**Original Research Article**

**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. It is the most frequent cause of stomach mucosal ulcers in children and is linked to the emergence of gastric cancer in adults. It is crucial to know the prevalence of *H. pylori* in adolescents and to understand the risk factors for them to contract the infection so that preventive measures can be instituted.

**Aim:** To determine the prevalence and risk factors of Helicobacter pylori infection among adolescents attending private and public secondary schools in South-South 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 to assay for the faecal antigen to *H. pylori*.

**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%Cl=1.066; 2.853, p=0.027), poor handwashing practices after toilet use (OR-1.668, 95%Cl=1.073; 2.594, p=0.023), and poor hygiene practice in washing of vegetables before consumption (OR-8.781, 95%Cl=1.102; 60.972, p=0.040) respectively.

**Conclusion:** The prevalence of *H. pylori* in this study is 59.7%. Lower mother's education, poor handwashing habits after toilet use and poor hygiene practices in washing vegetables before eating them are all risk factors for the infection.

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

*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 specimen3 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 studies13,14.15,16 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.

**2.1 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). 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.

**2.3 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**

**Percentage**

**Type of accommodation**

 **N %**

|  |  |  |
| --- | --- | --- |
| 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 (%) X2 *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 Tertiary  | 88 (57.1) 84 (55.3)  |  | 66 (42.9) 68 (44.7)  |  | 154 (100.0) 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 Absent****N(%) N (%)** | **Total X2 p value****N (%) /Fisher’s** |
|  |  |  |  | **Exact** |  |
| **Type of** |  |  |  |  |  |
| **accommodation** |  |  |  |  |  |
| Makeshift shelter | 59 (62.8) | 35 (37.2) | 94 (100.0) | 2.965 | 0.575 |
| (Batcher) |  |  |  |  |  |
| 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*****Variables Present N Absent N** |  | **X2** | ***p value*** |
| **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%Cl=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%Cl=1.102; 69.972, p=0.040 and OR-

1.668,95%Cl=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/tertiaryR |  | 1 |  |  |
| ***Do you wash your vegetables*** |  |  |  |  |
| ***before eating?*** |  |  |  |  |
| No | 2.173 | 8.781 | (1.102; 69.972) | 0.040\* |
| YesR |  | 1 |  |  |
| ***Do you wash hands with soap*** |  |  |  |  |
| ***and water after toilet use?*** |  |  |  |  |
| No | 0.512 | 1.668 | (1.073; 2.594) | 0.023\* |
| YesR |  | 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 Ayodele *et al*21 in South-South Nigeria both reported a prevalence of 1.8% and 2.1% respectively. The lower prevalences observed in these studies could be because of improved living conditions in Japan and the high socioeconomic class of those recruited in the study by Ayodele *et al*.21 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. Ajayi27 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*23in 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. 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.

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