Therefore to increase the number of schools sampled, the ratio was multiplied by 2 giving 2 public and 22 private schools. To select the 24 schools from a total of 288 schools (25 public school and 263 private schools) unique labelled numbers were assigned to each school, 1-25 for public school and 1-263 for private schools using Microsoft Excel. Using the RANDBETWEEN function of Microsoft Excel on the computer, a table of random numbers was generated for public schools and private schools respectively. The first 2 numbers in public schools and the first 22 numbers in private schools identified were used in the study. Where the principal of a school did not allow the study to be carried out, the next available school on the list was recruited instead.

Students were selected from each school in stage 3 and the number of students selected in each of the sampled 24 schools was determined based on proportionate allocation thus schools with greater population had greater representation. In stage 4, students were selected from each class. The number of students selected in each of the classes was determined based on proportionate allocation. Information on the adolescents' sociodemographic, socioeconomic characteristics, household characteristic and hygiene practices, were all investigated using an interviewer-administered questionnaire. This study received ethical approval after being presented to the institution's Research and Ethics Committee. An approval was also

obtained from the Universal Basic Education Board and the Rivers State Senior Secondary School Education Board. Stool samples collected from students were tested using the Stool Antigen Test (SAT).

2.3 Stool Antigen Detection

Stool analysis was carried out using *H. pylori* Stool Antigen dipstick, ACRO Rapid Test kit which contains a sample diluent (dilution buffer) and *H. pylori* Strip. Using a pipetting device, 1ml of dilution buffer was added to a test tube. A wooden applicator stick was used to turn the stool collected in a universal bottle until it forms a good mixture and to transfer a small portion (5-6mm diameter) to the test tube containing the dilution buffer. This mixture was vortexed for 15 seconds. The mixture of buffer and stool was centrifuged to obtain the supernatant. A micropipette was used to collect 500 microliters of the supernatant into another test tube. *H. pylori* Stool Antigen dipstick, ACRO Rapid Test, Germany (sensitivity 98.8%, specificity 98.4% and accuracy 98.6%) was dipped into the supernatant with the arrow downwards and read within 5-10 minutes. This is an in vitro qualitative process for the identification of *H. pylori* antigens in faeces. It is based on a lateral flow chromatography technique and uses a monoclonal anti-*H. pylori* antibody to identify *H. pylori* antigens in stool. In this test, anti-*H. pylori* antibodies are pre-coated on the membrane on the test line portion of the test strip. A colored line is produced during testing when the mixture migrates upward on the membrane due to capillary action and reacts with anti-*H. pylori* antibodies there. This colored line shows a positive result when it appears in the test region, but a negative result when it does not. A colored line will always emerge in the control line zone as a quality control, indicating that the correct volume of specimen has been introduced and that membrane wicking has taken place. If no line appears in the control region, the test result was interpreted as being invalid and the test repeated. Samples that still showed invalid results were discarded and subjects were not used in the study.

2.4 Data Analysis

Data were exported into Statistical Package for Social Sciences (SPSS) version 25.0 for analysis. Categorical data were summarized as proportions and displayed as percentages in tables or charts. Mean and standard deviation were used to summarize continuous numerical data. Independent t-tests were used to compare the mean differences. Association between nominal categorical variables was tested using Chi-square test of independence (where expected count is over 5 in at least 80% cells); otherwise, the Fisher's exact test was used. Such tests of associations were presented in tables.

Socio-demographic factors such as age and sex, social class, hygiene practices and household characteristics variables that yielded statistically significant results on bivariate analysis were entered into a logistic regression model with infection status (infected or not infected) as dependent variable.
Applying a scoring method, the children were categorized into socioeconomic classes depending on the s ocioeconomic classes of their parents or guardians according to a scoring system by *Oyedeji.*[17]

Odds ratio for each predictor variable was computed, alongside the corresponding 95% confidence limits, and presented in a table. Level of significance for the study was set at p-value < 0.05.

3. RESULT

A total of 409 participants were recruited for the study. Seven of them had invalid results and so a total of 402 subjects were analyzed for the study. The representation of males and females was approximately comparable with a ratio of 1:1.04 and the mean age of the subjects was 13.66 ± 2.16 years. A high percentage of fathers 306 (76.1%) and mothers 350 (87.0%) have at least a secondary education. There were more subjects from the private 223 schools (55.5%) than public schools 179 (44.5%). Fifty (12.4%) were from low socioeconomic class.

Table 1: Socio-demographic Variables of the participants

Variables (n=402)	Frequency N	Percentage %
Age (years)		
10 – 12	123	30.5
13 –15	200	49.8
16 – 18	79	19.7
Gender		
Male	197	49.0
Female	205	51.0
Father's Education		
No formal education	20	5
Primary	76	18.9
Secondary	154	38.3
Tertiary	152	37.8
Mother's Education		
No formal education	18	9.5
Primary	34	15.9
Secondary	174	42.0
Tertiary	176	32.6
Type of school		
Public	179	44.5
Private	223	55.5
Social class		
Low	50	12.5
Middle	177	44.0
High	175	43.5

3.1. Household Characteristic Variables of the subjects

More adolescents 183 (45.5%) live in self-contained apartments and majority had greater than 6 persons in the household 270 (67.2%). Two hundred and twelve (52.7%) shared room with 3 persons and more. Two hundred and eighty-nine (71.9%) of the subjects had at least three siblings in the home. A low percentage 4 (0.9%) of the respondents drank water from well and stream. Majority of the participants (92.1%) used water closet and 136 (33.6%) shared toilet with other families.

Table 2 Household Characteristics Variables of the Secondary School Adolescents

Variables	Frequency N	Percentage %
Type of accommodation		
Makeshift shelter(Batcher)	94	23.4
One-room	53	13.2
Self-contained	183	45.5
Flat	71	17.7
Duplex	1	0.2
Total number of people in household		
1-5 persons	132	32.8
>6persons	270	67.2
Number of persons sharing room with subject		
<3 persons	190	47.3
≥3 persons	212	52.7
Number of siblings		
1-2 siblings	113	28.1
3-4 siblings	160	39.8
≥5 siblings	129	32.1
Main source of drinking water		
Borehole	161	40.1
Sachet	130	32.4
Bottled	81	20.1
Pipe borne	26	6.5
Well	3	0.7
Stream	1	0.2
Toilet type		
Water closet	370	92.1
Pit latrine	23	5.7
Defecate in bush	9	2.2

3.2 Hygiene Practices Characteristics of the study subjects

Two hundred and forty (59.7%) of the respondents do not always wash vegetables prior to eating while 196 (48.8%) always wash hands with soap and water before meals. One hundred and forty-one (35.1%) do not always wash their hands after toilet use. Main source of food is at home 385 (95.8%)

Table 3 Hygiene Practices Characteristics of Secondary School Adolescents in the Study Population

Variables	Frequency	Percentage%
Wash vegetables prior to eating		
Always	162	40.3
Sometimes	230	57.2
No	10	2.5
Washing of hands with soap and water before meals		
Always	196	48.8
Sometimes	168	41.8
No	38	9.4
Washing of hands with soap and water after toilet use		
Always	261	64.9
Sometimes	59	14.7
No	82	20.4
Main source of food		
Home	385	95.8
Food vendor	9	2.2
Eatery/fast food	8	2.0

3.3 Prevalence of *Helicobacter pylori*

Two hundred and forty (59.7%) out of 402 tested positive for *H. pylori* giving a high prevalence among the study subjects.

Table 4: Result of Helicobacter *pylori* stool antigen test

Result of H.*pylori* Test	Frequency (n=402)	Percentage (%)
Positive	240	59.7%
Negative	163	40.3%

3.4 Relationship between sociodemographic, socioeconomic class and school type and the presence of *Helicobacter pylori* infection.

Although 120 (60%) of the subjects with *H. pylori* infections were in the 13–15 age group, the infection prevalence increased with age, peaking in the 16–18 age group and this was statistically significant (p=0.028). There was a declining prevalence of *H. pylori* infection in subjects with higher parental educational attainment. This finding was however only statistically significant with mother's level of education (p=0.010). There was however no statistically significant difference with gender, socioeconomic class and type of school in relation to *H. pylori* infection.

3.5 Relationship between Household Characteristics and Presence of *Helicobacter pylori* of the study subjects

The majority of participants who tested positive for *H. pylori* infection reside in self-contained apartments and flats (63.75%). The proportion of adolescents positive for *H. pylori* infection was highest in those living in batchers, with more than six persons in the homes and those with greater than five siblings in the household. These variables however did not show statistical significance. (p=0.575, p=0.543, p=0.056). As the number of persons sharing a room with the subject increased, the prevalence of *H. pylori* also increased among the subjects however this was not statistically significant (p=0.484)

Table 5: Relationship between sociodemographic, socioeconomic class of parents and type of school and the presence of *Helicobacter pylori*

	Helicobacter Pylori				
Variables	**Present N(%)**	**Absent N(%)**	**Total N (%)**	**X^2**	***p value***
Age (years)					
10 – 12	64 (52.0)	59 (48.0)	123 (100.0)	7.122	0.028*
13 – 15	120 (60.0)	80 (40.0)	200 (100.0)		
16 – 18	56 (70.9)	23 (29.1)	79 (100.0)		
Gender					
Male	112 (56.9)	85 (43.1)	197 (100.0)	1.303	0.254
Female	128 (62.4)	77 (37.6)			
Father's education					
No formal education	16 (80.0)	4 (20.0)	20 (100.0)	7.491	0.058
Primary	52 (68.4)	24 (31.6)	76 (100.0)		
Secondary School	88 (57.1)	66 (42.9)	154 (100.0)		
Tertiary	84 (55.3)	68 (44.7)	152 (100.0)		
Mother's education					
No formal education	25 (65.8)	13 (34.2)	38 (100.0)	11.348	0.010*
Primary	46 (71.9)	18 (28.1)	64 (100.0)		
Secondary school	105 (62.9)	64 (37.9)	169 (100.0)		
Tertiary	84(48.9)	67 (51.1)	131 (100.0)		
Socioeconomic class			`		
Low	27 (54.0)	23 (46.0)	50 (100.0)	1.167	0.558
Middle	110 (62.1)	67 (37.9)	177 (100.0)		
High	103 (58.9)	72(41.1)	175 (100.0)		
Type of school					
Public	112 (62.6)	67 (37.4)	179 (100.0)	1.103	0.294
Private	128 (57.4)	95 (42.6)	223 (100.0)		

*Statistically significant

Table 6: Relationship between Household Characteristics and Presence of *Helicobacter pylori* among the study subjects

	Helicobacter Pylori				
Variables	**Present N (%)**	**Absent N (%)**	**Total N (%)**	**X^2 /Fisher's Exact**	**p value**
Type of accommodation					
Makeshift shelter (Batcher)	59 (62.8)	35 (37.2)	94 (100.0)	2.965	0.575
One room	28 (52.8)	25 (47.2)	53 (100.0)		
Self-contained	109 (59.6)	74 (40.4)	183 (100.0)		
Flat	44 (62.0)	27 (38.0)	71 (100.0)		
Duplex	0 (0.0)	1 (100.0)	1 (100.0)		
Total number of people in household					
1-5 persons	76 (57.6)	56 (42.4)	132 (100.0)	0.369	0.543
>6 persons	164 (60.7)	106 (39.3)	270 (100.0)		
Number of persons sharing room with subject					
<3 persons	110 (57.9)	80 (42.1)	190 (100.0)	0.489	0.484
≥3 persons	130 (61.3)	82 (38.7)	212 (100.0)		
Number of siblings					
1-2 siblings	72 (63.7)	41 (36.3)	113 (100.0)	5.778	0.056
3-4 siblings	84 (52.5)	76 (47.5)	160 (100.0)		
>5 siblings	84 (65.1)	45 (34.9)	129 (100.0)		

3.6 Hygiene practices characteristics and toilet type in relation to the presence of *Helicobacter pylori* infection among the study population

H .pylori prevalence was high in subjects who do not wash their vegetables before eating 10 (90.9%) and lower in those who always washed their vegetables 25 (15.4%) before consumption and this was statistically significant (p=0.0001). There was also a statistically significant relationship between hand washing practices with soap and water after toilet use in relation to *H. pylori* infection. (p=0.039). There was however no significant relationship with washing hands before meals (p=0.342) and toilet type (p=0.638).

Table 7 Hygiene practices characteristics and toilet type in relation to the presence of *Helicobacter pylori* infection among the study population

	Helicobacter Pylori			**X^2**	***p value***
Variables	**Present N (%)**	**Absent N (%)**	**Total N (%)**		
Do you wash your vegetables before eating?					
Always	25 (15.4)	137 (84.6)	162 (100.0)	221.044	<0.001*
Sometimes	205 (89.5)	24 (10.5)	229 (100.0)		
No	10 (90.9)	1 (9.1)	11(100.0)		
Do you wash hands with soap and water before meals?					
Always	111 (56.6)	85 (43.4)	196 (100.0)	2.149	0.342
Sometimes	103 (61.3)	65 (38.7)	168 (100.0)		
No	26 (68.4)	12 (31.6)	38 (100.0)		
Do you wash hands with soap and water after toilet use?					
Yes	144 (55.2)	117 (44.8)	261 (100.0)	6.510	0.039*
Sometimes	39 (66.1)	20 (33.9)	59 (100.0)		
No	57 (69.5)	25 (30.5)	82 (100.0)		
Toilet type					
Water closet	222 (60.0)	148 (40.0)	370 (100.0)	0.898	0.638
Pit latrine	14 (60.9)	9 (39.1)	23 (100.0)		
Bush	4 (44.4)	5 (55.6)	9 (100.0)		

In summary the logistic regression analysis demonstrates that participants were approximately twice as likely to have the *H. pylori* infection if their mothers had only received primary or informal education as opposed to those whose mothers had received secondary and tertiary education. (OR-1.744,95%CI=1.066; 2.853, p=0.027).

Those who don't wash their vegetables before eating were approximately nine times more likely to have *H. pylori* infection while those who don't wash their hands with soap and water after toilet use were two times more likely to be infected with *H. pylori*. (OR-8.781, 95%CI=1.102; 69.972, p=0.040 and OR-1.668,95%CI=1.073; 2.594, p=0.023 respectively).

Table 8 Logistic Regression for Predictors of *Helicobacter pylori*

Variables	Coefficient(B)	OR	95% CI	p value
Age				
13 and above	0.416	1.516	(0.975; 2.359)	0.065
Less than13 [R]		1		
Mother's education				
No formal education/primary	0.556	1.744	(1.066; 2.853)	0.027*
Secondary/tertiary[R]		1		
Do you wash your vegetables before eating?				
No	2.173	8.781	(1.102; 69.972)	0.040*
Yes[R]		1		
Do you wash hands with soap and water after toilet use?				
No	0.512	1.668	(1.073; 2.594)	0.023*
Yes[R]		1		

*Statistically significant R – Reference category CI – Confidence interval

4. DISCUSSION

This study found a 59.7% prevalence of *H. pylori* infection, which is comparable to the 59% prevalence seen in a study by Mynepallis *et al.*[18] in Lagos. The fact that the subjects in this study attended public schools and shared similar sociodemographic characteristics and risk factors for *H. pylori* infection with those in the study by Mynepallis *et al*.[18] may be the cause of the similar results. Higher *H. pylori* prevalence was observed in the older adolescents, the female population, those who drank pipe-borne water, and those who had poor hand washing habits after defecation.

The prevalence of *H. pylori* infection found in this research was lower than the prevalence reported in several other earlier studies.[16,19] While Holcombe *et al*[19] reported a prevalence rate of 91% in Maiduguri in North-East Nigeria, Senbanjo *et al*[16] estimated a prevalence of 63.6% among healthy Nigerian children in Lagos, South-West Nigeria. The higher prevalence in these studies could be attributed to the serological method employed to detect *H. pylori* infection. The serological tests does not distinguish between previous and present infections. Furthermore, the studies by Senbanjo *et al*[16] and Holcombe *et al*[19] were conducted in hospitals and may not be an accurate representation of the society at large. Moreso, Galal *et al*[13] reported a prevalence of 64.6% in Egypt. The higher prevalence could be because only symptomatic children from both urban and rural communities were recruited in the study. It is important to highlight that *H. pylori* infection has been linked to PUD as the commonest cause, making it more likely in adolescents who already have PUD symptoms.[7,8]

In contrast to the prevalence obtained in this study, some other studies in Nigeria have reported lower prevalence rates. Okuda *et al*[20] in Japan and Kolawole *et al*[21] in North-Central Nigeria both reported a prevalence of 1.8% and 4.2% respectively in the paediatric population. The lower prevalences observed in these studies could be because of improved living conditions. Majority of the subjects in the current study were from the middle socioeconomic class, and are more likely to have poor hygiene practices than those from higher socioeconomic backgrounds, which could account for the higher prevalence of *H. pylori* infection in the current study.

The prevalence of *H. pylori* infection was shown to be increasing with age in this study. Similar findings of increasing prevalence with age have been reported in children by Soltani *et al*[22] in Iran, Aitila *et al*[14] in Uganda and Eremenini *et al*[15] in Owerri, Nigeria. The reason for this might be that older adolescents are more likely to be exposed to community environmental influences like eating from street vendors, living in unclean conditions, and observing poor hygiene practices than younger adolescents who might be more shielded by their parents and thus not be equally exposed to these risk factors. In addition, older adolescents are more exposed to outdoor activities such as playing football which further exposes them to soil containing *H. pylori*.[23]

There was no significant difference between gender and *H. pylori* infection in this study. This was similar to the findings by Al-Hussaini *et al*[24] in Saudi Arabia and Abbas *et al*[25] in East Sudan. This could be because comparable proportions of both gender were infected with *H. pylori*. On the other hand, Awuku *et al*[26] reported a higher prevalence of *H. pylori* infection among the female participants. The reason for this outcome could not be ascertained.

Socioeconomic class of the subjects was not significantly associated with *H. pylori* in this study although the proportion of *H. pylori* infection was higher in those subjects from middle socioeconomic class. Ajayi[27] in Lagos had similar findings as majority of the subjects were from middle socioeconomic class. The reason for this outcome in the current study could be because a higher proportion of subjects recruited were from the middle socioeconomic class. However, many studies have documented that subjects from lower socioeconomic class were at higher risks of contacting the infection as reported by Al-Hussaini *et al*[24] in Saudi Arabia, Abbas *et al*[25] in East Sudan, Aitila *et al*[14] in Uganda and Daniyan *et al*[23]in Nigeria. The authors attributed the reason to be that lower socioeconomic class was associated with poor sanitation, overcrowding, lack of portable water supply and poor hygiene practices.

Subjects whose mothers had no formal and primary education were two times at risk of having *H. pylori* infection compared to those with secondary and tertiary education. In this study, the level of literacy of mothers was significantly associated with *H. pylori* positivity and this could be because the mother's educational status reflects the healthy habits and hygienic practices of the subjects. Emerenini *et al*[15] in Owerri, Nigeria and *Al-Hussaini et al*[24] in Saudi Arabia also reported similar findings.

Overcrowding has been shown in many studies to be a risk factor for acquisition of *H. pylori* infection.[13,14,15,28] In the current study, the prevalence of *H. pylori* was not significantly associated with increased household population. Adedoyin *et al*[29] in Keffi, Nigeria had similar outcome with this study as there was no significant association with household number and *H. pylori* infection. The outcome of the study could be because overcrowding was defined based on the number of persons in the household and not the number of persons in a room as the sizes of the rooms were not taken into account in the present study.

The relationship between hygiene practice characteristics and presence of *H. pylori* infection in the subjects showed significant association in those who did not wash their vegetables before eating and those who did not wash their hands with soap and water after toilet use. Daniyan *et at*[23] in Nigeria and Szaflaarska-Poplawska *et al*[30] in Poland reported that consumption of uncooked vegetables was a significant risk factor to *H. pylori* acquisition. This may be because these vegetables grow in close proximity with soil that contains fecal matter and were not properly washed before consumption. The consumption of raw vegetables such as cabbage, lettuce, cucumber etc when not properly washed can pose a great risk for acquisition of this infection. In contrast to the current study, Mynepallis *et al*[18] and Adedoyin *et al*[29] did not show any significant difference with hand washing after defaecation and *H. pylori* infection. *H. pylori* infection is most often transmitted through contact with faeces. Thus, poor hand washing habits after toilet use and consumption of raw vegetables without properly washing them puts adolescents at high risk of contacting the infection. It is therefore important to train adolescents in schools on the need to wash vegetables thoroughly before consumption and to have good hand hygiene after defaecation.

The predictors of H. *pylori* infection in this study are low level of mother's education, those who did not wash their vegetables before eating and those who did not wash their hands with soap and water after toilet use. This conclusion highlights the necessity for enhancements in the school health program and the implementation of proper hygienic measures in the handling of food products prior to consumption and after defaecation.

5. CONCLUSION

The prevalence of *H. pylori* among adolescents in this study is high**.** Increasing age of the subjects, lower mother's education, poor handwashing habits after toilet use and consumption of unwashed vegetables are all risk factors for *H. pylori* infection. Adolescents should be routinely screened for *H. pylori* and treatment commenced for those infected to avert the gastrointestinal complications which occur in the paediatric population such as peptic ulcer diseases with perforation and possible onset of gastric cancers in the adult population. There is need to strengthen school health programs through quality health education on good hand hygiene practices, consumption of properly washed vegetables and other food items. There should be provision of healthful school environment with adequate clean water and good environmental sanitation. Improvement in the education of the girl child will go a long way to reduce the spread of the infection because the mother's educational status reflects the healthy habits and hygienic practices of their children.

6 LIMITATION

The use of upper gastrointestinal endoscopy could not be done in this study following the stool antigen test because of the cost as it is very expensive. It is an invasive procedure that requires the subjects to be placed under anaesthesia therefore there may be poor readiness of the subjects to participate in the research. However, endoscopy would have been able to demonstrate the areas of ulcers and metaplastic changes occurring within the gastrointestinal tract of the subjects.

7. CONSENT AND ETHICAL APPROVAL

This study received ethical approval after being presented to the University of Port Harcourt Teaching Hospital's Research and Ethics Committee in Nigeria. (UPTH/ADM/90/S.II/VOL.XI/942) An approval was obtained from Rivers State Senior Secondary School Education Board and Universal Basic Education Board. Notification from the school board was served to the principals of the selected public schools and permission obtained before commencement of the study. Written informed consent was obtained from parents of participants and assent also obtained before commencement of the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Authors' contributions

This work was carried out in collaboration among all authors. The final manuscript was read and approved by each author.

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UPTH RESEARCH ETHICS COMMITTEE

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ETHICAL APPROVAL

PREVALENCE, RISK FACTORS AND NUTRITIONAL EFFECT OF HELICOBACTER PYLORI INFECTION AMONG ADOLESCENTS ATTENDING SECONDARY SCHOOL IN PORT HARCOURT METROPOLIS".

We refer to your letter dated 26 October, 2020 requesting for Modification of your Ethical Approval project titled "**PREVALENCE AND RISK FACTORS OF HELICOBACTER PYLORI INFECTION AND ITS EFFECTS ON THE NUTRITIONAL STATUS OF ADOLESCENTS IN SECONDARY SCHOOLS IN PORTHARCOURT, NIGERIA to PREVALENCE, RISK FACTORS AND NUTRITIONAL EFFECT OF HELICOBACTER PYLORI INFECTION AMONG ADOLESCENTS ATTENDING SECONDARY SCHOOL IN PORT HARCOURT METROPOLIS".**

After a critical appraisal of your proposal by the University of Port Harcourt Teaching Hospital Research Ethics Committee, approval is hereby given to you to commence your study.

Note the following:

1. The study can only be started after it is approved by the examining body.
2. The approved proposal must be presented to your department/unit.
3. We will conduct periodic inspection of your methods to ascertain best practices.
4. At the completion of