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Prevalence of *Helicobacter pylori* Infection and Associated Risk Factors among Schoolchildren at Dhamar City, Yemen

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***Abstract*—** *Helicobacter pylori* infection is one of the most common chronic infections and a global public health problem, affecting over 50% of the population worldwide. Childhood is the age in which most *H. pylori* infections tend to be acquired particularly in developing nations. This study was designed to determine the prevalence of *Helicobacter pylori* infection among Schoolchildren as well as to evaluate the correlation between risk factors including age, sex, education, symptoms and nutrition with the infection rate. *H. pylori*-antigen and *H. pylori*- antibody tests were used to detect the infection by *H. pylori*. Total 120 blood-serum samples and 120 fecal samples were collected randomly from schoolchildren comprising eleven schools at Dhamar city. Study was carried out from November 2019 to March 2020. The results revealed that the rate of infection was 75.8% of *H. pylori* Antigen and 74.2% of *H. pylori* Antibody. The highest rate of infection by *H. pylori*-Ag was recorded in Oqbah, Hafsah and Yemen Modern Schools, whereas *H. pylori*-Ab recorded the highest rate in Oqbah, Al-jawdah and Al-motafawgeen Schools. According to the gender, the rate of infection among female students was higher compared to the male students. Moreover, the highest infection of *H. pylori* was in students aged between six to eight. In addition, the elementary school showed high infections in correlation with education. Finally, the current study showed a significant relationship between *H. pylori* infection with the pathological symptoms and type of nutrition.

Keywords— Prevalence; Risk factors; Helicobacter pylori; Infection; School students

I. INTRODUCTION

Stomach considered as almost sterile organ due to hydrochloric acid production, which prevents the survival of viruses, bacteria, and other microorganisms. However, the discovery of Helicobacter pylori showed the existence of microorganisms adapted not only to survive in an acidic environment, but also to colonize this particular part of digestive tract [1]. *H. pylori* has evolved to be uniquely suited to thrive in the harsh stomach environment, *H. pylori* bacteria secrete urease enzyme that converts urea to ammonia until reduces the acidity of the stomach and make it a more hospitable home for *H. pylori* [2]. It is a gram-negative, non-spore forming bacterium, spiral and curved bacillus, which grows under microaerophilic conditions at an optimum temperature of 35-37°C and high humidity, it has two to six flagella that provide motility to resist the rhythmic contractions of stomach and penetrate the gastric mucosa. It has 2.4 to 4.0 mm in length and 0.5 to 1.0 mm in width [3], [4].

H. pylori infection is one of the most common chronic infections and a global public health problem, affecting over 50% of the population worldwide [5]. Childhood is the period in which most *H. pylori* infections tend to be acquired especially in developing nations [6]. *H. pylori* is considered to be the major cause of chronic gastritis and duodenal ulcer in childhood and an important cofactor in the development of gastric cancer or mucosa-associated lymphoid tissue lymphoma and other complications, such as cancer [7]. The incidence and prevalence rates of childhood infection with *H. pylori* vary greatly [8]. Within developed nations, prevalence rates of *H. pylori* infection among children have been shown to range from as low as 1.8% to as high as 65% [9], while in developing countries, the prevalence is generally higher reaching up to 90% in some countries [10]. This infection mostly acquired during childhood through the fecal-oral and oral-oral route, and persists throughout life [5]. These differences are related to several environmental factors, such as different infectious mechanisms, better hygienic and social conditions and, as an additional factor, the excessive use of antibiotics in the treatment of several bacterial infections [6].

In Dhamar city, the prevalence of *H. pylori* among school students have been neglected, and there is no available published information on the prevalence of *H. pylori* infection in children at Dhamar city. Therefore, this study aimed to determine the prevalence of *H. pylori* infection among school students at Dhamar city as well as to

investigate the risk factors that may be associated with infection.

II. RELATED WORK

The mode of transmission for *H. pylori* is not certainly known; School children in developing countries are at higher risk of *H. pylori* infection. Several factors control transmission in developing countries including low socioeconomic status, poor quality of drinking water, overcrowding, poor personal and environmental hygiene, and food contamination [8]. The organism has been found in faeces, saliva, and dental plaques, suggesting a fecal-oral and oral-oral path of transmission, particularly within families [11]. Initial infection with this organism is usually silent but symptoms and pathologic changes occur later in life [5]. The clinical conditions and pathologic changes associated with *H. pylori* infection include gastrointestinal manifestations such as gastritis ulcer disease (gastric ulcer and duodenal ulcer), gastric carcinoma, gastrointestinal bleeding, Mucosa-Associated Lymphoid Tissue Lymphoma (MALT) [12].

H. pylori infections of the pediatric population have also been associated with specific complications such as gastritis, failure to thrive and iron deficiency anemia [13]. While H. pylori has been disappearing from the stomach of humans, the incidence of the related disorders, acid reflux disease, Barrett's esophagus, and esophageal cancer have been rising dramatically [2].

Gastritis is an inflammation or injury of gastric mucosa and epithelium by an autoimmune response and hypersensitivity reactions that usually caused by *H. pylori* infection [4].

Treatment mostly is a combination therapy of three or four drugs regimen including Amoxicillin, Clarithromycin, Tetracycline, Metronidazole plus PPIs with or without bismuth compounds. H. pylori eradication regimen have high cure rates approximately 80%, minimal bacterial resistance and non-significant side effects [4],[8]

III. MATERIALS AND METHODS

Study area

The study was conducted in Dhamar city (Figure 1), geographically located between 43.30 to 44.50 latitude, 14-15 longitude and at altitude of 2400 meter. In summer, the temperature ranges between 28.20 and 25.30 Celsius, while it declines in winter between18 to -1 below zero Celsius during the night and early morning as well as the relative humidity is 49% [14], [15].

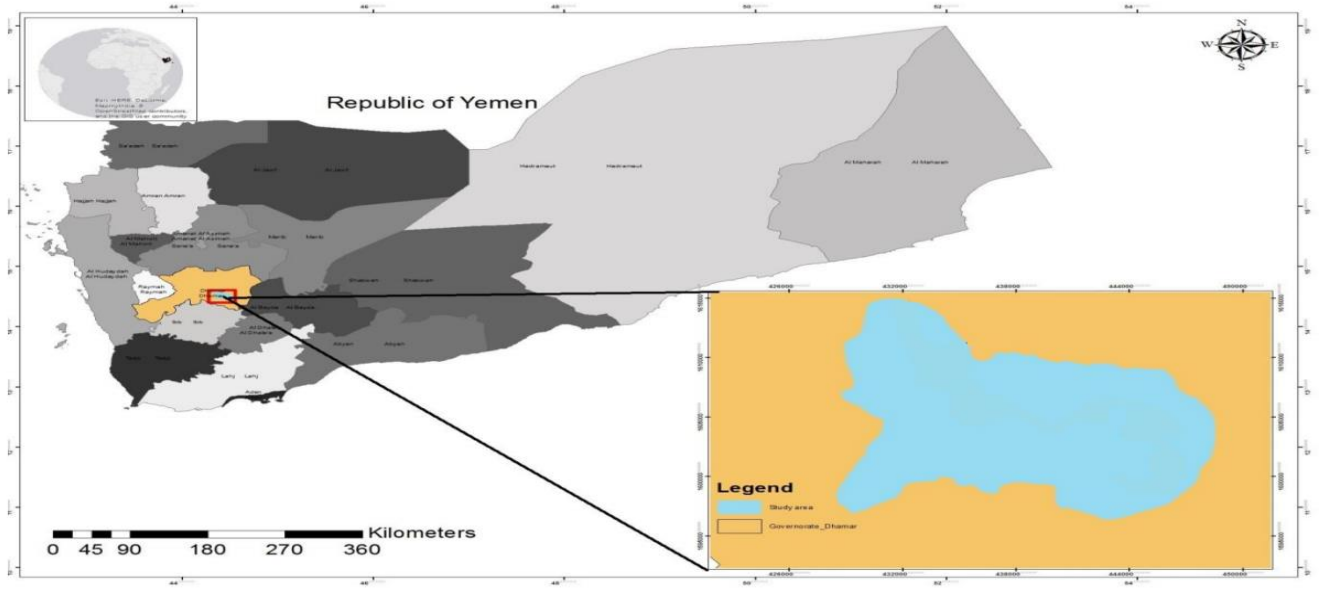

Figure 1. Map showing location of study area, Dhamar City, Yemen [15]

Study population and Sampling

The sampling was carried out during the period from November 2019 to March 2020. Two hundred and twenty-four (240) samples were collected, 120 faeces samples, and 120 blood samples randomly were collected from schools' students (male and female), different age groups. The included schools in this study were Al-wehdah, Oqbah, Hafsah, Aisha, Belgees, Yemen Modern, Al-jawdah, Toyoor Al-jannah, Al-safwah, Al-motafawgeen and Modern Science schools. Personal information about students was recorded such as name, gender, age, education level, type of nutrition, symptoms. For blood samples, 5 ml of venous blood were collected from students in a plain tube without anticoagulant. The tube was labeled and allowed to clot and forwarded by the sterile container to the laboratory. For stool samples, about 20 grams of stool were collected into a sterile container, to provide fresh stool samples within 2 h. The specimens were transported to the laboratory into ice-box according to [5],[16],[17]. The appropriate permissions were taken from the concerned authorities for sample collection, and permissions were taken from the patients to make the interview and the sampling. Patients were informed about the purpose of this research and a verbal agreement was

given by the patient before any sample collection or interview.

Detection of *Helicobacter pylori*

In the laboratory, blood was centrifuged, and serum was separated to be used for detection of *H. pylori* antibodies using *H. pylori* antibody test card (*Fastep* Houston®, Rapid Diagnostic Test; USA). The test was carried out according to [18]. Interpretation of result: Positive result / Both control line and the test line appears, negative result, only control line appears.The collected specimens of stool were examined by a one-step *H. pylori* antigen cassette test (OnSite® *H. pylori*-Ag Rapid Test, USA) for the detection of *H. pylori*. It was a qualitative immuonochromatographic assay using monoclonal antibodies. The test cassettes in the pre-application period were stored between 4 and 8ºC during the study. The *H. pylori* stool antigen (HpSA) test was performed according to the manufactures recommendation. The tests were done with fresh stool samples. The results were evaluated within 10 min, and tests with any change of color of the test-line were interpreted as positive [19].

Statistical analysis

Statistical analysis was performed using SPSS software version 21. Data was analyzed using Chi square to detect the statistically significant correlation among variables. Evaluations were carried the 95% confidence interval and $P< 0.05$ was considered statistically significant.

IV. RESULTS AND DISCUSSION

Out of the total respondents, 91 (75.8%) and 89 (74.2%) were positive to *H. pylori* Antibody and *H. pylori* Antigen respectively (table 1). Frequently, *H. pylori* infection take places earlier in life and at a lower frequency in the developed countries than in developing world [20]. It is largely accepted that H. pylori infection acquired during childhood can cause complications in adulthood [21].

Table 1. Prevalence of Antibody and Antigen of *H. pylori* infection among schoolchildren

Result	***H. pylori*-Ab**		***H. pylori*-Ag**	
	No.	%	No.	%
Positive	91	75.8	89	74.2
Negative	29	24.2	31	25.8
Total	120	100	120	100

According to schools, the highest percentage of *H. pylori* infections were recorded in Oqbah, Hafsah and Yemen Modern Schools that represent 10.1% of *H. pylori*-Ag, however the highest percentage to *H. pylori*-Ab were in Oqbah, Al-jawdah and Al-motafawgeen schools (9.9%). Whereas the lowest prevalence of *H. pylori*-Ag and *H. pylori*-Ab were in Toyoor Al-jannah School which were 5.6% and 4.4% respectively (Table 2). This results are consistent to those of the previous study of Yemeni patients infected by *H. pylori* associated with chronic dyspepsia which reported infection rate between 75%-82.2% [22],[23]. In addition, the infection rate was high compared to those reported by [24], who stated that of five hundred healthy children with age less than 10 years, only 9% detected as *H. pylori* seropositive in the study of prevalence of *H. pylori* in Sana'a, Yemen. Moreover, the infection rate was higher than those reported by [25], that studied the prevalence of *H. pylori* among public secondary school students in Ikeja Local Government, Lagos state, which recorded infection rate 59.0% (59/100).

Table 2. Prevalence of *H. pylori* infection based on the schools

School	**Antigen**				**Antibody**			
	Positive		Neg.	**P- value**	Positive		Neg.	**P- value**
	No.	**%**	**No.**		**No.**	**%**	**No.**	
7-July (n=10)	8	9.0	2		8	8.8	2	
Al-wehdah (n=10)	8	9.0	2		8	8.8	2	
Oqbah (n=10)	9	10.1	1		9	9.9	1	
Hafsah (n=10)	9	10.1	1		7	7.7	3	
Aisha (n=10)	6	6.7	4		6	6.6	4	
Belgees (n=10)	6	6.7	4		8	8.8	2	
Yemen modern (n=10)	9	10.1	1	**0.450**	7	7.7	3	**0.327**
Al-jawdah (n=10)	6	6.7	4		9	9.9	1	
Toyoor Al-jannah (n=10)	5	5.6	5		4	4.4	6	
Al-safwah (n=10)h	8	9.0	2		8	8.8	2	
Al-motafawgeen (n=10)	8	9.0	2		9	9.9	1	
Modern Science (n=10)	7	7.9	3		8	8.8	2	
Total (n=120)	89		31		91		29	

Generally, the positivity ratio of *H. pylori* is decreasing over the years [26]. the relationship of *H. pylori* infection with the gender of students showed high rate of infection among female students with 58.4% and 61.5% of *H. pylori* antigen and antibody respectively (Table 3). This results were consistent with those obtained by [18] which showed high prevalence rate of *H. pylori* among female (40.7%) compared with low infection rate of male (38.2%). The current study has shown no important differences of *H. pylori* infection rate with the gender of students. This

suggests that maintaining all exposures constant, both girls and boys would be infected equally. [27] indicated that the infection risk is the same for males and females. This study found that, although not significantly difference, large percentage of female were tested positive to *H. pylori* infection compared to their male colleagues. In addition, the highest infection rate of *H. pylori* was among students at Elementary schools, which was 59.6% and 56.0% of *H. pylori*-Ag and *H. pylori*-Ab respectively (Table 3), while the lowest was among students at Preparatory school.

Table 3. The relationship between *H. pylori* infection with gender and education level

Gender	Antigen Positive No.	%	Neg. No.	P- value	Antibody Positive No.	%	Neg. No.	P- value
Male (n=46)	37	41.6	9		35	38.5	11	
Female (n=74)	52	58.4	22	**0.216**	56	61.5	18	**0.958**
Total	89		31		91		29	
Education level								
Elementary school (n=73)	53	59.6	20		51	56.0	22	
Preparatory school (n=17)	10	11.2	7		13	14.3	4	
High school (n=30)	26	29.2	4	**0.099**	27	29.7	3	**0.095**
Total	89		31		91		29	

There was no significant association between *H. pylori*-Ag and Ab with the education level. The prevalence of *H. pylori* infection was increased with the increasing in age of school children. The highest infection rate of *H. pylori* was recorded in children aged between six to eight with 27.7% to antigen and 29.2% to antibody, while the lowest was recorded in age between fifteen to eighteen years (table 4). The trend is converse to what was demonstrated in others studies where infection rates increased with age [28]. The prevalence of *H. pylori* infection increased with increase in age, which was 16.2%, 27.2%, and 36.71% for children aged 1 to 5 years, 6 to 10 years, and 11 to 15 years, respectively [8]. Several studies shown that the rate of *H. pylori* infection increases significantly with age, with more than 80% of children being infected by the age of 10 years [29], [30]. With respect to age we stated, similar to other reports, that *H. pylori* infection increases with childhood age in this population, possibly due to the children have more contact with infection sources. During neonatal life, infection source can be limited to person-to-person from family members, caretakers, or nursery attendants [31]. As age increase, exposure to various infection sources increases hence the ultimate rate of infection. This finding can explain why the rate of infection is higher in school children. Generally, the rate of infection is higher in school children due to the poor sanitary facilities and lack of clean drinking waters [32]. According to [33], the colonization of *H pylori* rises progressively with age, and children are more influenced among human populations. Furthermore, the distribution of *H. pylori* infection based on the sampling date showed the highest rate of *H. pylori*-Ag in February (25.8%), whereas the highest rate of *H. pylori*-Ab (24.2%) in November. While the lowest rate to *H. pylori*-Ag and *H. pylori*-Ab infection was on March (10.1% and 13.2% respectively) (table 4).

Table 4. The relationship between *H. pylori* infection with age, sampling date, and infection type

Age groups	Antigen Positive No.	%	Neg. No.	P- value	Antibody Positive No.	%	Neg. No.	P- value
6-8	26	29.2	10		25	27.5	11	
9-11	22	24.7	9		21	23.1	10	
12-14	22	24.7	8	**0.776**	24	26.4	6	**0.158**
15-18	19	21.3	4		21	23.1	2	
Total	89		31		91		29	
Months								
November (n=28)	22	24.7	6		22	24.2	6	
December (n=29)	19	21.3	10		20	22.0	9	
January (n=19)	16	18.0	3		16	17.6	3	
February (n=30)	23	25.8	7	**0.520**	21	23.1	9	**0.576**
March (n=14)	9	10.1	5		12	13.2	2	
Total	89		31		91		29	
Type of infection								
No infection (n=14)	0	0.0	14		0	0.0	14	
Previous (n=14)	0	0.0	14	**0.000**	0	0.0	14	**0.000**
Recent (n=92)	89	100.	3		77	84.6	15	
Total	89		31		91		29	

Also, the highest infection rate of *H. pylori* was in students getting infection recently for both *H. pylori*-Ag and *H. pylori*-Ab that represented 100.0% and 84.6% respectively. There was a high association between *H. pylori* infection with the type of infection of students.The most symptoms associated with *H. pylori* infection were nausea, stomachache, vomiting, headache and loss of appetite, which represented 75.4%, 85.4%, 75.3%, 93.3% and 23.6% respectively for *H. pylori*-Ag (Table 5). However, the symptoms related to *H. pylori*-Ab were nausea (74.7%), stomachache (76.9%), vomiting (68.1%), headache (91.2%) and anorexia (22.0%). There was a high association between *H. pylori* infection with symptoms of nausea, stomachache, vomiting, and headache, whereas there was no significant association between *H. pylori* infection with the anorexia. After the acquisition of the *H. pylori*, acute infection characteristically yields an upper gastrointestinal illness with nausea, abdominal pain, vomiting and fever. The symptoms may last for 1 - 2 weeks. After the acquisition of the organisms and the initial acute stage of the infection, colonization with *H. pylori* occurs in many patients. Such colonization persists for years, perhaps decades, or even a lifetime. Years later, the infection develop to include gastritis and peptic ulcer disease comprising nausea, anorexia, vomiting, epigastric pain, and even less specific symptoms such as belching [34].

Table 5. The pathological symptoms of students infected by *H. pylori*

(Symptoms)		Antigen				Antibody			
		Positive		Negative	P-Value	Positive		Negative	P-Value
		No.	%	No.		No.	%	No.	
Nausea	Yes	67	75.4	10	**0.000**	68	74.7	9	**0.000**
	No	22	24.7	21		23	25.3	20	
Stomachache	Yes	76	85.4	5	**0.000**	70	76.9	11	**0.000**
	No	13	14.6	25		21	32.1	18	
Vomiting	Yes	67	75.3	7	**0.000**	62	68.1	12	**0.015**
	No	22	24.7	24		29	31.9	17	
Headache	Yes	83	93.3	18	**0.000**	83	91.2	18	**0.001**
	No	6	6.7	13		8	8.8	11	
Anorexia	Yes	21	23.6	4	**0.305**	20	22.0	5	**0.793**
	No	68	76.4	27		71	78.0	24	

The most nourishments associated with *H. pylori*-Ag infection were sandwiches (97.8%) then crisps and fried food (95.5%). The highest rate of infection with *H. pylori*-Ab was obtained in students who eat fried food (89.0%), whereas the lowest infection were in students consuming the crisps food which represented 8.8%. There was a high association between *H. pylori* infection with type of nutrition (Table 6). According to [35], the intakes of fruits, vegetables, meats and milk products were associated with the incidence of *H. pylori* infection in a sample of 5861 Mexican with age from11 to 21 years. [36] showed that after eradication of *H. pylori* in 183 peptic ulcer and gastritis patients aged between 28 and 82 years, consumption of fruits increased from 4.0 to 4.3 servings /week, while consumption of vegetables and meats did not change. The type of water and foods during childhood is a main risk factor for *H. pylori* infection. The contaminated water and food with *H. pylori* usually is transmitted by the fecal-oral routs to reach the child and persist for long-life [37]. Several previous studies worldwide have investigated the association between nutritional patterns and *H. pylori*. Some studies have reported that salty, pickled, fermented, or smoked foods increased the risk of *H. pylori* infection [38, 39, 40]. Also, high intake of fruits, vegetables or of antioxidants were found to be protective factors infection in some studies [38], [41], [42]. Moreover, [43] reported that lower consumption of raw vegetables was significantly associated with higher risk of *H. pylori* infection in a group of Iranian students. Also, study by [44] on patients with peptic ulcer in Pune, India, found that meat consumption as well as the consumption of restaurant food increased the risk for *H. pylori* infection.

Table 6. The relationship between nutrition and *H. pylori* infection

Nutrition Risk assessments		Antigen				Antibody			
		Positive		Negative	P-Value	Positive		Negative	P-Value
		No.	%	No.		No.	%	No.	
Crisps	Yes	85	95.5	19	**0.000**	8	8.8	8	**0.010**
	No	4	4.5	12		83	91.2	21	
Pulp / Pith	Yes	39	43.8	5	**0.009**	40	44.0	4	**0.004**
	No	50	56.2	26		51	56.0	25	
Spices food	Yes	64	71.9	18	**0.181**	66	72.5	16	**0.108**
	No	25	28.1	13		25	27.5	13	
Fried food	Yes	85	95.5	11	**0.000**	81	89.0	15	**0.000**
	No	4	4.5	20		10	11.0	14	
Sandwiches	Yes	87	97.8	22	**0.000**	85	39.4	24	**0.084**
	No	2	2.2	9		6	6.6	5	

V. CONCLUSION

The study concluded that the rate of *H. pylori* infection among schoolchildren at Dhamar city was high of *H. pylori* Antibody and *H. pylori Antigen*. The highest percentage of *H. pylori* infections according to the name of schools was in Oqbah, Hafsah and Yemen modern schools to *H. pylori*-Ag. Also, the highest percentage of infections based on H. *pylori*-Ab were in Oqbah, Al-jawdah and Al-motafawgeen schools. The highest rate of infection was recorded among female students compared to male students regarding *H. pylori* antigen and antibody. Based on the education level, high infection of *H. pylori* was recorded among students at Elementary schools. Also, the highest infection of *H. pylori* was found in age between six to eight. This study found that there is a high significant associated between *H. pylori* infections with the pathological symptoms of students, and type of nutrition. The most nourishments associated *with H. pylori* infection were sandwiches then crisps and fried food.

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Compliance with Ethical Standards

Conflict of interest: The authors declare that they have no conflict of interest.

REFERENCES

[1] A. Kornienko, N. Parolova, S. Ivanov S, "Gastric microbiota and probiotics opportunities in *Helicobacter pylori* eradication in children" *Open Access*, **Vol.11, Issue.1, pp.13-22, 2020.**

[2] A. Amer, J. Hassan, I. Al-Saimary, "Current Concepts in the Immunological Diagnosis of *H. pylori* in Basrah Pediatric Oncology Unit" *J Trop Dis*. **Vol.2, Issue.144, pp.2, 2014.**

[3] M. L. Brown,*"Helicobacter pylori*: epidemiology and routes of transmission" *Epidemiologic reviews*, **Vol.22, pp.283-297, 2000.**

[4] M. Haghighi, N. Dara, R. Ghanaie, et al., "Evaluation of Clarithromycin and Metronidazole Resistance of *Helicobacter pylori* Infection in Symptomatic Iranian Children" *Int. J. Pediatr*, **Vol.7, Issue.2, pp. 8925-33, 2018.**

[5] Y. Awuku, D. Simpong, I. Alhassan, et al., "Prevalence of *Helicobacter pylori* infection among children living in a rural setting in Sub-Saharan Africa" *BMC Public Health*,**Vol.17, pp.360, 2017.**

[6] M. Moubri, N. Kalach, R. Larras,"Adapted first-line treatment of *Helicobacter pylori* infection in Algerian children" *Annals of Gastroenterology*, **Vol.32, pp.1-7, 2019.**

[7] K. Namkin, M. Zardast, F. Basirinejad, "Saccharomyces Boulardii in *Helicobacter pylori* Eradication in Children: A Randomized Trial From Iran" *J. Pediatr*, **Vol.26, Issue.1, pp. e3768, 2016.**

[8] P. Aitila, M. Mutyaba, S. Okeny, "Prevalence and Risk Factors of *Helicobacter pylori* Infection among Children Aged 1 to 15 Years at Holy Innocents Children's Hospital, Mbarara, South Western Uganda" Hindawi. *Journal of Tropical Medicine*,**Vol.6, 2019.**

[9] E. Roma, E. Miele, *"Helicobacter pylori* infection in pediatrics" *Helicobacter*,**Vol.20, pp.47-53, 2015**.

[10] E. Hestvik, T. Tylleskar, D.H. Kaddu-Mulindwa,*"Helicobacter pylori* in apparently healthy children aged 0-12 years in urban kampala, uganda: a community-based cross sectional survey". J. *BMC Gastroenterology*, **Vol.10, pp.62, 2010.**

[11] M. Naumann, O. Sokolova, N. Tegtmeyer, et al.,"*Helicobacter pylori*: a paradigm pathogen for subverting host cell signal transmission" *Trends in microbiology*,**Vol.25, pp.316-3282, 2017.**

[12] A. Benavides-Ward, F. Vasquez-Achaya, W. Silva-Caso, et al., *"Helicobacter pylori* and its relationship with variations of gut microbiota in asymptomatic children between 6 and 12 year"s. *BMC Res Notes*,**Vol.11, pp.468, 2018**

[13] S. Kato, T. Osaki, S. Kamiya, et al., *"Helicobacter pylori* sabA gene is associated with iron defciency anemia in childhood and adoles- cence". *PLoS ONE*, **Vol.12, Issue.8, pp. e0184046, 2017**

[14] H. Al-Dobaee, "Assessing the influence of climate change on cereal crop production in Dhamar Water and environment centre," Sana'a University, Sana'a, Yemen, http://www wec edu ye/wpcontent/uploads/2017/05/Lecture-**13, 2016**.

[15] H. Al Aizari, L. Ahamed, F. Mhammde, et al., "Quality assessment of ground water in Dhamar City, Yemen" *International Journal of Environment*,**Vol.6, Issue.4, pp.56-71, 2017**.

[16] S. Kameswara, C. Mynepalli, O. Maureen, et al., "Prevalence of Helicobacter pylori and hygiene practices among public secondary school students in Ikeja local government area, Lagos, Nigeria". *J. Health*, **Vol.4, Issue.6, pp.250-258, 2004.**

[17] Abu-Mugesieb RM. (2007): *Risk Factors Associated with Helicobacter pylori Infection in Gaza, Palestine*. Submitted in Partial Fulfillment for the Master Degree of Science in Biological Science-Medical Technology. The Islamic University-**Gaza. 2007**.

[18] D.A.AL-Mashhadany, L.Q. Ismael, A.M. Zaki, "Seroprevalence of Helicobacter pylori among Human in Erbil Governorate, Kurdistan Region, Iraq". *RJLBPCS*,**Vol.4, Issue.2, pp.26, 2018**.

[19] T. Yucel, D. Aygin, S. Sen, "The prevalence of Helicobacter pylori and the Related Factors among University Students in Turkey", *Jpn. J. Infect. Dis*.,**Vol.61, pp.179-183, 2008**.

[20] Z. Ding, S. Zhao, S. Gong, et al.,"Prevalence and risk factors of *Helicobacter pylori* infection in asymptomatic chinese children: a prospective, cross-sectional, population-based study Alimentary" *Pharmacology & Terapeutics*,**Vol.42, Issue.8, pp.1019-1026, 2015.**

[21] O.Yucel, "Prevention of *Helicobacter pylori* infection in childhood" *World Journal of Gastroenterology*,**Vol.20, Issue.30, pp. 10348–10354, 2014.**

[22] A.A. Gunaid, N. A. Hassan, I. Murray-Lyon, "Prevalence and risk factors for *Helicobacter pylori* infection among Yemeni dyspeptic patients", *Saudi Med J*., **Vol.24, pp.512-517, 2003.**

[23] N. Bahumid, G. Al-Kazimi, A. Taresh, et al., "An epidemiological view of *Helicobacter pylori* infection among patients who underwent upper gastrointestinal tract endoscopy in Aden". *Univ. Aden J Nat App Sci*. **Vol.13, pp. 159-164, 2009.**

[24] H. A. Al-Shamahy, "Seroprevalence of *Helicobacter pylori* among children in Sana'a, Yemen". *Ann Saudi Med*., **Vol.25, Issue.144, pp.299-303, 2005**.

[25] S.Mynepalli, O. Maureen, A. Mumuni, "Prevalence of *Helicobacter pylori* and hygiene practices among public secondary school students in Ikeja local government area, Lagos, Nigeria". *Health, Open Access*,**Vol.6, Issue.4, pp.250-258, 2014.**

[26] A. Ozden, G. Bozday, M. Ozkan,"Changes in the sero-epidemiological pattern of *Helicobacter pylori* infection over the last 10 years in Turkey", *Turkish Journal of Gastroenterology*, **Vol.15, pp.156-158, 2004**.

[27] N. Uemura, S. Okamoto, S. Yamamoto, et al.,"*Helicobacter pylori* infection and the development of gastric cancer". *N Engl J Med*, **Vol.345, pp.784-789, 2001.**

[28] F. Jaime, A. Villagr, C. Serrano, et al.,"Frequency of *Helicobacter pylori* infection in 144 school age chilean children" *Revista M´ edica de Chile*,**Vol.141, Issue.10, pp. 1249–1254, 2013.**

[29] F. Al-Badaii, A. Al-taibi, H. Al-shaeri, E. Homied, M. Obad, F. Al-khatari, S. Al-khawlani, A. Al Sanabani, "Isolation, Identification and Antibiotic Susceptibility of Bacteria from Upper Respiratory Tract Infections at Dhamar Governorate, Yemen", *International Journal of Scientific Research in Biological Sciences*, **Vol.8, Issue.2, pp.12-19, 2021**.

[30] D. Ertem, H. Harmanci, E. Pehlivanoglu, *"Helicobacter pylori* infection in Turkish preschool and schoolchildren: role of socioeconomic factors and breast-feeding", *Turk. J. Pediatr*, **Vol.45, pp.114-122, 2003.**

[31] J. E. Everhart,"Recent developments in the epidemiogy of *Helicobacter pylori*", *Gastroenterol Clin North Am*.,**Vol.29, pp.559-578, 2000.**

[32] D. Mahalanabis, M. M. Rahman, S. Sarker, et al.,*"Helicobacter pylori* infection in the young in Bangladesh: Prevalence, socioeconomic and nutritional aspects," *International Journal of Epidemiology*, **Vol.25, Issue.4, pp.894-898, 1996**.

[33] J. Kenneth, M. D. Ryan, "Sherris Medical Microbiology", *McGraw-Hill Publication*, **India, 2018.**

[34] Jawetz, Melnick, Adelberg, "Medical Microbiology", Twenty-Seventh Edition, *McGraw-Hill Publication*, **India, 2019.**

[35] C. Constanza, L. Eduardo,"Determinants of *Helicobacter pylori* seroprevalence in Mexican adolescents", *Helicobacter*, **Vol.9, Issue.2, pp.106-114, 2004.**

[36] S. Olafsson, A. Bestard,"Changes in food tolerance and lifestyle after eradication of *Helicobacter pylori*", *Scand, J. Gastroenterol*, **Vol.38, Issue.3, pp.268-276, 2003**.

[37] F. Al-Badaii, A. Abdul Halim. "Potential Risk Assessment of Drinking Water Source Exposed to Contamination Using Microbial Indicators and Multiple Antibiotic Resistance Index," *Iranian (Iranica) Journal of Energy & Environment*, **Vol. 2, Issue 1, pp. 81-92, 2021**

[38] F. Al-Badaii, M. Shuhaimi-Othman, "Water pollution and its impact on the prevalence of antibiotic- resistant E. coli and total coliform bacteria: a study of the Semenyih River, Peninsular Malaysia", *Water Quality, Exposure and Health*, **Vol.7, Issue.3, pp.319-330, 2015**.

[39] A. Shafika, C. Rawan, T. Fida, C. Christy, "Dietary habits andHelicobacter pylori infection: a cross sectional study at a Lebanese hospital" *BMC Gastroenterology*,**Vol.18, pp.48, 2018.**

[40] J. G. Fox, C. A. Dangler, N. S. Taylor, A. King, T. J. Koh, T. C. Wang, "High-salt diet induces gastric epithelial hyperplasia and parietal cell loss, and enhances Helicobacter pylori colonization in C57BL/6 mice", *Cancer Research*, **Vol.59, pp.4823-4831, 1999.**

[41] S. Tsugane, Y. Tei, T, Takahashi, S. Watanabe, K. Sugano, "Salty food intake and risk of *Helicobacter pylori* infection", *Jpn J Cancer Res*,**Vol.2, pp.474-482, 1994.**

[42] H. Hwang, J. Dwyer, "Diet RRM. *Helicobacter pylori* infection, food preservation and gastric cancer risk: are there new roles for preventative factors", *Nutr Rev*., **Vol.52, pp.75-83, 1994.**

[43] K. Shinchi, H. Ishii, K. Imanishi, S. Kono, "Relationship of cigarette smoking, alcohol use, and dietary habits with *Helicobacter pylori* infection in Japanese men", *Scand J Gastroenterol*, **Vol.32, pp.651-657, 1997.**

[44] O. Eslami, M. Shahraki, T. Shahraki, H. Ansari,"Association of *Helicobacter pylori* infection with metabolic parameters and dietary habits among medical undergraduate students in southeastern of Iran", *Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences*, **Vol.22, pp.12, 2017.**

[45] R.S. Mhaskar, I. Ricardo, A. Azliyati, R. Laxminarayan, B. Amol, W. Santosh, "Assessment of risk factors of *Helicobacter pylori* infection and peptic ulcer disease", *J Glob Infect Dis*, **Vol.5, pp.60-67, 2013.**

