Relationship between active *Helicobacter pylori* infection and risk factors of cardiovascular diseases, a cross-sectional hospital-based study in a Sub-Saharan setting

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**Abstract**

**Background:** Chronic inflammation has been reported as one of the novel coronary heart disease (CHD) risk factors. Knowing that *Helicobacter pylori* (*H. pylori*) provokes a local inflammation, the relationship between *H. pylori* infection and cardiovascular disease (CVD) has received considerable attention. However, the attempt to demonstrate the association between *H. pylori* and specific cardiovascular disease risk factors is always a challenging issue due to the conflicting reports in the literatures.

**Methods:** We performed a cross-sectional study of 363 consecutive dyspeptic subjects in three reference health facilities in Cameroon from October 2020 to October 2021. Each participation gave a written consent and the study was approved by the local Ethical Committee. Check-up for cardiovascular disease (CVD) risk factors such as dyslipidemia-related parameters, obesity-related parameter, high blood pressure as well as *H. pylori* detection was done for each participant. Data was analyzed using SPSS statistical package.

**Results:** *Helicobacter pylori* infection was significantly associated with higher total cholesterol level (OR: 2.3324, \(p = 0.0002\)) and higher LDL cholesterol level (OR: 2.3096, \(p = 0.0006\)). The crude OR of *H. pylori* status on the prevalence of high body mass index (BMI) was 1.0813 (\(p = 0.7300\)) and the adjusted OR for confounding factors was 1.1785 (\(p = 0.5095\)). The strength of the association between *H. pylori* infection and blood pressure, shows an OR of 1.3807 (\(p = 0.2991\)), 1.0060 (\(p = 0.9855\)) and 1.4646 (\(p = 0.2694\)) for diastolic pressure, hypertension and high heart rate respectively, while that of systolic pressure was 0.8135 (\(p = 0.4952\)). *H. pylori* infection is associated with dyslipidemia in our milieu.

**Keywords:** Dyslipidemia, Hypertension, Overweight/obesity, Cardiovascular risk factors, *Helicobacter pylori* infection, Cameroon

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**Background**

Cardiovascular diseases (CVD) involves coronary heart disease or cerebrovascular disease [1]. They are the primary cause of death in the Western world [1]. Coronary heart disease is responsible for nearly 735,000 heart attacks [2]. It is estimated that 630,000 of people die for coronary disease each year in the U.S [2].
Cerebrovascular disease is related to atherothrombosis mechanism [1], whereas coronary heart disease occurs when the lumen of arteries that supply the heart has been reduced as a result of plaque builds up in their walls [2]. Because heart disease is widely found and sometimes progress to an ultimate and complex state without precursor’s signs, it is important to identify their associated risk factors. The more someone is exposed to these risk factors, the greater is its probability to acquire coronary heart disease (CHD) and heart attack. The American Heart Association recommends that attention should be pay in prevention of heart disease early in life. The sooner you assess and manage your risk factors, the higher your opportunity to live without heart attack.

Several risk factors of coronary heart disease and heart attack has been identified and reported in the literature [3]. These included high blood pressure (BP), high blood cholesterol levels, smoking, alcohol consumption, diabetes, overweight or obesity, lack of physical activity, unhealthy diet and stress known as modifiable traditional risk factors; getting older, male sex, being postmenopausal, family history of heart disease, and race which cannot be controlled. However, a great percentage of patients with CVD are without these traditional risks [4], suggesting that other factors may contribute in the development of this chronic disease. Chronic inflammation has been reported as one of the novel coronary heart disease (CHD) risk factors [5]. Chronic infection in general and undetected ones particularly has been incriminated as the cause of these inflammatory condition, emphasizing the implication of microorganisms that are commonly detectable in asymptomatic individuals in this chronic process [6]. The proposed mechanism by which these pathogen may lead to CVD included direct spoil of the vessel wall with local vascular inflammation as consequence [7], or indirect induction of endothelial dysfunction and dyslipidemia, resulting in CVD through systemic inflammation [8]. Helicobacter pylori is a Gram-negative bacterium that infects the gastric mucosa [9]. With nearly half of the world’s population been affected, Helicobacter pylori infection represents a significant health burden [10]. Despite the fact that a high proportion of infected individuals remains asymptomatic or displays rather minor unspecific symptoms [11], infection with this pathogen may lead to gastro-duodenal pathologies which ranges from mild gastritis to gastric adenocarcinoma [12] and have been associated in the pathogenesis of some extra gastrointestinal disorders [13, 14]. Mucosal damage induced by gastric Helicobacter pylori infection result both from the direct effects of bacterial virulence factors and as a consequence of the inflammatory response elicited by the bacterium [15]. Derya et al. in their study noticed that gastric mucosal IFN-ϒ, TNF-α, IL-6, IL-10, IL-17A mRNA genomic expressions were increased in H. pylori-infected chronic active gastritis compared with normal gastric mucosa groups [16]. The authors also noticed that the relative mRNA expressions of TNF-α, IL-6, IL-10, IL-17A, TGF-β were found to have a significant increase between gastric carcinoma and control patients [16]. H. pylori-specific gastric mucosal T cell responses are Th1 and Th17, with Th1 in the greatest amount [17, 18]. Th17 has demonstrated a significant contribution to the progression of autoimmune disease and inflammation in the gastrointestinal tract [19]. IL-17 is the main cytokine from Th17 cell and has many associated cytokines, such as IL-1β, IL-6, IL-21, and IL-23 [19]. IL-17 together with IL-21 and IL-23 plays a role in inflammation site formation, either directly or indirectly. The IL-17/IL-21 and IL-17/IL-23 axes have multiple inflammatory effect on epithelial, endothelial, and fibroblast cells [20, 21]. IL-21 increases proinflammatory cytokines released from macrophages, enhancing proliferation of lymphoid cells, and promoting B cell differentiation, whereas the expression of IL-23 in patients with H. pylori infection is elevated and positively correlates with the degree of neutrophils and monocyte infiltration [22].

Knowing that the vast majority of H. pylori infected individuals remains asymptomatic, that Helicobacter pylori provokes a local inflammation in almost all host [12], that this pathogen is implicated in extra digestive disorders, and that local and systemic inflammation by microbes and infectious agents is a cardiovascular disease risk factor [13, 14], the relationship between H. pylori infection and CVD has received considerable attention [23, 24].

However, results from the studies on the relationship between H. pylori infection and CVD are quite controversal. Some reports demonstrated a substantial higher prevalence of H. pylori infection in patients with previous history of CVD and supported a possible link between H. pylori infection and CVD development [25, 26]. In contrast, other reports showed that the seroprevalence of H. pylori infection in patients with previous CVD and supported a possible link between H. pylori infection and CVD development [25, 26]. In contrast, other reports showed that the seroprevalence of H. pylori was not associated with coronary artery disease and that H. pylori status did not determine the risk of CVD [27, 28].

If H. pylori is a possible contributor to cardiovascular disease (CVD) progression, this pathogen might directly or indirectly induces endothelial dysfunction leading to vascular inflammation and atherosclerosis or this pathogen by acting on traditional risk factors of CVD might probably induce atherosclerosis progression. Hence, earlier diagnosis and possibly eradication of H. pylori might be necessary for preventing atherosclerosis progression, especially in high-risk population for H. pylori infection. In Cameroon, H. pylori infection rate ranging from 92.2 to 64.34% respectively in the North-west and the Littoral
BMI (kg/m²): [Weight (kg)]/[Height (m)]². According to BMI value, participants were classified in 3 categories; normal (<25 kg/m²), overweight (25 to 30 kg/m²) and obese (>30 kg/m²) [33].

Assessment of heart dysfunction
Heart dysfunction was evaluated through blood pressure and heart rate measurement following the World Health Organization (WHO) guidelines [34]. These parameters were taken for each participant by trained technicians after resting for at least 5 min in a sitting position using an Omron® digital memory blood pressure monitor (Health Care Co Ltd, Kyoto, Japan). Hypertension was defined according to WHO/International Society of Hypertension guidelines as systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg [34]. Eligible subjects previously aware for their hypertension status were also considered as having hypertension. Patients were classified relative to heart rate into three groups; those having tachycardia (heart rate < 60 beats/min), those having bradycardia (heart rate > 100 beats/min) and those with normal heart rate (60 to 100 beats/min).

Assessment of dyslipidemia
About 5 ml of venous blood were collected in a dry tube from each subject and were used to determine the serum levels of total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C) and triglyceride (TG) using colorimetric methods (Biosystem Costa Brava, 3008030, Spain). The sensitivity of each test as detection limit was 4.4 mg/dl or 0.05 mmol/l for TG, 0.28 mg/dl or 0.007 mmol/l for LDL-C, 0.5 mg/dl or 0.01 mmol/l for HDL-C and 0.3 mg/dl or 0.008 mmol/l for TC. Total cholesterol value > 200 mg/dl was defined as hypercholesterolemia, LDL-cholesterol value > 130 mg/dl as high LDL cholesterol, triglycerides value > 150 mg/dl as hyper triglyceridaemia, and HDL-cholesterol value < 40 mg/dl as low HDL cholesterol.

Assessment of H. pylori infection
During Esophagastroduodenoscopy examinations (FOGD), biopsy samples were collected from the antrum, the fundus and the angulus for H. pylori detection. These specimens were fixed in formalin 10% and sent to anatomo-pathology laboratory for histologic analysis. Gastric biopsies were removed from formalin and inserted into an accessioned cassette. The cassette was placed into a tissue processing automate for dehydration, clearing and impregnation with liquid paraffin. The biopsy obtained at the end of this tissue processing step was embedded in paraffin, cut into fine sections using a microtome and then placed on glass slides. The slides were stained using Giemsa-stained for H. pylori detection. The results were scored blindly with the use of patients codes.

Subjects and methods
Study participants
This study included 363 subjects complaining for gastrointestinal disorders and who have undergone upper endoscopy with H. pylori detection using histological examination, and check-up for cardiovascular disease (CVD) risk factors such as high body mass index, high blood pressure, dyslipidemia at the Regional Hospital Bafoussam, General Hospital Yaounde and Cathedral Medical Centre Yaounde from October 2020 to October 2021. We employed a consecutive sampling for data collection, requesting consent from all volunteer patients in the selected health facilities who fulfilled the eligibility criteria for the study during the study period. To avoid confounding bias, we excluded possible confounding medical conditions known to be associated with the health outcome. The exclusion criteria were as follows: (1) patients with any gastrointestinal medications (Antibiotics for H. pylori eradication or proton pump inhibitors); (2) patients who frequently use non-steroidal anti-inflammatory drugs; (4) Pregnant and breastfeeding women; (4) patients under 15 years of age and (5) patients for whom endoscopic and blood sampling was not possible. Non-cooperative patients were also excluded.

Assessment of cardiovascular risk factors
Body mass index (BMI) determination
For each participant, height and weight were measured and used to calculated body mass index (BMI) as follows: BMI (kg/m²): [Weight (kg)]/[Height (m)]². According to BMI value, participants were classified in 3 categories; normal (<25 kg/m²), overweight (25 to 30 kg/m²) and obese (>30 kg/m²) [33].
Assessment of others variables

Information on sociodemographic and economic factors (age, sex, and income level), lifestyle (smoking, alcohol consumption, and physical activity), medication history (current and regular use of antibiotics, proton pump inhibitors (PPI) consumption, non-steroidal anti-inflammatory drugs (NSAIDs) consumption, antihypertensive medication), and personal medical history (hypertension status, diabetic status, family history of hypertension, family history of diabetes mellitus, and family history of obesity) were requested from the subjects in a semi-structured questionnaire.

Socioeconomic class or income level was stratified into low income (≤2500$/month), middle income (2500–8500$/month) and high income (>8500$/month) [10].

Regular exercise was defined as physical activity at least 30 min ≥ 3 days per week [35]. Smoking status was assessed as never smoker, former smoker, or current smoker. Current smoking was defined as having smoked at least one cigarette per day for more than half a year. Those who had smoked but stopped smoking for more than 1 month during the survey were defined as former smoking [35].

Current alcohol consumption referred to those who were drinking at least one time per week for more than half a year, former drinker referred to those who had previously consumed alcohol but stopped drinking for more than 6 months and never or occasionally (once or twice per month) [35].

Statistical analysis

Results from were expressed as means ± standard deviation, ratio or percentages. Student t-test were used to compare groups of continuous variables, the Fisher exact test or Chi-square test for categorical variables. The strength of the association between H. pylori status and risk factor of cardiovascular diseases was assessed by means of odd risks (ORs) with 95% confidence intervals (CIs) using univariable and multivariable logistic regression analyses. The variables used for the multivariable analysis included; sociodemographic and economic factors (age, sex, income level), life style (smoking status, alcohol consumption, physical activity), and personal medical histories (history of hypertension, history of diabetes mellitus, history of obesity) stratified respectively as model 1, 2, 3 multivariate logistic analysis and model 4 for the overall variable. A p-value < 0.05 was considered statistically significant. SPSS statistical package (Windows version 19.0) was used for analysis.

Results

Characteristics of the study population

A total of 363 consecutive dyspeptic subjects who underwent upper endoscopy in the Gastroenterology Department of the selected health facilities were included in this study. Out of the 363 subjects, 188 (51.79%) were women and 175 (48.21%) were men, their mean age was 47.53 ± 17.07 years and ranged from 15 to 97 years old. Participants were subdivided into five age group (≤20, 20–35, 35–50, 50–65 and > 65 years old) and the age group from 50 to 65 years the most represented (33.66%; 122/363). Fifty two percent of subjects (52.28%, 192/363) were from middle class with 2500–8500$/month, followed by 46.00% (167/363) from low income or poorly skilled class and 1.10% (4/363) from elite class with relatively high income (>8500$/month). Regarding smoking and alcohol consumption, participant were classified into non-smokers and non-drinkers because the number of former smokers or former drinkers were not representative in our sample population. Current smokers and drinkers frequency were 5.5% (20/363) and 23.41% (85/363) respectively in our population. Regular exercise was recorded in 42.42% (154/363) of subjects and among the 363 participants, 17.63% (64), 25.06% (91) and 16.80% (61) had a family history of hypertension, diabetes mellitus and obesity respectively (Table 1).

Distribution of cardiovascular risk factors in the study population

As far as risk of dyslipidemia-related variables are concerned, the mean value of total cholesterol, LDL cholesterol, HDL cholesterol and triglycerides were 215.38 ± 59.58 g/l (range 86–412 g/l), 110.02 ± 45.21 g/l (12.98–229.6 g/l), 51.79 ± 21.03 g/l (4.3–119 g/l) and 145.91 ± 61.94 (13.39–318) respectively among our sample population. Hypercholesterolemia (>200 g/l) was detected in 61.70% (224/363), high LDL cholesterol (>130 g/l) in 37.19% (135/363), low HDL cholesterol (<40 g/l) in 39.12% (142/363) and hyper-triglyceridemia in 44.07% (160/363) of the overall subjects. Regarding dyslipidemia in relation to socio-demographic, lifestyle and medical history of participants, individuals with family history of hypertension (OR: 2.162 (1.247–3.798), p = 0.0059) and those aged above 35 years old (X² = 12.9720, p = 0.0114) were more prone to hyper-cholesterolemia, those with middle or high level income were more prone to high LDL cholesterol (OR: 1.7401 (1.1330–2.6727), p = 0.0114) and men were more prone to low HLD cholesterol than women (OR: 1.6307 (1.0638–2.4956), p = 0.0248) (Table 2). Approximately 13% (12.94%, 47/363) of participants were with high blood pressure or hypertension
(blood pressure > 140/90 mmHg), 16.52% (60) and 15.15% (55) respectively with high diastolic blood pressure (> 90 mmHg) and systolic blood pressure (> 140/90 mmHg). High heart rate (> 100 beat/min) was detected in 13.22% (48/363) of patients (Table 3). The mean value of diastolic blood pressure, systolic blood pressure and heart rate was 77.024 ± 11.21 mmHg (range: 41–104 mmHg), 124.11 ± 19.29 mmHg (range: 80–191 mmHg) and 79.53 ± 12.10 beat/min (range: 45–114 beat/min) respectively. None of the evaluated sociodemographic, lifestyle and medical history parameters have a significant impact on blood pressure. However, individuals with history of obesity were with a high risk to have high heart rate than unexposed ones (OR: 2.5221 (1.2442–5.1124), p = 0.0103), (Table 3).

The mean value of the body mass index was 24.79 ± 4.03 kg/m² (16.30–37.6 kg/m²) in our sample population. Approximately forty percent (39.94%) of our sample population was with high body mass index, 31.12% for overweight and 8.81% for obesity. Examining high BMI with respect to sociodemographics, lifestyle and medical history, participants in age group above 20 years were significantly more prone to overweight/obesity than younger ones (OR: 7.2221 (1.6616–31.3910), p = 0.0084), (Table 4).

**H. pylori infection in the study population**

The prevalence of *H. pylori* in the study population was 65.94% (239/363); 63.83% (120/188) among women and 68.00% (119/175) among men, but the difference related to the gender was not significant (p = 0.4025). Rate of *H. pylori* infection with age was relatively constant in each age group (65.56 to 77.27%) except that of the group in the age range 20–35 years which was slightly low (54.16%), but with no significant difference (X² = 6.8206, p = 0.1457). Participants from the low and middle income groups were most affected by *H. pylori* infection compared to those from the high income group, but the different was not significant (X² = 3.4654, p = 0.1768).

Regarding lifestyle of participants, 65.00% and 64.71% of smokers and alcohol consumers versus 35.00% and 35.29% were *H. pylori* infected. However, the differences were not significant (p = 0.935 and 0.801 respectively), (Table 5).

**H. pylori infection and dyslipidemia**

Higher prevalence of each dyslipidemia marker in abnormal range was found among *H. pylori* positive individuals compared to *H. pylori* negative ones, with a significant difference regarding total cholesterol and LDL cholesterol levels (p = 0.0007 and 0.0024 respectively). In fact, 73.21% versus 26.79%, 77.04 versus 22.96%, 69.72 versus 30.28%, and 68.75 versus 31.25% of *H. pylori* positive subjects versus *H. pylori* negative ones were with hypercholesterolemia, high LDL, low HDL and high triglycerides respectively (Table 6).

In addition, *H. pylori* infected individuals compared to *H pylori* uninfected ones had a significantly higher mean value of total cholesterol concentration (223.2 ± 3.781 versus 200.2 ± 5.096 g/l, t = 3.562, p = 0.0004) and LDL concentration (116.6 ± 2.954 versus 97.26 ± 3.734 g/l, t = 3.459, p = 0.0006) and a marginal lower value of HDL (51.01 ± 1.366 versus 52.92 ± 1.912 g/l, t = 0.8027, p = 0.4227) and higher triglycerides concentration (146.2 ± 3.513 versus 142.5 ± 4.964, t = 0.6168, p = 0.5378), (Table 6).

### Table 1 Characteristics of the study population

| Variables                        | Number (%) |
|----------------------------------|------------|
| **Socio-demographic and economic** |            |
| Sex ratio (1/1.07)               |            |
| Female                           | 188 (51.79)|
| Male                             | 175 (48.20)|
| Age (years). Mean ± SD. [min–max] |            |
| ≤ 20                             | 22 (6.06)  |
| [20–35]                          | 72 (19.83) |
| [35–50]                          | 101 (27.82)|
| [50–65]                          | 122 (33.66)|
| > 65                             | 46 (12.67) |
| Income level ($/month)           |            |
| Unemployed or low class (≤ 2500) | 167 (46.00)|
| Middle class (2500–8500)         | 192 (52.89)|
| Elite (≥ 8500)                   | 4 (1.10)   |
| **Lifestyle**                    |            |
| Smoking                          |            |
| Yes                              | 20 (5.5)   |
| No                               | 343 (94.5) |
| Alcohol consumption              |            |
| Yes                              | 85 (23.41) |
| No                               | 278 (76.58)|
| Physical activity                |            |
| Yes                              | 154 (42.42)|
| No                               | 209 (57.58)|
| **Medical history**              |            |
| History of hypertension          |            |
| Yes                              | 64 (17.63) |
| No                               | 282 (77.68)|
| History of diabetes mellitus     |            |
| Yes                              | 91 (25.06) |
| No                               | 253 (69.69)|
| History of obesity               |            |
| Yes                              | 61 (16.80) |
| No                               | 284 (78.23)|

[Continued...]
Table 2  Distribution of dyslipidemia-related variables according to socio-economic, lifestyle and medical history factors

| Variable                        | N    | Present n (%) | Absent n (%) | OR (95% CI) [X^2] | p value |
|---------------------------------|------|---------------|--------------|-------------------|---------|
| Hyper total cholesterol         | 224  | 139           |              |                   |         |
| Age (years)                     |      |               |              |                   |         |
| ≤ 20                            | 22   | 12 (54.54)    | 10 (45.46)   | [12.9720]         | 0.0114* |
| [20–35]                         | 72   | 33 (45.83)    | 39 (54.17)   |                   |         |
| [35–50]                         | 101  | 63 (62.38)    | 38 (37.62)   |                   |         |
| [50–65]                         | 122  | 87 (73.31)    | 35 (26.69)   |                   |         |
| > 65                            | 46   | 29 (63.03)    | 17 (36.97)   |                   |         |
| Age ≤ 20                        |      |               |              |                   |         |
| Yes                             | 22   | 12 (54.55)    | 10 (45.45)   | 1.3695 (0.5753–3.2600) | 0.4773  |
| No                              | 341  | 212 (62.17)   | 129 (37.83)  |                   |         |
| Gender                          |      |               |              |                   |         |
| Female                          | 188  | 118 (62.77)   | 70 (37.23)   | 0.9113 (0.5967–1.3918) | 0.6673  |
| Male                            | 175  | 106 (60.57)   | 69 (39.43)   |                   |         |
| Income level                    |      |               |              |                   |         |
| Low                             | 167  | 105 (62.87)   | 62 (37.13)   | [2.3822]          | 0.3039  |
| Middle                          | 192  | 118 (65.25)   | 74 (34.75)   |                   |         |
| High                            | 4    | 1 (25.00)     | 3 (75.00)    |                   |         |
| Low income level                |      |               |              |                   |         |
| Yes                             | 152  | 95 (62.50)    | 57 (37.50)   | 0.8730 (0.5747–1.3263) | 0.5245  |
| No                              | 196  | 119 (60.71)   | 77 (39.29)   |                   |         |
| Alcohol consumption             |      |               |              |                   |         |
| Yes                             | 85   | 46 (54.12)    | 39 (45.88)   | 0.6626 (0.4052–1.0837) | 0.1011  |
| No                              | 278  | 178 (64.03)   | 100 (35.97)  |                   |         |
| Physical activity               |      |               |              |                   |         |
| Yes                             | 154  | 92 (59.74)    | 62 (40.26)   | 0.8656 (0.5645–1.3272) | 0.5081  |
| No                              | 209  | 132 (63.16)   | 77 (36.84)   |                   |         |
| History of hypertension         |      |               |              |                   |         |
| Yes                             | 64   | 34 (53.13)    | 30 (46.88)   | 2.162 (1.247–3.798) | 0.0059* |
| No                              | 282  | 97 (34.40)    | 185 (65.60)  |                   |         |
| History of diabetes mellitus    |      |               |              |                   |         |
| Yes                             | 91   | 58 (63.74)    | 33 (36.26)   | 1.0744 (0.6535–1.7662) | 0.7773  |
| No                              | 253  | 157 (62.06)   | 96 (37.94)   |                   |         |
| History of obesity              |      |               |              |                   |         |
| Yes                             | 61   | 44 (72.13)    | 17 (27.87)   | 1.6851 (0.9172–3.0956) | 0.0926  |
| No                              | 284  | 172 (60.56)   | 112 (39.44)  |                   |         |
| High LDL-C                      |      |               |              |                   |         |
| Age (years)                     |      |               |              |                   |         |
| ≤ 20                            | 22   | 14 (63.63)    | 8 (36.36)    | [2.9524]          | 0.5658  |
| [20–35]                         | 72   | 49 (68.05)    | 23 (31.94)   |                   |         |
| [35–50]                         | 101  | 62 (61.38)    | 39 (38.61)   |                   |         |
| [50–65]                         | 122  | 71 (58.20)    | 51 (41.81)   |                   |         |
| > 65                            | 46   | 32 (69.57)    | 14 (30.43)   |                   |         |
| Age ≤ 20                        |      |               |              |                   |         |
| Yes                             | 22   | 8 (36.36)     | 14 (63.64)   | 1.0384 (0.4239–2.5437) | 0.9343  |
| No                              | 341  | 127 (37.24)   | 214 (62.76)  |                   |         |
| Gender                          |      |               |              |                   |         |
| Female                          | 188  | 72 (38.30)    | 116 (61.70)  | 0.9063 (0.5918–1.3881) | 0.6511  |
| Male                            | 175  | 63 (36.00)    | 112 (64.00)  |                   |         |
| Variable                        | N    | Present n (%) | Absent n (%) | OR (95% CI) [X²] | p value |
|--------------------------------|------|---------------|--------------|------------------|---------|
| **Income level**               |      |               |              |                  |         |
| Low                            | 167  | 52 (31.14)    | 115 (68.86)  | [6.7140]         | 0.0348* |
| Middle                         | 192  | 80 (41.66)    | 112 (58.34)  |                  |         |
| High                           | 4    | 3 (75.00)     | 1 (25.00)    |                  |         |
| Low income level               |      |               |              |                  |         |
| Yes                            | 152  | 46 (30.26)    | 106 (69.74)  | 1.7401 (1.1330–2.6727) | 0.0114* |
| No                             | 196  | 83 (42.55)    | 113 (57.45)  |                  |         |
| **Smoking**                    |      |               |              |                  |         |
| Yes                            | 20   | 7 (35.00)     | 13 (65.00)   | 0.9055 (0.3522–2.3283) | 0.8368  |
| No                             | 343  | 128 (37.32)   | 215 (62.68)  |                  |         |
| **Alcohol consumption**        |      |               |              |                  |         |
| Yes                            | 85   | 31 (36.47)    | 54 (63.53)   | 0.9606 (0.5803–1.5901) | 0.8757  |
| No                             | 278  | 104 (37.41)   | 174 (62.59)  |                  |         |
| **Physical activity**          |      |               |              |                  |         |
| Yes                            | 154  | 55 (35.71)    | 99 (64.29)   | 0.8961 (0.5819–1.3799) | 0.6184  |
| No                             | 209  | 80 (38.28)    | 129 (61.72)  |                  |         |
| **History of hypertension**    |      |               |              |                  |         |
| Yes                            | 64   | 21 (32.81)    | 43 (67.19)   | 0.7413 (0.4177–1.3157) | 0.3064  |
| No                             | 282  | 112 (39.72)   | 170 (60.28)  |                  |         |
| **History of diabetes mellitus**|      |               |              |                  |         |
| Yes                            | 91   | 35 (38.46)    | 56 (61.54)   | 0.9885 (0.6042–1.3173) | 0.9634  |
| No                             | 253  | 98 (38.74)    | 155 (61.26)  |                  |         |
| **History of obesity**         |      |               |              |                  |         |
| Yes                            | 61   | 28 (45.90)    | 33 (54.10)   | 1.4248 (0.8155–2.4895) | 0.2137  |
| No                             | 284  | 106 (37.32)   | 178 (62.68)  |                  |         |
| Low HDL-C                      |      |               |              |                  |         |
| Age (years)                    |      |               |              |                  |         |
| ≤ 20                           | 22   | 9 (40.91)     | 13 (59.09)   | [0.3881]         | 0.9834  |
| [20–35]                        | 72   | 27 (37.50)    | 45 (62.5)    |                  |         |
| [35–50]                        | 101  | 39 (38.63)    | 62 (61.37)   |                  |         |
| [50–65]                        | 122  | 50 (40.98)    | 72 (59.02)   |                  |         |
| > 65                           | 46   | 17 (36.96)    | 29 (63.04)   |                  |         |
| Age ≤ 20                       |      |               |              |                  |         |
| Yes                            | 22   | 9 (40.91)     | 13 (59.09)   | 0.9231 (0.3839–2.2194) | 0.8581  |
| No                             | 341  | 133 (39.00)   | 208 (61.00)  |                  |         |
| Gender                         |      |               |              |                  |         |
| Male                           | 175  | 58 (33.14)    | 117 (66.86)  | 1.6307 (1.0638–2.4956) | 0.0248* |
| Female                         | 188  | 84 (44.68)    | 104 (55.32)  |                  |         |
| **Income level**               |      |               |              |                  |         |
| Low                            | 167  | 63 (37.72)    | 104 (62.27)  | [0.6540]         | 0.7211  |
| Middle                         | 192  | 78 (40.62)    | 114 (59.37)  |                  |         |
| High                           | 4    | 1 (25.00)     | 3 (75.00)    |                  |         |
| Low income level               |      |               |              |                  |         |
| Yes                            | 152  | 56 (36.84)    | 96 (63.16)   | 1.1154 (0.7348–1.6932) | 0.6079  |
| No                             | 196  | 79 (40.31)    | 117 (59.69)  |                  |         |
| Smoking                        |      |               |              |                  |         |
| Yes                            | 20   | 7 (35.00)     | 13 (65.00)   | 0.8296 (0.3228–2.1324) | 0.6982  |
| No                             | 343  | 135 (39.36)   | 208 (60.64)  |                  |         |
| Alcohol consumption            |      |               |              |                  |         |
| Yes                            | 85   | 31 (36.47)    | 54 (63.53)   | 0.8637 (0.5225–1.4278) | 0.5678  |
| No                             | 278  | 111 (39.93)   | 167 (60.07)  |                  |         |
| Variable                      | N  | Present n (%) | Absent n (%) | OR (95% CI) [X²] | p value |
|-------------------------------|----|---------------|--------------|------------------|---------|
| Physical activity             |    |               |              |                  |         |
| Yes                          | 154| 58 (37.66)    | 96 (62.34)   | 0.8993 (0.5865–1.3788) | 0.6263  |
| No                           | 209| 84 (40.19)    | 125 (59.81)  |                  |         |
| History of hypertension      |    |               |              |                  |         |
| Yes                          | 64 | 26 (40.63)    | 38 (59.38)   | 1.0864 (0.6247–1.8895) | 0.7691  |
| No                           | 282| 109 (38.65)   | 173 (61.35)  |                  |         |
| History of diabetes mellitus |    |               |              |                  |         |
| Yes                          | 91 | 31 (34.07)    | 60 (65.93)   | 0.7649 (0.4634–1.2624) | 0.2944  |
| No                           | 253| 102 (40.32)   | 151 (59.68)  |                  |         |
| History of obesity           |    |               |              |                  |         |
| Yes                          | 61 | 20 (32.79)    | 41 (67.21)   | 0.7274 (0.4053–1.3056) | 0.2862  |
| No                           | 284| 114 (40.14)   | 170 (59.86)  |                  |         |
| High TG                      |    |               |              |                  |         |
| Age (years)                  |    |               |              |                  |         |
| ≤ 20                         | 22 | 9 (40.91)     | 13 (59.09)   | [4.3294]         | 0.3633  |
| [20–35]                      | 72 | 26 (36.13)    | 46 (63.87)   |                  |         |
| [35–50]                      | 101| 42 (41.59)    | 59 (58.41)   |                  |         |
| [50–65]                      | 122| 59 (48.36)    | 63 (51.64)   |                  |         |
| > 65                         | 46 | 24 (52.17)    | 22 (47.83)   |                  |         |
| Age ≤ 20                     |    |               |              |                  |         |
| Yes                          | 22 | 9 (5.56)      | 13 (6.40)    | 1.1466 (0.4774–2.7541) | 0.7596  |
| No                           | 341| 151 (94.37)   | 190 (93.56)  |                  |         |
| Gender                       |    |               |              |                  |         |
| Female                       | 188| 81 (43.09)    | 107 (56.91)  | 1.0871 (0.7181–1.6457) | 0.6932  |
| Male                         | 175| 79 (45.14)    | 96 (54.86)   |                  |         |
| Income level                 |    |               |              |                  |         |
| Low                          | 167| 68 (40.72)    | 99 (59.28)   | [1.4309]         | 0.4890  |
| Middle                       | 192| 90 (46.87)    | 102 (53.13)  |                  |         |
| High                         | 4  | 2 (50.00)     | 2 (50.00)    |                  |         |
| Low income level             |    |               |              |                  |         |
| Yes                          | 152| 63 (41.45)    | 89 (58.55)   | 1.2392 (0.8224–1.8671) | 0.3053  |
| No                           | 196| 92 (46.94)    | 104 (53.06)  |                  |         |
| Smoking                      |    |               |              |                  |         |
| Yes                          | 20 | 12 (60.00)    | 8 (40.00)    | 1.9764 (0.7878–4.9580) | 0.1466  |
| No                           | 343| 148 (43.15)   | 195 (56.85)  |                  |         |
| Alcohol consumption          |    |               |              |                  |         |
| Yes                          | 85 | 42 (49.41)    | 43 (50.59)   | 1.3244 (0.8136–2.1558) | 0.2584  |
| No                           | 278| 118 (42.45)   | 160 (57.55)  |                  |         |
| Physical activity            |    |               |              |                  |         |
| Yes                          | 154| 69 (44.81)    | 85 (55.19)   | 1.0526 (0.6923–1.6006) | 0.8104  |
| No                           | 209| 91 (43.54)    | 118 (56.46)  |                  |         |
| History of hypertension      |    |               |              |                  |         |
| Yes                          | 64 | 31 (48.44)    | 33 (51.56)   | 1.1979 (0.6955–2.0633) | 0.5150  |
| No                           | 282| 124 (43.97)   | 158 (56.03)  |                  |         |
| History of diabetes mellitus |    |               |              |                  |         |
| Yes                          | 91 | 44 (48.35)    | 47 (51.65)   | 1.1983 (0.7413–1.9371) | 0.4604  |
| No                           | 253| 111 (43.87)   | 142 (56.13)  |                  |         |
| History of obesity           |    |               |              |                  |         |
| Yes                          | 61 | 25 (40.98)    | 36 (59.02)   | 0.8111 (0.4628–1.4214) | 0.4645  |
| No                           | 284| 131 (46.13)   | 153 (53.87)  |                  |         |

LDL-C: Low-density lipoprotein cholesterol; HDL-C: High density lipoprotein cholesterol; TG: Triglycerides; N: Number; X²: Chi square; (95% CI): 95% confidence intervals; OR: Odd ratio; Bold value with *: Significant., Chi-square value are in []
### Table 3: Distribution of high blood pressure and high heart rate according to socio-economic, lifestyle and medical history factors

| Variable                        | N   | Present n(%) | Absent n(%) | OR (95% CI)     | p value |
|---------------------------------|-----|--------------|-------------|-----------------|---------|
| High diastolic pressure         |     |              |             |                 |         |
| Age (years)                     |     |              |             |                 |         |
| ≤ 20                            | 22  | 4 (18.18)    | 18 (81.82)  | [9.0621]        | 0.0596  |
| [20–35]                         | 72  | 5 (6.94)     | 67 (93.06)  | [ ]             |         |
| [35–50]                         | 101 | 19 (18.81)   | 82 (81.19)  | [ ]             |         |
| [50–65]                         | 122 | 27 (22.13)   | 95 (77.87)  | [ ]             |         |
| > 65                            | 46  | 5 (10.87)    | 41 (89.13)  | [ ]             |         |
| Age ≤ 20                        |     |              |             |                 |         |
| Yes                             | 22  | 4 (18.18)    | 18 (81.82)  | 0.8842 (0.2883–2.7117) | 0.8296 |
| No                              | 341 | 56 (16.42)   | 285 (83.58) | [ ]             |         |
| Gender                          |     |              |             |                 |         |
| Female                          | 188 | 31 (16.49)   | 157 (83.51) | 1.0060 (0.5779–1.7510) | 0.9832 |
| Male                            | 175 | 29 (16.57)   | 146 (83.43) | [ ]             |         |
| Income level                    |     |              |             |                 |         |
| Low                             | 167 | 31 (18.56)   | 136 (81.44) | [1.5753]        | 0.4549  |
| Middle                          | 192 | 29 (15.11)   | 163 (84.89) | [ ]             |         |
| High                            | 4   | 0 (0.00)     | 4 (100.00)  | [ ]             |         |
| Low income level                |     |              |             |                 |         |
| Yes                             | 152 | 28 (18.42)   | 124 (81.58) | 0.7443 (0.4290–1.2912) | 0.2934 |
| No                              | 196 | 29 (14.80)   | 167 (85.20) | [ ]             |         |
| Smoking                         |     |              |             |                 |         |
| Yes                             | 20  | 5 (25.00)    | 15 (75.00)  | 1.7490 (0.6109–5.0077) | 0.2976 |
| No                              | 343 | 55 (16.03)   | 288 (83.97) | [ ]             |         |
| Alcohol consumption             |     |              |             |                 |         |
| Yes                             | 85  | 17 (20.00)   | 68 (80.00)  | 1.3664 (0.7329–2.5477) | 0.3260 |
| No                              | 278 | 43 (15.47)   | 235 (84.53) | [ ]             |         |
| Physical activity               |     |              |             |                 |         |
| Yes                             | 154 | 23 (14.94)   | 131 (85.06) | 0.8162 (0.4625–1.4402) | 0.4833 |
| No                              | 209 | 37 (17.70)   | 172 (82.30) | [ ]             |         |
| History of hypertension         |     |              |             |                 |         |
| Yes                             | 64  | 11 (17.19)   | 53 (82.81)  | 1.0657 (0.5177–2.1937) | 0.8629 |
| No                              | 282 | 46 (16.31)   | 236 (83.69) | [ ]             |         |
| History of diabetes mellitus    |     |              |             |                 |         |
| Yes                             | 91  | 14 (15.38)   | 77 (84.62)  | 0.9134 (0.4727–1.7651) | 0.7876 |
| No                              | 253 | 42 (16.60)   | 211 (83.40) | [ ]             |         |
| History of obesity              |     |              |             |                 |         |
| Yes                             | 61  | 10 (16.39)   | 51 (83.61)  | 1.0145 (0.4803–2.1429) | 0.9698 |
| No                              | 284 | 46 (16.20)   | 238 (83.80) | [ ]             |         |
| High systolic pressure          |     |              |             |                 |         |
| Age (years)                     |     |              |             |                 |         |
| ≤ 20                            | 22  | 2 (9.09)     | 20 (90.91)  | [6.1702]        | 0.1868  |
| [20–35]                         | 72  | 7 (9.72)     | 65 (90.28)  | [ ]             |         |
| [35–50]                         | 101 | 14 (13.86)   | 87 (72.28)  | [ ]             |         |
| [50–65]                         | 122 | 26 (21.31)   | 96 (78.69)  | [ ]             |         |
| > 65                            | 46  | 6 (13.04)    | 40 (86.96)  | [ ]             |         |
| Age ≤ 20                        |     |              |             |                 |         |
| Yes                             | 22  | 2 (9.09)     | 20 (90.91)  | 1.8403 (0.4178–8.1066) | 0.4201 |
| No                              | 341 | 53 (15.54)   | 288 (84.46) | [ ]             |         |
Table 3 (continued)

| Variable                        | N    | Present n(%) | Absent n(%) | OR (95% CI)       | p value  |
|---------------------------------|------|--------------|-------------|-------------------|----------|
| Gender                          |      |              |             |                   |          |
| Female                          | 188  | 27 (14.36)   | 161 (85.64) | 1.1358 (0.6398–2.0164) | 0.6637   |
| Male                            | 175  | 28 (16.00)   | 147 (84.00) |                   |          |
| Income level                    |      |              |             |                   |          |
| Low                             | 167  | 27 (16.17)   | 140 (83.83) | [0.8966]          | 0.6387   |
| Middle                          | 192  | 28 (14.58)   | 164 (85.42) |                   |          |
| High                            | 4    | 0 (0.00)     | 4 (100.00)  |                   |          |
| Low income level                |      |              |             |                   |          |
| Yes                             | 152  | 25 (16.45)   | 127 (83.55) | 0.8148 (0.4626–1.4352) | 0.4784   |
| No                              | 196  | 28 (14.29)   | 168 (85.71) |                   |          |
| Smoking                         |      |              |             |                   |          |
| Yes                             | 20   | 4 (20.00)    | 16 (80.00)  | 1.4321 (0.4602–4.4561) | 0.5352   |
| No                              | 343  | 51 (14.87)   | 292 (85.13) |                   |          |
| Alcohol consumption             |      |              |             |                   |          |
| Yes                             | 85   | 14 (16.47)   | 71 (83.53)  | 1.1398 (0.5879–2.2100) | 0.6985   |
| No                              | 278  | 41 (14.75)   | 237 (85.25) |                   |          |
| Physical activity               |      |              |             |                   |          |
| Yes                             | 154  | 25 (16.23)   | 129 (83.77) | 1.1563 (0.6494–2.0591) | 0.6217   |
| No                              | 209  | 30 (14.35)   | 179 (85.65) |                   |          |
| History of hypertension         |      |              |             |                   |          |
| Yes                             | 64   | 12 (18.75)   | 52 (81.25)  | 1.4383 (0.7051–2.9339) | 0.3177   |
| No                              | 282  | 39 (13.83)   | 243 (86.17) |                   |          |
| History of diabetes mellitus    |      |              |             |                   |          |
| Yes                             | 91   | 16 (17.58)   | 75 (82.42)  | 1.4225 (0.7411–2.7303) | 0.2895   |
| No                              | 253  | 33 (13.04)   | 220 (86.96) |                   |          |
| History of obesity              |      |              |             |                   |          |
| Yes                             | 61   | 8 (13.11)    | 53 (86.89)  | 0.8946 (0.3965–2.0185) | 0.7885   |
| No                              | 284  | 41 (14.44)   | 243 (85.56) |                   |          |
| High blood pressure             |      |              |             |                   |          |
| Age (years)                     |      |              |             |                   |          |
| ≤ 20                            | 22   | 2 (9.09)     | 20 (90.91)  | [8.3676]          | 0.0790   |
| [20–35]                         | 72   | 4 (5.56)     | 68 (94.44)  |                   |          |
| [35–50]                         | 101  | 14 (13.86)   | 87 (86.14)  |                   |          |
| [50–65]                         | 122  | 23 (18.85)   | 99 (81.15)  |                   |          |
| > 65                            | 46   | 4 (8.70)     | 42 (91.30)  |                   |          |
| Age ≤ 20                        |      |              |             |                   |          |
| Yes                             | 22   | 2 (9.09)     | 20 (90.91)  | 1.5184 (0.3435–6.7126) | 0.5818   |
| No                              | 341  | 45 (13.20)   | 296 (86.80) |                   |          |
| Gender                          |      |              |             |                   |          |
| Female                          | 188  | 23 (12.23)   | 165 (87.77) | 1.1402 (0.6177–2.1049) | 0.6748   |
| Male                            | 175  | 24 (13.71)   | 151 (86.29) |                   |          |
| Income level                    |      |              |             |                   |          |
| Low                             | 167  | 23 (13.77)   | 144 (86.23) | [0.7299]          | 0.6942   |
| Middle                          | 192  | 24 (12.5)    | 168 (87.5)  |                   |          |
| High                            | 4    | 0 (0.00)     | 4 (100.00)  |                   |          |
| Low income level                |      |              |             |                   |          |
| Yes                             | 152  | 21 (13.82)   | 131 (86.18) | 0.8372 (0.4568–1.5345) | 0.5654   |
| No                              | 196  | 24 (12.24)   | 172 (87.76) |                   |          |
| Variable | N   | Present n(%) | Absent n(%) | OR (95% CI)        | p value |
|----------|-----|--------------|-------------|-------------------|---------|
| Smoking  |     |              |             |                   |         |
| Yes      | 20  | 3 (15.00)    | 17 (85.00)  | 1.1992 (0.3376–4.2597) | 0.7787  |
| No       | 343 | 44 (12.83)   | 299 (87.17) |                   |         |
| Alcohol consumption |     | | | | |
| Yes      | 85  | 12 (14.12)   | 73 (85.88)  | 1.1413 (0.5634–2.3119) | 0.7136  |
| No       | 278 | 35 (12.59)   | 243 (87.41) |                   |         |
| Physical activity |     | | | | |
| Yes      | 154 | 22 (14.29)   | 132 (85.71) | 1.2267 (0.6632–2.2690) | 0.5150  |
| No       | 209 | 25 (11.96)   | 184 (88.04) |                   |         |
| History of hypertension |     | | | | |
| Yes      | 64  | 11 (17.19)   | 53 (82.81)  | 1.5147 (0.7215–3.1799) | 0.2725  |
| No       | 282 | 34 (12.06)   | 248 (87.94) |                   |         |
| History of diabetes mellitus |     | | | | |
| Yes      | 91  | 13 (14.29)   | 78 (85.71)  | 1.1936 (0.5944–2.3966) | 0.6188  |
| No       | 253 | 31 (12.25)   | 222 (87.75) |                   |         |
| History of obesity |     | | | | |
| Yes      | 61  | 6 (9.84)     | 55 (90.16)  | 0.7284 (0.2930–1.8109) | 0.4953  |
| No       | 284 | 37 (13.03)   | 247 (86.97) |                   |         |
| High heart rate |     | | | | |
| N        | 48  |              | 315         |                   |         |
| Age (years) |     | | | | |
| ≤ 20     | 22  | 3 (13.64)    | 19 (86.36)  | [1.7282]          | 0.7856  |
| [20–35]  | 72  | 8 (11.11)    | 64 (88.89)  |                   |         |
| [35–50]  | 101 | 14 (13.86)   | 87 (86.14)  |                   |         |
| [50–65]  | 122 | 19 (15.57)   | 103 (84.43) |                   |         |
| > 65     | 46  | 4 (8.7)      | 42 (91.30)  |                   |         |
| Age ≤ 20 |     | | | | |
| Yes      | 22  | 3 (13.64)    | 19 (86.36)  | 0.9624 (0.2738–3.3833) | 0.9523  |
| No       | 341 | 45 (13.20)   | 296 (86.80) |                   |         |
| Gender   |     | | | | |
| Female   | 188 | 28 (14.89)   | 160 (85.11) | 0.7373 (0.3987–1.3636) | 0.3314  |
| Male     | 175 | 20 (11.43)   | 155 (88.57) |                   |         |
| Income level |     | | | | |
| Low      | 167 | 22 (13.17)   | 145 (86.83) | [0.6269]          | 0.7309  |
| Middle   | 192 | 26 (13.54)   | 166 (86.46) |                   |         |
| High     | 4   | 0 (0.00)     | 4 (100.00)  |                   |         |
| Low income level |     | | | | |
| Yes      | 152 | 19 (12.50)   | 133 (87.50) | 1.0133 (0.5530–1.8566) | 0.9660  |
| No       | 196 | 26 (13.27)   | 170 (86.73) |                   |         |
| Smoking  |     | | | | |
| Yes      | 20  | 1 (5.00)     | 19 (95.00)  | 0.3318 (0.0434–2.5349) | 0.2876  |
| No       | 343 | 47 (13.70)   | 296 (86.30) |                   |         |
| Alcohol consumption |     | | | | |
| Yes      | 85  | 10 (11.76)   | 75 (88.24)  | 0.8421 (0.4005–1.7708) | 0.6505  |
| No       | 278 | 38 (13.67)   | 240 (86.33) |                   |         |
| Physical activity |     | | | | |
| Yes      | 154 | 19 (12.34)   | 135 (87.66) | 0.8736 (0.4699–1.6239) | 0.6692  |
| No       | 209 | 29 (13.88)   | 180 (86.12) |                   |         |
Table 3 (continued)

| Variable                        | N  | Present n(%) | Absent n(%) | OR (95% CI) | p value |
|---------------------------------|----|--------------|-------------|-------------|---------|
| History of hypertension         |    |              |             |             |         |
| Yes                             | 64 | 9 (14.06)    | 55 (85.94)  | 1.0851 (0.4951–2.3781) | 0.8383  |
| No                              | 282| 37 (13.12)   | 245 (86.88) |             |         |
| History of diabetes mellitus    |    |              |             |             |         |
| Yes                             | 91 | 10 (10.99)   | 81 (89.01)  | 0.7690 (0.3641–1.6241) | 0.4911  |
| No                              | 253| 35 (13.83)   | 218 (86.17) |             |         |
| History of obesity              |    |              |             |             |         |
| Yes                             | 61 | 14 (22.95)   | 47 (77.05)  | 2.5221 (1.2442–5.1124) | 0.0103* |
| No                              | 284| 30 (10.56)   | 254 (89.44) |             |         |

N. n: Number; (95% CI): 95% confidence intervals; OR: Odd ratio; Bold value with *: Significant., Chi-square value are in [ ]

The strength of the association of *H. pylori* infection and each dyslipidemia’s marker were analyzed by determining the OR and the corresponding 95% CI value. Our results show that compared to *H. pylori* negative patients, the OR of *H. pylori* status on the prevalence of hypercholesterolemia, high LDL, low HDL and high triglycerides were 2.3324 (95% CI 1.4935–3.6423, p = 0.0002), 2.3096 (95% CI 1.4289–3.7331, p = 0.0006), 1.3321 (95% CI 0.8489–2.0902, p = 0.2123) and 1.2620 (95% CI 0.8129–1.9592, p = 0.2327) respectively. We also adjusted for confounding factors (age, sex, income in model 1; smoking, alcohol consumption, physical activity in model 2; family histories of hypertension, diabetes mellitus and obesity in model 3 and the overall confounders in model 4) in the logistic regression and a similar results was noticed (OR: 2.5944 (95% CI 1.5766–4.2692, p = 0.0002); OR: 2.6794 (95% CI 1.5839–4.5328, p = 0.0002); OR: 1.4103 (95% CI 0.8588–2.3160, p = 0.1743); and OR: 1.1116 (95% CI 0.6918–1.7861, p = 0.6620 respectively in model 4), (Table 7).

**H. pylori** infection and heart dysfunction

Regarding heart dysfunction, high diastolic blood pressure, high systolic blood pressure and hypertension were commonly found in *H. pylori* infected individuals compared to non-infected ones. But the difference was not significant ($X^2$: 1.10, p = 0.576; $X^2$: 2.2252, p = 0.3287; $X^2$: 0.0003, p = 0.9855 respectively). Also, higher heart rate was frequent among infected individuals compared to uninfected ones, but with a non-significant difference ($X^2$: 1.235, p = 0.5394).

Concerning the mean value of heart dysfunction markers, a similar mean value of diastolic pressure (77.18 ± 0.7757 versus 77.35 ± 0.925 mmHg), a lower mean value of systolic pressure (121.7 ± 1.284 versus 137 ± 12.3 mmHg) and a higher mean heart rate value (80.00 ± 0.8606 versus 78.56 ± 1.12 beat/min) were noticed in *H. pylori* infected patients compared to non-infected ones, but with non-significant differences ($t$ = 0.1324, p = 0.8947; $t$ = 1.732, p = 0.0841; $t$ = 0.9968, p = 0.3195 respectively), (Table 6).

The strength of the association between *H. pylori* infection and heart dysfunction, shows an OR of 1.3807 (95% CI 0.7510–2.5384, p = 0.2991), 1.0060 (95% CI 0.5270–1.9204, p = 0.9855) and 1.4646 (95% CI 0.7441–2.8829, p = 0.2694) for diastolic pressure, hypertension and high heart rate respectively among *H. pylori* infected patients compared with uninfected ones, while that of systolic pressure was 0.8135 (95% CI 0.4495–1.4723, p = 0.4952). This relation persist even when adjusted with confounders in model 1, 2, 3 and 4) with the OR of 1.6772 (0.8404–3.3474, p = 0.1424); 1.0866 (0.5292–2.2310, p = 0.8210); 1.3765 (0.6460–2.9330, p = 0.4077) and 0.9589 (0.4900–1.8764, p = 0.9024) respectively regarding model 4, (Table 7).

**H. pylori** and overweigh/obesity

High body mass index were commonly found among *H. pylori* positive subjects. In fact, 67.26% versus 32.74% of individuals with overweight and 65.62% versus 34.38% of obese individuals were *H. pylori* infected. However the difference was non-significant compared to subjects with normal weight ($X^2$: 0.1493, p = 0.9281). Regarding BMI mean value according to *H. pylori* status, a slightly higher and non-significant BMI mean value was recorded among *H. pylori* infected individuals compared with uninfected ones (24.84 ± 0.2515 versus 24.7 ± 0.3862 kg/m², t = 0.3146, p = 0.7609), (Table 6).

The strength of the association between *H. pylori* infection and high BMI was analyzed by determining the OR and the corresponding 95% IC value. Our results show that compared to *H. pylori* negative patients, the crude OR of *H. pylori* status on the prevalence of high BMI was 1.0813 (95% CI 0.6936–1.6859, p = 0.7300) and the adjusted OR for confounding factors in model 4 using the
logistic regression was 1.1785 (95% CI 0.7234–1.9201, \( p = 0.5095 \)), (Table 7).

**Discussion**

In this cross-sectional study of dyspeptic patients who underwent upper endoscopy with *H. pylori* detection in three health facilities in Cameroon, we investigated the association of *H. pylori* infection and risk factors for cardiovascular disease (that is dyslipidemia, high blood pressure and heart rate, high body mass index). We also evaluated the impact of potential confounders such as socio-economic parameters, lifestyle and medical histories on this association.

Our results showed that *H. pylori* infected individuals were more at risk of hypercholesterolemia, high LDL cholesterol, low HDL cholesterol and high triglycerides levels, with a significant difference regarding the proportion of infected subjects with hypercholesterolemia.

Table 4 Distribution of high BMI according to socio-economic, lifestyle and medical history parameters

| Variable                  | N   | Present n (%) | Absent n (%) | OR (95% CI)       | p value  |
|---------------------------|-----|---------------|--------------|-------------------|----------|
| High BMI                  | 145 | 218           |              |                   |          |
| Age (years)               |     |               |              |                   |          |
| \( \leq 20 \)             | 22  | 1 (9.09)      | 20 (90.91)   | [19.2034]         | 0.0007*  |
| [20–35]                   | 72  | 19 (26.39)    | 53 (73.61)   |                   |          |
| [35–50]                   | 101 | 46 (45.54)    | 55 (54.46)   |                   |          |
| [50–65]                   | 122 | 59 (48.36)    | 63 (51.64)   |                   |          |
| > 65                      | 46  | 19 (41.30)    | 27 (58.70)   |                   |          |
| Age \( \leq 20 \)         |     |               |              |                   |          |
| Yes                       | 22  | 2 (9.09)      | 20 (90.91)   | 7.2221 (1.6616–31.3910) | 0.0084*  |
| No                        | 341 | 143 (41.94)   | 198 (58.06)  |                   |          |
| Gender                    |     |               |              |                   |          |
| Female                    | 188 | 81 (43.09)    | 107 (56.91)  | 0.7617 (0.4995–1.1613) | 0.2059   |
| Male                      | 175 | 64 (36.57)    | 111 (63.43)  |                   |          |
| Income level              |     |               |              |                   |          |
| Low                       | 167 | 59 (35.33)    | 108 (64.67)  | [2.8105]          | 0.2453   |
| Middle                    | 192 | 84 (43.75)    | 108 (56.25)  |                   |          |
| High                      | 4   | 2 (50.00)     | 2 (50.00)    |                   |          |
| Low income level          |     |               |              |                   |          |
| Yes                       | 152 | 57 (37.50)    | 95 (62.50)   | 1.2956 (0.8558–1.9616) | 0.2210   |
| No                        | 196 | 86 (43.88)    | 110 (56.12)  |                   |          |
| Smoking                   |     |               |              |                   |          |
| Yes                       | 20  | 4 (20.00)     | 16 (80.00)   | 0.3582 (0.1173–1.0939) | 0.0715   |
| No                        | 343 | 141 (41.11)   | 202 (58.89)  |                   |          |
| Alcohol consumption       |     |               |              |                   |          |
| Yes                       | 85  | 38 (44.71)    | 47 (55.29)   | 1.2921 (0.7907–2.1115) | 0.3064   |
| No                        | 278 | 107 (38.49)   | 171 (61.51)  |                   |          |
| Physical activity         |     |               |              |                   |          |
| Yes                       | 154 | 57 (37.01)    | 97 (62.99)   | 0.8080 (0.5271–1.2385) | 0.3279   |
| No                        | 209 | 88 (42.11)    | 121 (57.89)  |                   |          |
| History of hypertension   |     |               |              |                   |          |
| Yes                       | 64  | 29 (45.31)    | 35 (54.69)   | 1.3151 (0.7607–2.2735) | 0.3268   |
| No                        | 282 | 109 (38.65)   | 173 (61.35)  |                   |          |
| History of diabetes       |     |               |              |                   |          |
| Yes                       | 91  | 36 (39.56)    | 55 (60.44)   | 1.0015 (0.6135–1.6346) | 0.9954   |
| No                        | 253 | 100 (39.53)   | 153 (60.47)  |                   |          |
| History of obesity        |     |               |              |                   |          |
| Yes                       | 61  | 29 (47.54)    | 32 (52.46)   | 1.4335 (0.8218–2.5005) | 0.2045   |
| No                        | 284 | 110 (38.73)   | 174 (61.27)  |                   |          |

N, n: Number; BMI: Body mass index; (95% CI): 95% confidence intervals; OR: Odd ratio; Bold value with *: Significant. Chi-square value are in [ ]
or high LDL-cholesterol \( p = 0.0006 \), and the mean value of total cholesterol \( p = 0.0004 \) or LDL cholesterol levels \( p = 0.0006 \) compared to non-infected ones. This positive relationship between \textit{H. pylori} infection and markers of dyslipidemia persisted even after adjusted with confounders, indicating \textit{H. pylori} infection as a risk factor for dyslipidemia.

Our result is consistent to that of studies investigating on the impact of \textit{H. pylori} colonization on lipid profile. In fact, \textit{H. pylori} infection was significantly associated with higher total cholesterol level \( p < 0.001 \), higher LDL cholesterol level \( p < 0.001 \), and lower HDL cholesterol level \( p < 0.001 \) in a cross-sectional study of 37,263 asymptomatic subjects [35]. Similarly, a lower HDL-cholesterol and higher triglyceride levels among CLO-positive patients was reported [36]. In a study comparing the lipid profiles of \textit{H. pylori} uninfected patients without CVD to \textit{H. pylori} infected patients with CVD, the authors demonstrate no significant changes in triglycerides, total cholesterol, and LDL levels but a significant lower HDL level in both groups [37].

Regarding \textit{H. pylori} eradication on the lipid profile, a rise in HDL levels and a drop in low density lipoprotein (LDL) levels was noticed with \textit{H. pylori} eradication [38], a significant decreased of the total cholesterol (TC) and LDL-C levels in \textit{H. pylori} infected patients after receiving anti-\textit{H. pylori} treatment [39]. These previous findings, coupled with ours show that \textit{H. pylori} infection promotes dyslipidemia by raising cholesterol, LDL cholesterol and triglyceride levels and reducing HDL cholesterol level.

Inflammatory cytokines such as tumor necrosis factor-\( \alpha \) (TNF-\( \alpha \)), interleukin-1, interleukin-6 production is stimulated in the host by \textit{Helicobacter pylori}' lipopolysaccharides [40]. This up regulate of inflammatory cytokines induces by \textit{H. pylori} infection impairs lipids metabolism [41, 42], which lead to atherosclerosis in \textit{H. pylori} infected patients [43, 44]. Some authors reported that increasing in serum levels of some pro-inflammatory cytokines (IL-1b, IL-8, and TNF-\( \alpha \)) goes along with the increment of cardiovascular diseases risk [45]. In fact, lipoprotein lipase activity is inhibited by TNF-\( \alpha \) of [46], in such condition lipids are transferred from the tissue which turn up the blood level of triglycerides and reduced that of HDL cholesterol [47, 48]. IL-6 and TNF-\( \alpha \) also interfere in lipid metabolism by increasing liver cholesterol synthesis. In fact, these cytokines impair the 3-hydroxy-3-methyl glutaryl coenzyme A reductase gene expression and reduce liver cholesterol catabolism by inhibiting cholesterol hydroxylase [49]. Hence, \textit{H. pylori} infection may has a role in promoting atherosclerosis through dyslipidemia since it had been shown that changes in cholesterol levels are associated with changes in CVD incidence rate [50]. It is demonstrated that, a 10% move to lower position in serum cholesterol produces a fall in CHD risk of 50% in 40 years aged individuals, 40%, 30% and 20% of

### Table 5 \textit{H. pylori} infection in the study population and potentials risk factors for infection

| Variables                  | Number (%) | HP +ve, \( n = 239 \) | HP −ve, \( n = 124 \) | \( \chi^2 \) (p value) |
|-----------------------------|------------|------------------------|------------------------|------------------------|
| Sex                         |            |                        |                        |                        |
| Female                      | 188 (51.79)| 120 (63.83)            | 68 (36.17)             | 0.7008 (0.402)         |
| Male                        | 175 (48.21)| 119 (68.00)            | 56 (32.00)             |                        |
| Age (years)                 |            |                        |                        |                        |
| \( \leq 20 \)               | 22 (6.06)  | 17 (77.27)             | 5 (22.73)              | 6.8206 (0.1457)        |
| [20–35]                     | 72 (19.83) | 39 (54.16)             | 33 (45.84)             |                        |
| [35–50]                     | 101 (27.82)| 71 (70.30)             | 30 (29.70)             |                        |
| [50–65]                     | 122 (33.61)| 80 (65.56)             | 42 (34.44)             |                        |
| >65                         | 46 (12.67) | 32 (69.56)             | 14 (30.44)             |                        |
| Income level ($/month)      |            |                        |                        |                        |
| Low class \( \leq 2500 \)   | 152 (41.87)| 104 (68.42)            | 48 (31.58)             | 3.4654 (0.1768)        |
| Middle class \((2500–8500)\)| 192 (52.89)| 125 (65.10)            | 67 (34.90)             |                        |
| Elite \((\geq 8500)\)       | 4 (1.10)   | 1 (25.00)              | 3 (75.00)              |                        |
| Smoking                     |            |                        |                        |                        |
| Yes                         | 20 (5.51)  | 13 (65.00)             | 7 (35.00)              | 0.0066 (0.935)         |
| No                          | 343 (94.49)| 226 (65.89)            | 117 (34.11)            |                        |
| Alcohol consumption         |            |                        |                        |                        |
| Yes                         | 85 (23.42) | 55 (64.71)             | 30 (35.29)             | 0.0635 (0.801)         |
| No                          | 278 (76.58)| 184 (66.19)            | 94 (33.81)             |                        |

N: Number; HP: \textit{H. pylori}; +ve: Positive; −ve: Negative; \( \chi^2 \): Chi-square
in those aged 50, 60 and 70 years old [50]. Regarding HDL cholesterol, a 1 mg/dl rise in HDL level is associated with a 2% and 3% drop in coronary risk in men and women respectively [50]. Since both LDL cholesterol and HDL cholesterol are directly associated with atherosclerosis and CVD, they are principal marker for high blood cholesterol therapy [50]. Thus, *H. pylori* eradication is beneficial to reduce the occurrence of dyslipidemia, thereby preventing the occurrence of cardiovascular disease.

However, there are contradictory results indicating that *H. pylori* infection may not alter lipid profile or interfere in lipid metabolism. A non-significant difference between plasma cholesterol, triglyceride levels or lipid profile and *H. pylori* seropositivity was reported by Rengström et al. [51] and Jamshid et al. [6] in their study.

| Variable | Number (%) | HP +ve n (%) | HP – ve n (%) | [t value; p-value] (X2 value; p-value) |
|----------|------------|--------------|---------------|-------------------------------------|
| Total cholesterol (g/l) | 215.38 ± 5.958, (86–412) | 223.2 ± 3.781 | 200.2 ± 5.096 | [3.562; 0.0004*] (X2 value; p-value) |
| Hypo cholesterol (< 150) | 59 (16.25) | 30 (50.85) | 29 (49.15) | [14.58; 0.0007*] |
| Normal (150 to 200) | 80 (22.03) | 45 (56.25) | 35 (43.75) | |
| Hyper cholesterol (> 200) | 224 (61.70) | 164 (73.25) | 60 (26.75) | |
| LDL (g/l), Mean ± SD, (Range) | 110.02 ± 45.21, (12.98–229.6) | 116.6 ± 2.954 | 97.26 ± 3.734 | [3.459; 0.0006*] |
| Hypo (< 90) | 130 (35.25) | 76 (58.46) | 54 (41.54) | [12.056; 0.0024*] |
| Normal (90 to 130) | 98 (26.99) | 59 (60.20) | 39 (39.80) | |
| Hyper (> 130) | 135 (37.19) | 104 (77.04) | 31 (22.96) | |
| HDL (g/l), Mean ± SD, (Range) | 51.79 ± 21.03, (4.3–119) | 51.01 ± 1.366 | 52.92 ± 1.912 | [0.8027; 0.4227] |
| Hypo (< 40) | 142 (39.12) | 99 (69.72) | 43 (30.28) | [4.966; 0.0831] |
| Normal (40 to 60) | 185 (50.96) | 122 (65.94) | 63 (34.06) | |
| Hyper (> 60) | 36 (9.97) | 18 (50.00) | 18 () | |
| TGA (g/l), Mean ± SD, (Range) | 145.91 ± 56.14, (13.39–318) | 146.2 ± 3.513 | 142.5 ± 4.964 | [0.6168; 0.5378] |
| Hypo (< 40) | 6 (1.65) | 3 (50.00) | 3 (50.00) | [1.5816; 0.4535] |
| Normal (40–150) | 197 (54.26) | 126 (63.96) | 71 (36.04) | |
| Hyper (> 150) | 160 (44.07) | 110 (68.75) | 50 (31.25) | |
| BMI (kg/m²), Mean ± SD, (Range) | 24.79 ± 1.03, (16.30–37.6) | 24.84 ± 0.2515 | 24.7 ± 0.3862 | [0.3146; 0.7690] |
| Hypo (< 18.5–24.9) | 218 (60.05) | 142 (56.14) | 76 (43.86) | [0.1493; 0.9281] |
| Normal (18.5–24.9) | 113 (31.12) | 76 (65.26) | 37 (32.74) | |
| Overweight (25–29.9) | 32 (8.81) | 21 (65.62) | 11 (34.38) | |
| Obesity (≥ 30) | | | | |
| DBP (mmHg), Mean ± SD, (Range) | 77.02 ± 11.21, (41–104) | 77.18 ± 0.7757 | 77.35 ± 0.925 | [0.1324; 0.8947] |
| Hypo (< 80) | 225 (61.98) | 146 (68.89) | 79 (31.11) | [1.10; 0.576] |
| Normal (80 to 90) | 78 (21.48) | 50 (64.10) | 28 (35.90) | |
| Hyper (> 90) | 60 (16.52) | 43 (71.67) | 17 (28.33) | |
| SBP (mmHg), Mean ± SD, (Range) | 124.11 ± 19.29, (80–191) | 121.7 ± 1.284 | 137 ± 12.3 | [1.732; 0.0841] |
| Hypo (< 120) | 163 (44.90) | 114 (69.94) | 49 (30.06) | [2.2252; 0.3287] |
| Normal (120 to 140) | 145 (39.94) | 91 (62.76) | 46 (37.24) | |
| Hyper (> 140) | 55 (15.15) | 34 (61.82) | 21 (38.18) | |
| Blood pressure (mmHg) | /, (41/80–104/191) | /, (41/80–104/191) | /, (41/80–104/191) | /, (41/80–104/191) |
| Hypo (< 120/80) | 152 (41.87) | 98 (64.47) | 54 (35.53) | [0.2373; 0.8881] |
| Normal (120–140/80–90) | 164 (45.17) | 110 (97.07) | 54 (2.93) | |
| Hyper (> 140/90) | 47 (12.94) | 31 (65.96) | 16 (34.04) | |
| Heart rate (beat/min) | 79.53 ± 12.10, (45–114) | 80.00 ± 0.8606 | 78.56 ± 1.12 | [0.9968; 0.3195] |
| Hypo (< 60) | 287 (79.06) | 186 (64.81) | 101 (35.19) | [1.235; 0.5394] |
| Normal (60 to 100) | 48 (13.22) | 35 (72.92) | 13 (27.08) | |
| Bradycardia (< 60) | 28 (7.71) | 18 (64.28) | 10 (35.72) | |
Table 7  Relationship between *Helicobacter pylori* infection and dyslipidaemia, heart dysfunction, overweight/obesity adjusting with potential confounders (socio-economic lifestyle and medical history parameters) assessed by multivariable linear regression analysis

| Variable                  | Univariate logistic regression OR (95% CI) | p value | Multivariate logistic regression OR (95% CI) | p value | Model 1 | Model 2 | Model 3 | Model 4 |
|---------------------------|------------------------------------------|---------|------------------------------------------|---------|---------|---------|---------|---------|
| **Dyslipidemia**          |                                          |         |                                          |         |         |         |         |         |
| Hyper total cholesterol   | 2.3324 (1.4935–3.6423)                   | 0.0002* | 2.5848 (1.6235–4.1155)                  | 0.0001* | 2.4100 (1.5324–3.7903) | 0.0001* | 2.3373 (1.4610–3.7391) | 0.0004* | 2.5944 (1.5766–4.2692) | 0.0002* |
| High LDL-C                | 2.3096 (1.4289–3.7331)                   | 0.0006* | 2.5793 (1.5560–4.2754)                  | 0.0002* | 2.3600 (1.4550–3.8280) | 0.0005* | 2.3612 (1.4412–3.8684) | 0.0006* | 2.6794 (1.5839–4.5328) | 0.0002* |
| Low HDL-C                 | 1.3321 (0.8489–2.0902)                   | 0.2123  | 1.2658 (0.7919–2.0234)                  | 0.3247  | 1.3480 (0.8565–2.1216) | 0.1969  | 1.4080 (0.8786–2.2563) | 0.1550  | 1.4103 (0.8588–2.3160) | 0.1743  |
| High TG                   | 1.2620 (0.8129–1.9592)                   | 0.2327  | 1.1407 (0.7249–1.7951)                  | 0.5693  | 1.2714 (0.8154–1.9825) | 0.2894  | 1.2431 (0.7885–1.9598) | 0.3487  | 1.1116 (0.6918–1.7861) | 0.6620  |
| Heart dysfunction         |                                          |         |                                          |         |         |         |         |         |
| High DBP                  | 1.3807 (0.7510–2.5384)                   | 0.2991  | 1.3082 (0.7348–2.3291)                  | 0.3614  | 1.4359 (0.7764–2.6554) | 0.2488  | 1.4466 (0.7600–2.7534) | 0.2609  | 1.6772 (0.8404–3.3474) | 0.1424  |
| High SBP                  | 0.8135 (0.4495–1.4723)                   | 0.4952  | 0.8575 (0.4655–1.5796)                  | 0.6218  | 0.8020 (0.4412–1.4578) | 0.4692  | 0.9498 (0.4999–1.8047) | 0.8751  | 0.9589 (0.4900–1.8764) | 0.9024  |
| Hypertension              | 1.0060 (0.5270–1.9204)                   | 0.9855  | 1.0781 (0.5527–2.1032)                  | 0.8253  | 0.9870 (0.5151–1.8927) | 0.9695  | 1.0980 (0.5540–2.1760) | 0.7888  | 1.0866 (0.5292–2.2310) | 0.8210  |
| High heart rate           | 1.4646 (0.7441–2.8829)                   | 0.2694  | 1.3885 (0.6947–2.7735)                  | 0.3529  | 1.4854 (0.7514–2.9366) | 0.2551  | 1.4730 (0.7065–3.0708) | 0.3015  | 1.3765 (0.6460–2.9330) | 0.4077  |
| BMI                       | 1.0813 (0.6936–1.6859)                   | 0.7300  | 1.1474 (0.7240–2.1815)                  | 0.5585  | 1.1063 (0.7054–1.7349) | 0.6601  | 1.1104 (0.6992–1.7635) | 0.6571  | 1.1785 (0.7234–1.9201) | 0.5095  |

DBP: Diastolic blood pressure; SBP: Systolic blood pressure; N, n: Number, (95% CI): 95% confidence intervals; OR: Odd ratio. Bold value with *: Significant. Model 1: Adjusted with sociodemographic and economic factors (sex, gender and income level); Model 2: Adjusted with lifestyle factors (smoking, alcohol consumption, physical activity); Model 3: Adjusted with medical history (history of hypertension, diabetes mellitus, and obesity); Model 4: Adjusted for all the confounding factors (Sociodemographic and economic, lifestyle and medical history).
population. Patel et al. also did not find differences in the plasma cholesterol or triglyceride levels, among H. pylori positive and negative patients [52]. The difference in the methods used for H. pylori detection, the sample size, the type of population as well as the potential confounders choose for analysis may explain such discrepancy among findings. In fact, serological tests characterized by their inability to differentiate between current and past infection, since the antibody titers can remain high for months after the elimination of the infection and also linked to the cross reactivity with other antibodies are widely used for H. pylori detection in studies related H. pylori infection and CVD [35]. Hence, these studies are not reliable to check for the relationship between H. pylori current infection and CVD.

The impact of H. pylori infection was also evaluation on markers of heart dysfunction; high blood pressure (hypertension) and high heart rate known as cardiovascular risk factors. High blood pressure increases the amount of work for heart. This heart extra effort extends the size of heart muscle which become inflexible, causing heart dysfunction. A two–threefold increase incidence of atherosclerotic CVD occurs along with hypertension [50]. Even individuals with high normal blood pressure (BP) values are in high risk to develop CVD [50]. Hypertension favors the development of all clinical manifestations of CHD such as myocardial infarction, angina pectoris, and sudden death. Hypertension is also implicated in the occurrence of atherothrombotic brain infarction such as intracerebral hemorrhage [50]. In 40–70 years aged individuals, every 20-point or 10-point increase in systolic blood pressure or diastolic blood pressure respectively starting at 115/75 mmHg, rise the risk of heart attack and folded over once stroke [50].

Our results on heart dysfunction related to H. pylori status showed that H. pylori infected individuals were more times subjected to a higher blood pressure (hypertension), to a higher diastolic blood pressure and to a higher heart rate compared with uninfected ones, but the differences were non-significant. We also saw that H. pylori infected individuals were not commonly found among subjects with a higher systolic blood pressure. This positive relationship between H. pylori infection and hypertension, high diastolic pressure and high heart rate although non-significant persist even after adjusted with confounders in each model type, indicating that H. pylori infection is related to these heart functional abnormalities.

Our finding is consistent with previous study investigating the effect of H. pylori on blood pressure. Hartog et al. in their study found that H. pylori infection was weakly associated with hypertension with a non-significant difference [53]. Xiong et al., found a significantly high blood pressure with a higher diastolic blood pressure in H. pylori-positive adults compared to for H. pylori negative but not to systolic blood pressure [54]. Similarly, Wan et al. in their cross-sectional study noticed a positive link between H. pylori infection with diastolic blood pressure but not with systolic blood pressure [55]. A community-based study in Iran also found that H. pylori immunoglobulin G (IgG) antibodies are significantly associated with hypertension [56], while Migneco et al. noticed a significant decrease in diastolic blood pressure after H. pylori eradication in hypertensive patients [57].

Controversial data showing that H. pylori infection did not influence neither systolic blood pressure nor diastolic blood pressure have been published in the literature [58, 59]. A cross-sectional study on hypertensive and normotensive Chinese Mongolian subjects did not find a link between H. pylori and hypertension [60]. The studied population, sample size, methods for H. pylori detection and adjustment for potential confounders may explain such inconsistent findings.

The mechanisms sustained the link between H. pylori infection and hypertension have been documented despite the contradictory results regarding this issue. H. pylori colonization impaired digestion and absorption of nutrients such as vitamin B6, vitamin B12, and folic acid in the stomach [61] resulting in the deficiency in these important coenzymes for methionine metabolism and turn up homocysteine levels among infected individuals [62]. Homocysteine causes platelet aggregation and vasoconstriction by inhibiting nitric oxide (NO) secretion in endothelial cells, it also favors the binding of lipoproteins to fibrinogen which predisposes to arteriosclerosis and hypertension [63]. Such reasons may explain why H. pylori infection are more subjected to high blood pressure than uninfected ones. H. pylori infected subjects also had increased levels of fibrinogen, a marker of vascular inflammation. It inhibits the reduction of NO which result in vasoconstriction and hypertension in peripheral blood vessel [64], this may justify the fact that individuals with H. pylori infection had high diastolic blood pressure but not high systolic blood pressure, since diastolic blood pressure widely relies to peripheral resistance. The dyslipidemia and dysglycemia observed among our population may also explain such high diastolic blood pressure, since it is documented that diastolic function is correlated with lipid profile [65].

Obesity represents a major public health problem regarding the increase number of affected individuals over the past century. An estimate rise of overweight/obesity of 27.55 and 47.1% respectively among adults and children has been reported between 1980 and 2013 [66], with the highest frequencies recorded among individuals from developed countries. In addition, obesity decreases
the expected length of life and induces failure to perform function properly in many organs and systems [67]. Obesity is correlated to mortality due to chronic diseases such as diabetes, chronic kidney disease, gastrointestinal disease, and cardiovascular disease [68].

In the current study, 39.94% of the subjects were with high body mass index, 31.12% for overweight and 8.81% for obesity. Regarding overweight/obesity related to H. pylori status, our findings showed that the majority of individuals with overweight and obesity were H. pylori infected, with the OR higher than one, but the differences were not significant.

Our finding is in accordance with those of previous studies demonstrating that H. pylori positive subjects are more in risk of having high BMI than H. pylori negative ones or showing an association between H. pylori infection and overweight/obesity [10]. A significant association between obesity and H. pylori positivity was noticed among a young obese group of Turks compare to the control group [69], in Czech people [70] and in Swedish subjects [71]. A similar positive correlation between H. pylori infection and increased BMI or overweight/obesity was noticed in an Israel cohort of 235,107 individuals [72], and in a systematic review among Chinese population [73]. Moreover, H. pylori infection rates of 37.36%, 41.88%, 45.77% (p for trend = 0.006) were recorded respectively among normal, overweight and obese subjects, indicating trend of increasing of BMI with H. pylori infection [74].

There are conflicted findings reporting no link between H. pylori infection and overweight/obesity in the literature, despite the large documentation on the positive association between this comorbidities. In fact, H. pylori colonization was found to be not related with overweight/obesity in Japanese and Greek subjects [75–77]. A similar negative relationship was noticed in studies from USA [78, 79].

Suggestions on the mechanisms that might link H. pylori infection to high BMI have been illustrated. One mechanism is related to leptin and ghrelin, gastrointestinal hormones involved in energy balance. Ghrelin causes excessive eating and obesity by stimulating food intake [80], whereas leptin reduces excessive eating and obesity by inhibiting eating [81]. Lower serum leptin and ghrelin levels has been demonstrated in H. pylori-positive patients [82]. Another mechanism is related to insulin resistance. Insulin resistance is known as an important risk factor for metabolic disorders such as obesity [83]. It has been shown that H. pylori infection are more subjected to insulin resistance [84] and therefore may be more likely to get obesity than uninfected ones. The interaction between H. pylori invasion and obesity on the immune system has also incriminated as one mechanism. In fact, the aptitude of monocytes to convert into macrophages is reduced in obese patients [69], indicating an improvement of H. pylori survival in obese people’s immune environment. In other hands, intestinal immune system in the presence of microorganism invasion promotes the development of metabolic disease such as obesity [85]. In fact, to proliferate and differentiate into adipocytes, pre-adipocytes could develop phagocytic activity as macrophage-like cells [86], which suggest that the presence of H. pylori may stimulate the growth of adipose tissue and thereby obesity.

Conclusion
Our finding showed that H. pylori infection is associated with increased risk of dyslipidemia in our sample population. In view of that, H. pylori eradication would be beneficial to reduce the occurrence of dyslipidemia, thereby preventing the occurrence of cardiovascular disease in our milieu. However, it would be more interested to follow these patients in order to assess the variation of lipid profile over the time in relation to H. pylori infection. Our further attention is focused on the pathophysiological pathways of H. pylori on lipid metabolic and on the assessment of H. pylori colonization as an independent risk factor for coronary heart disease, that is the pathogen might directly invade the vessel wall, leading to localized vascular inflammation and resulting in cardiovascular disease.

Abbreviations
CVD: Cardiovascular disease; CHD: Coronary heart disease; TC: Total cholesterol; LDL-C: Low density lipoprotein cholesterol; HDL-C: High density lipoprotein cholesterol; TG: Triglycerides; BP: Blood pressure; DBP: Diastolic blood pressure; SBP: Systolic blood pressure; BMI: Body mass index; TNF-α: Tumor necrosis factor-α; IL: Interleukin; HP or H. pylori: Helicobacter pylori.

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Author contributions
LBMK conceived of the study, designed the experiments and supervised the work. JLNK collected the biopsy sample and performed H. pylori detection. LDNT and FNGF carried out the check-up for cardiovascular risk factors. JPD and KMLB provided the facilities for the study and drafted the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study are not publicly available because they are confidential but are available from the corresponding author on reasonable request.
Declarations

Ethics approval and consent to participate
This study was approved by the Institutional Review Board of each selected Medical Center (Ref: 07-19/HGY/DG/DPM/NC-TR for the General Hospital Yaoundé, Ref: 01-19MC/TSVM/LSM/AutoTech/2019/10/03 for the Cathedral Medical Centre Yaoundé and Ref: 2330/L/MINISANTE/S/G/DRSP/OHRB/D for the Regional Hospital Bafoussam) and was conducted in accordance with the Declaration of Helsinki.

Informed consent
Participation was voluntary and each subject involved in the study gave a written informed consent. The Children were enrolled after their parents or legal guardians received an information notice and an oral explanation of the study and provided a written informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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