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Seroprevalence of anti-*Helicobacter pylori* and anti-CagA antibodies among healthy children according to age, sex, ABO blood groups and Rh status in south-east of Iran

Güney İran'da sağlıklı çocuklarda yaş, cinsiyet, ABO kan grupları ve Rh durumuna göre anti-*Helikobakter pilori* ve anti-CagA antikor seroprevalansı

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Background/aims: *The aim of this study was to evaluate the seroprevalence of anti-Helicobacter pylori (H. pylori) and anti-cytotoxin associated antigen A (CagA) antibodies in healthy children and to investigate the relation with age, sex, ABO blood groups and Rh status.* ***Methods:*** *Serum samples from 386 children (187 males, 199 females), aged 1-15 years, were tested for the presence of antibody to H. pylori and its virulence factor (CagA) by use of ELISA. ABO blood grouping was also done by hemagglutination test.* ***Results:*** *The overall seroprevalence of H. pylori infection was 46.6%. The prevalence of anti-H. pylori antibody was significantly (p<0.05) higher in males (51.9%) compared to females (41.7%). The prevalence of anti-CagA antibody in infected children was 72.8%. Although the prevalence of anti-CagA antibody was higher in males (78.4%) compared to females (66.3%), the difference was not statistically significant (p=0.07). In age subgroups of 1-5 years, 6-10 years and 11-15 years, the prevalence of anti-H. pylori was 37.6%, 46.9% and 54.9% and in infected children, the prevalence and the mean titer of anti-CagA antibody were 63.8%, 75.94 Uarb/ml; 75%, 63.32 Uarb/ml and 79.45%, 57.11 Uarb/ml; respectively. The seroprevalences of anti-H. pylori and anti-CagA (in infected children) were 53% and 77.3% in blood group A, 50.5% and 64.7% in blood group B, 44.4% and 62.5% in blood group AB, 41.6% and 76.8% in blood group O, 45.9% and 73% in Rh(+) phenotype and 54.84% and 70.6% in Rh(-) phenotype, respectively. There was no significant difference in the prevalence of either antibody between ABO blood groups or Rh status groups. However, within blood group A, the prevalence of anti-H. pylori and anti-CagA was significantly higher in males compared to females (p<0.05).* ***Conclusions:*** *These results showed that almost half of the children acquire H. pylori infection. Anti-CagA antibody is also common in the children. The seroprevalences of anti-H. pylori and anti-CagA antibodies were higher in males and increased with age. However, the mean titer of anti-CagA antibodies decreased with increasing age. ABO blood groups may partly influence the prevalence of H. pylori infection, especially in male gender..*

Key words: *Helicobacter pylori*, antigen A, seroprevalence, ABO blood groups, children, Iran, sex

Amaç: *Bu çalışmanın amacı sağlıklı çocuklarda anti-Helikobakter pilori (H. pilori) ve Anti sitotoksin assosiye antijen A (CagA) antikor prevalansını ve bunun cinsiyet, yaş, ABO kan grupları ve Rh subgruplarına ile ilişkisini araştırmaktır.* ***Yöntem:*** *1-15 yaş arası 386 çocuktan (186 kız, 199 erkek) elde edilen serumlarda ELİSA yöntemiyle H. pilori'ye ve Cag-A'ya karşı antikor bakıldı. ABO kan grupları da hemaglutinasyon testiyle çalışıldı.* ***Bulgular:*** *H. pilori enfeksiyonu prevalansı %46.6 oranındaydı. Anti-H. pilori antikor prevalansı erkeklerde (%51.9) kızlardan (%41.7) daha yüksekti (p<0.05). Anti-Cag-A antikoru ise enfekte çocukların %72.8'inde pozitif saptandı. AntiCag-A antikoru da her ne kadar erkeklerde (%78.4) kızlardan (%66.3) daha yüksek olsa da bu istatistiksel olarak anlamlı değildi (p=0.07). 1-5 yaş, 6-10 yaş ve 11-15 yaş gruplarında Anti-H. pilori antikor prevalansı sırasıyla %37.6, %46.9 ve %54.9 idi. Enfekte çocuklarda Anti-Cag-A antikoru prevalansı ve ortalama titresi sırasıyla %63.8, 75.4 Uarb/ml, %75 63.32 Uarb/ml ve %79.45 57.11 Uarb/ml'dir. A kan grubu olan çocuklarda Anti-H. pilori antikor ve AntiCag-A ab (enfekte çocuklarda) sırasıyla %53 ve %77.3, B kan grubunda %50.5 ve %64.7, AB kan grubunda %44.4 ve %62.5, 0 kan grubunda %41.6 ve %76.8, Rh (+) fenotiplerde %45.9 ve %73, Rh (-) fenotiplerde ise %54.84 ve %70.6 olarak tesbit edildi. Sonuç olarak ABO kan grupları ve Rh alt grupları arasında her bir antikor için anlamlı bir fark yoktu. Bununla birlikte A kan grubunda olanlarda her iki antikor için erkek prevalansı kızlardan daha yüksekti (p<0.05).* ***Sonuç:*** *Bu sonuçlar çocukların yarısının H. pilori ile enfekte olduğunu göstermektedir. Anti Cag-A antikoru da çocuklarda sıktır. Anti H. pilori ve Anti-Cag-A antikor prevalansı erkeklerde daha yüksektir ve yaşla artmaktadır. Bununla birlikte AntiCag-A anikor ortalama titreleri artan yaşla birlikte azalmaktadır. ABO kan gruplarını H. pilori prevalansını özellikle erkeklerde kısmen etkilemektedir.*

Anahtar kelimeler: *Helikobakter pilori*, antijen A, seroprevalans, ABO kan grupları, çocuk, Güney İran, cinsiyet

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INTRODUCTION

Helicobacter pylori (*H. pylori*) infection is widespread among human populations, including Iranian communities, and is considered to play a major role in the pathogenesis of several gastroduodenal diseases, including gastric ulcer, duodenal ulcer, gastric mucosa-associated lymphoid tissue (MALT) lymphoma, and distal gastric cancer. Previous seroepidemiologic studies indicated that about 50% of adults in developed countries and nearly 90% of adults in developing countries were positive for serum antibodies against *H. pylori* (1, 2).

Despite significant advances in the understanding of the biology of *H. pylori*, the factors that determine the outcome of infection are still poorly understood. The host factors might be important with regard to the outcome of infection by this organism, e.g., to explain why only a proportion of infected subjects develop peptic ulcers. In addition to host factors, bacterial factors seem to influence the inflammatory response and the development of a more severe pathology.

Early epidemiologic studies carried out before *H. pylori* identification found that non-secretors of the glycoprotein form of their ABO blood group antigens and persons of blood group O were overrepresented among patients with peptic ulcers (3). Consistent with these observations, some studies reported the relation of blood group O and *H. pylori* infection (4,5). Although *H. pylori* is also associated with development of gastric carcinoma, a significantly higher proportion of persons with blood group A has been reported among these patients (6). However, other studies failed to find an association between *H. pylori* infection and ABO blood groups (7, 8).

Regarding bacterial factors, cytotoxin associated antigen A (CagA) is thought to be the major *H. pylori* virulence factor involved in the pathogenesis of *H. pylori* diseases. CagA is produced by only a subset of *H. pylori* isolates, defined as *H. pylori* type I. Bacterial strains which do not express CagA are termed *H. pylori* type II. Type I *H. pylori* strains have been associated with the most severe gastroduodenal diseases in human (9). Because the acquisition of *H. pylori* seems to occur predominantly in childhood, this study was conducted to evaluate the prevalence of antibodies to *H. pylori* and its virulence factor CagA in asymptomatic healthy children and to investigate associations with age, sex, ABO blood groups and Rh status.

MATERIALS AND METHODS

Subjects

From August 2005 to December 2005, a cross-sectional seroprevalence study was carried out among healthy children in Rafsanjan (a city located in Kerman province, in South-East of Iran). Totally, 386 children were included in the study (187 males, 199 females; aged 1-15 years). Children were recruited from randomly selected schools and health centers. School students were randomly selected for blood samplings by their registration number and similar procedures were performed in health centers. Peripheral blood (2-3 ml) was collected from each participant at the time of interview. The blood samples were centrifuged and the sera were separated and frozen at 0001 20°C until analysis.

Informed consents were obtained from parents of all the children before blood samplings. Children were recruited if their parents agreed with the study and signed the informed consents. The study was evaluated and approved by the Ethical Committee of Rafsanjan University of Medical Sciences.

Determination of *H. pylori*-specific antibodies in serum

The serum levels of anti-*H. pylori* immunoglobulin G were measured by using the commercial enzyme-linked immunosorbent assay (ELISA) (Trinity Biotec, Ireland). The sensitivity of this method was previously estimated as >98% in Iranian children (10). According to the manufacturer's guidelines, the results were obtained as Immune Status Ratio (ISR) and values of ≥1.1 were considered positive. Serum levels of anti-CagA IgG were also assayed by ELISA method using commercial kits (Diagnostic Bioprobes, Italy). The serum concentrations of anti-CagA antibodies were expressed in arbitrary units per milliliter (Uarb/ml) as no International Standard is available. According to the manufacturer's guidelines, 5 Uarb/ml is used to discriminate the negative from positive samples. Moreover, in each group, the serum concentrations of anti-CagA antibody were expressed as mean ± SD.

Blood grouping

ABO blood groups and Rh phenotype evaluations were carried out by standard hemagglutination assays.

Statistical Analysis

Differences in variables were analyzed using Kruskal-Wallis, Mann-Whitney U test, chi-square and Fisher exact tests as appropriate and p-values of less than 0.05 were considered significant. All the available data were analyzed by a computer program (SPSS, Chicago, IL, USA).

RESULTS

The seroprevalence of *H. pylori*-specific antibodies according to age and sex are shown in Table 1. The overall seroprevalence of anti-*H. pylori* IgG in healthy children was 46.6%. The seropositivity rate in males was significantly higher than that observed in females ($p<0.05$) (Table 1). In *H. pylori*-infected children, the overall prevalence of serum anti-CagA IgG antibodies was 72.8% with mean titer of 64.1 Uarb/ml ± 67.63. Both the prevalence and the mean titer of serum anti-CagA IgG antibodies were higher in males compared to females, but the difference did not reach statistical significance (Table 1). As demonstrated in Table 1, the seroprevalence of both anti-*H. pylori* and anti-CagA antibodies increased with age; however, the mean titer of anti-CagA antibodies decreased with increasing age. In all age subgroups, the seroprevalence of *H. pylori*-specific antibodies and the magnitude of the IgG response to CagA were higher in males compared to females, although the differences were not statistically significant.

In the 386 randomly selected children, ABO blood groupings were performed and the results are shown in Table 2. According to data from the local Blood Transfusion Center, the local blood group distribution is consistent with results of this study. The seroprevalence of *H. pylori*-specific antibodies and the mean titer of anti-CagA antibodies according to ABO blood groups are demonstrated in Tables 2 and 3. The seroprevalence of *H. pylori* was lower in subjects with blood group O compared to other blood groups, although the difference did not reach statistical significance ($p=0.08$). Within blood group A, the seroprevalence of *H. pylori* was significantly higher in males compared to females ($p<0.05$; Table 3). The seroprevalence of *H. pylori* was also higher in males with blood group A compared to males with other blood groups, but the difference was not statistically significant ($p=0.07$; Table 3).

The seroprevalence of anti-CagA antibodies in *H. pylori*-infected children with blood groups A and O

Table 1. Seroprevalence of *H. pylori*-specific antibodies in children according to age and sex

Age group	Sex	Anti-*H. pylori* seropositivity	Anti-CagA seropositivity	Mean titer of anti-CagA (Uarb/ml)
1-5 years	Male	26 / 58 (44.8%)	16/26 (61.5%)	86.26 ± 104.1
	Female	21 / 67 (31.3%)	12/21 (57.1%)	63.17 ± 78.25
	Total	47 /125 (37.6%)	30/47 (63.8%)	75.94 ± 93.23
6-10 years	Male	29 / 59 (49.2%)	24/29 (82.8%)	64.77 ± 57.78
	Female	31 / 69 (44.9%)	21/31 (67.7%)	61.96 ± 62.23
	Total	60 /128 (46.9%)	45/60 (75%)	63.32 ± 59.63
11-15 years	Male	42 / 70 (60%)	36/42 (85.7%)	61.8 ± 50.97
	Female	31 / 63 (49.2%)	22/31 (64.5%)	50.76 ± 54.84
	Total	73 /133 (54.9%)	58/73 (79.45%)	57.11 ± 52.56
Total	Male	97 /187 (51.9%)	76/97 (78.4%)	69.24 ± 70.83
	Female	83 /199 (41.7%)	55/83 (66.3%)	58.08 ± 63.58
	Total	180 /386 (46.6%)	131/180 (72.8%)	64.1 ± 67.63

Table 2. Relationship of ABO blood groups and antibodies against *Helicobacter pylori* (anti-HP) and CagA in children

Blood group	Frequency	Serum anti-HP (+)	Serum anti-CagA (+)	Serum anti-CagA Concentration (Uarb/ml)	p*	p**
A	83 /386 (21.5%)	44/83 (53%)	34/44 (77.3%)	57.06*** ± 57.01	0.2	0.2
B	101 /386 (26.2%)	51/101 (50.5%)	34/51 (64.7%)	55.35 ± 61.67	0.3	0.5
AB	36 /386 (9.3%)	16/36 (44.4%)	10/16 (62.5%)	62.18 ± 57.23	0.7	0.5
O	166 /386 (43%)	69/166 (41.6%)	53/69 (76.8%)	75.5 ± 79.01	0.09	0.3
Total	386 /386 (100%)	180/386 (46.6%)	128/180 (71.1%)	64.1 ± 67.63	-	-

*Represents differences in seroprevalence of *H. pylori* between a particular blood group and other blood groups, **Represents differences in seroprevalence of anti-CagA antibody between a particular blood group and other blood groups, ***Serum anti-CagA antibody level expressed as mean ± SD

Table 3. Seroprevalence of antibodies against *Helicobacter pylori* (anti-HP) according to ABO blood groups and sex

Blood group	Sex	Serum anti-HP (+)	Serum anti-CagA (+)	Serum anti-CagA Concentration (Uarb/ml)	p*	p**
A	Male	28/ 44(63.6%)	25/ 28 (89.3%)	63.84 ± 55.23	0.07	0.05
	Female	16/ 39(41%)	9/ 16 (56.3%)	45.19 ± 59.91	0.9	
	Total	44/ 83(53%)	34/ 44 (77.3%)	57.06 ± 57.01	0.2	
B	Male	23/ 42(54.8%)	18/ 23 (78.3%)	64.55 ± 53.76	0.6	0.3
	Female	28/ 59(47.5%)	16/ 28 (57.1%)	47.8 ± 67.51	0.3	
	Total	51/101(50.5%)	34/ 51 (64.7%)	55.35 ± 61.67	0.3	
AB	Male	8/ 19(42.1%)	6/ 8 (75%)	71.31 ± 56.63	0.3	0.5
	Female	8/ 17(47.1%)	4/ 8 (50%)	53.05 ± 60.16	0.6	
	Total	16/ 36(44.4%)	10/ 16 (62.5%)	62.18 ± 57.23	0.7	
	Male	38/ 82(46.3%)	27/ 38 (71.1%)	75.63 ± 91.57	0.2	0.14
O	Female	31/ 84(36.9%)	26/ 31 (83.9%)	75.33 ± 61.71	0.2	
	Total	69/166(41.6%)	53/ 69 (76.8%)	75.5 ± 79.01	0.08	
Total	Male	97/187(51.9%)	76/ 97 (78.4%)	69.24 ± 70.83		
	Female	83/199(41.7%)	55/ 83 (66.3%)	58.08 ± 63.58	0.05	
	Total	180/386(46.6%)	131/180 (72.8%)	64.1 ± 67.63		

*Represents differences in seroprevalence of *H. pylori* in children of same gender between a particular blood group and other blood groups, **Represents differences in seroprevalence of *H. pylori* between males and females in a particular blood group

Table 4. Seroprevalence of antibodies against *Helicobacter pylori* (anti-HP) according to Rh blood groups and sex

Blood group	Sex	Serum anti-HP (+)	Serum anti-CagA (+)	Serum anti-CagA Concentration (Uarb/ml)	p*	p**
Rh+	Male	88/171(51.46%)	70/ 88(79.5%)	72.8 ± 72.7	0.07	0.03
	Female	75/184(40.76%)	49/ 75(65.3%)	55.25 ± 60.97	0.9	
	Total	163/355(45.9%)	119/163(73%)	64.72 ± 67.92	0.2	
Rh-	Male	9/ 16 (56.25%)	6/ 9(66.7%)	84.68 ± 84.68	0.6	0.3
	Female	8/ 15 (53.33)	6/ 8(75%)	34.48 ± 34.99	0.3	
	Total	17/ 31 (54.84%)	12/ 17(70.6%)	58.1 ± 66.45	0.3	

*Represents differences in seroprevalence of *H. pylori* in children of the same gender between a particular blood group and other blood groups, **Represents differences in seroprevalence of *H. pylori* between males and females in a particular blood group

was higher than that observed in other infected children, but the differences were not statistically significant. Within blood group A, the seroprevalence of anti-CagA antibody was significantly higher in infected males compared to infected females ($p<0.04$). In blood groups B, AB and O, the seroprevalence of anti-CagA antibody was higher in infected males compared to infected females, but the differences were not statistically significant.

The mean serum concentration of anti-CagA antibodies was higher in blood group O compared to the other blood groups, but the difference again did not reach significance (Table 3). The mean serum concentrations of anti-CagA antibodies were higher in *H. pylori*-infected males of blood groups A, B and AB as compared to infected females, but the differences were not significant.

The seroprevalence of *H. pylori*-specific antibodies and the mean titer of anti-CagA antibodies according to Rh status are shown in Table 4. There was also no significant association between Rh status and the prevalence of anti-*H. pylori* antibody. Moreover, the seroprevalence of anti-CagA antibodies and the mean serum concentration of anti-CagA antibodies were similarly expressed in Rh-positive and -negative children (Table 4).

DISCUSSION

H. pylori infection is thought to play an etiologic role in several gastroduodenal diseases. In epidemiological studies, serum tests could offer high sensitivity and specificity. Serum assaying of anti-*H. pylori* IgG or IgA antibodies could be used to determine prevalence of acute and chronic infections (11, 12). The results of the present study showed that the overall seroprevalence of *H. pylori* infection was 46.6% in healthy Iranian children aged 1-15 years from Rafsanjan, Iran. In different studies, the prevalence of *H. pylori* in children is variable, having been reported as 60% in those aged 4 years in Ethiopia (13), 7.5% in those aged 2-18 years in Czech (14), 44% in those aged 6

months to 17 years in Turkey (15), 8% in those aged 1-3 years and 24.5% in those aged 18-23 years in the United States (16), 50% in those aged 1-9 years and 80% in those aged 10-19 years in Libya (17), 56% in those aged 1-14 years in Brazil (18), 96% in those aged 1-14 years in Saudi Arabia (19) and 80% in those aged 1.5-5 years in Bangladesh (20). Moreover, it has been reported that almost all children in Gambia and Nigeria are infected by *H. pylori* at age of 5 years (21,22). On the other hand, Heuberger et al. (23) reported the prevalence of *H. pylori* infection among adolescents aged 15-16 years living in Switzerland. They found one of the lowest prevalences of *H. pylori* infection among adolescents in Europe (7.3%). This discrepancy may be attributed largely to differences including race, ethnic background and socioeconomic status, such as family income, size of the family, type of housing, location of housing, water supply, health and education level, and presence of pets (24-27). However, more studies need to identify the most common risk factors of *H. pylori* infection in Iranian children to develop the preventive strategies to interrupt the spread of the infection.

In the present study, it has been shown that the prevalence of *H. pylori* infection increased progressively and steeply with advanced age. This overall infection rate curve shared common patterns with other reports, although considerable differences exist between developing and developed countries (28).

The results of the present study showed that more than 72% of infected children had antibodies to CagA. The *cagA* has been identified as a possible marker of virulence of *H. pylori* (9). Since the cytotoxin-associated gene product (CagA, 120 to 140 kDa) encoded by *cagA* is immunodominant, serum IgG antibodies to the CagA antigen may be a reliable marker of carriage of a *cagA*$^+$ *H. pylori* strain (29, 30). The seroprevalence of anti-CagA antibody varies geographically. In other studies, the seroprevalence of anti-CagA antibody in *H. pylori*-infected asymptomatic children was evaluated, and was reported to be 56.7% at age 1-14 years in Saudi Arabia (16), 82% at age 1.5-5 years in Bangladesh (20), 46.9% at age 1-15 years in Mexico (31) and 88.5% and 81.3% at age 3-12 years in two counties of China (32).

In our previous study, the seroprevalence of anti-CagA antibody in asymptomatic adults from the same population was 60%, with mean titer of 48.1 Uarb/ml ± 29.2 (33). Interestingly, it seems that the prevalence and the magnitude of the IgG response to CagA were higher in children compared to adults. Accordingly, the age of the subjects may also influence the seropositivity rate and the titer of anti-CagA antibodies. However, in children, an inverse correlation was observed between the titer of anti-CagA antibody with increasing age. These observations are difficult to interpret; one possibility would be that at older ages the bacterial colonization may gradually shift from *cagA*-positive strains to *cagA*-negative strains, and accordingly, in some adult subjects *cagA*-positive strains may disappear.

Our results showed that the prevalence of anti-*H. pylori* antibody was significantly higher in males compared to females. Although results similar to ours were reported from other countries (34, 35), they were inconsistent with other findings recently reported in Iranian children from Tehran city, in which higher prevalence of *H. pylori* was determined in females compared to males (10). However, in some studies, no significant statistical differences were observed between sexes (36). Our results showed for the first time that the prevalence of anti-CagA was markedly higher in males compared to females. In our previous study, similar results were found in *H. pylori*-infected asymptomatic adults (33). Accordingly, it seems that the male gender is more susceptible to infection and colonization by *CagA*-positive strains of *H. pylori*. This differential susceptibility may be directly related to the long-term clinical outcome. It has been reported that the males are at a greater risk of *H. pylori* clinical manifestations (37, 38). These observations may account for the higher prevalence of duodenal ulcer and gastric cancer in males. More studies should be conducted to document that this differential susceptibility in males and females can cause the male preponderance to peptic ulcer disease and gastric cancer.

For many years, blood group O was reported to be associated with duodenal ulcer disease, while gastric ulcer and gastric carcinoma were associated with blood group A (2). Lin et al. (39) demonstrated the close relationship between *H. pylori* infection and blood group O in patients with gastroduodenal diseases in Central Taiwan. Although in some studies, blood group O was reported to be related to *H. pylori* infection, we found a weak negative association between *H. pylori* infection and blood group O. In our study, children with

blood group O were not vulnerable to *H. pylori* infection. The results of the present study are consistent with similar studies from other countries (7, 8). Accordingly, the association of blood group O and peptic ulcer may be due to some particular pathological effects in the blood group O background. It has been reported that the increased susceptibility of subjects with blood group O to peptic ulcer disease might be due to higher density of colonization by *H. pylori* and higher inflammatory responses (correlated with release of interleukin (IL)-6 and tumor necrosis factor (TNF-α) to *H. pylori* compared to colonization in persons with other blood groups. It has also been demonstrated that epithelial cells of persons with blood group O bound significantly more to *H. pylori* than cells of persons with other blood groups (40, 41).

The results of the present study showed a markedly positive association between blood group A and the prevalence of *H. pylori*–specific antibodies in male children. This may account for the higher prevalence of gastric carcinoma in subjects with blood group A or higher rate of peptic ulcer in the male gender (37, 38, 42, 43). More studies are needed to clarify that this can cause the preponderance of blood group A to develop gastric cancer. With respect to Rh status, the seroprevalence of *H. pylori*-specific antibodies was similarly expressed between positive- and negative-Rh phenotypes, thus representing no association between Rh status and *H. pylori* seroprevalence.

In the present study, we assessed for the first time the possible association between ABO blood groups and acquisition of *cagA*-positive strain of *H. pylori*. We found that the anti-CagA antibodies were more prevalent in *H. pylori*-infected children with blood groups A and O. In fact, the association of *cagA*-positive strain with blood groups A and O may partly increase the risk of gastric involvement in *H. pylori*-infected subjects with these blood groups and may provide an explanation of why these subjects more often develop gastrointestinal sequelae. Accordingly, blood groups A and O may be risk factors for acquiring of *cagA*-positive *H. pylori* strain.

In conclusion, our epidemiological study in healthy Iranian children demonstrated that the seroprevalence of *H. pylori* infection was 46.6%. Anti-CagA antibody was common in the children. The prevalences of anti-*H. pylori* and anti-CagA antibodies increased with age and were higher in males compared to females. An inverse correlation was observed between the mean titer of anti-CagA antibodies and older ages. Moreover, the prevalence of *H. pylori*-specific antibodies was not significantly different between ABO blood groups or Rh phenotypes, although ABO blood groups may partly influence the seroprevalence of antibody against *H. pylori* and *CagA*. In male gender, a positive association was found between blood group A and *H. pylori* infection. The anti-CagA antibody was also slightly more prevalent in infected children with blood groups A and O.

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