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Dietary and socio-economic factors in relation to *Helicobacter pylori* re-infection

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Abstract

AIM: To examine if dietary and socio-economic factors contribute to *Helicobacter pylori* (*H pylori*) re-infection.

METHODS: The population of patients consisted of subjects in whom *H pylori* infection had been successfully treated in the past. Patients were divided into two groups: Ⅰ-examined group (111 persons with *H pylori* re-infection) and Ⅱ-control group (175 persons who had not been re-infected). The respondents were interviewed retrospectively on their dietary habits and socio-economic factors.

RESULTS: A statistically significant lower frequency of fermented dairy products ($P < 0.0001$), vegetables ($P = 0.02$), and fruit ($P = 0.008$) consumption was noted among patients with *H pylori* re-infection as compared to those who had not been re-infected.

CONCLUSION: High dietary intake of probiotic bacteria, mainly *Lactobacillus*, and antioxidants, mainly vitamin C (contained in fruit and vegetables), might decrease the risk of *H pylori* re-infection.

Key words: Nutrition; Probiotics; *Helicobacter pylori* re-infection; Vitamin C; Lifestyle factors

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INTRODUCTION

Helicobacter pylori (*H pylori*) infection exerts a decisive role in the pathogenesis of peptic ulcer disease and gastric cancer[1-3]. Epidemiological studies have shown that it is probably one of the most common bacterial infections throughout the world, involving 30% of the population living in developed countries and up to 80%-90% of the population in developing regions[4]. Poland, like most of the Eastern European countries, has an overall infection rate of 73% and an infection rate for the subjects over 25 years of age of 85%-95%[5]. Infection usually takes place in early childhood and youth; but, a proportion of the population becomes infected as adults[6-9]. Vectors of the bacteria are humans, by whom the infection is transmitted by oral-oral and faecal-oral routes[3,5]. The risk of infection is related mainly to socio-economic status[10-12].

The important role of nutritional factors that might facilitate infection, such as low intake of antioxidants, mainly vitamin C, and high salt consumption, is also stressed[13,14]. Moreover, some research has shown that, in *in vitro* conditions, probiotic bacteria (especially *Lactobacillus*) might reduce the risk of *H pylori* infection[15-17].

Owing to the wide implementation of eradication therapy, the recurrence of peptic ulcers has decreased significantly[18,19]. However, in some patients re-infection occurs and ulcers reappear. Re-infection affects ca. 1%-13% of patients annually, depending on the population studied[20-24]. It is believed that dietary and

socio-economic factors may contribute to the *H pylori* re-infection.

The aim of this study was to evaluate whether there are differences in dietary habits and lifestyle between subjects after effective eradication who were re-infected and patients who were not re-infected.

MATERIALS AND METHODS

The study was carried out in 2002-2007 in a group of patients from the Provincial Gastroenterological Clinic of the Brodnowski Hospital in Warsaw who had ulcer disease or functional dyspepsia, and had been referred for endoscopic examination of the upper digestive tract. All the patients had been successfully treated for *H pylori* infection in the past and successful eradication after at least 6 wk after completion of the treatment was confirmed. The effectiveness of treatment was diagnosed by histology and a urease test (both negative) or urea breath test. Patients with neoplastic diseases were not included, along with persons with no confirmed eradication by the above mentioned methods and those who did not agree to take part in the research.

Patients were divided into two groups by *H pylori* status. One hundred and eleven patients were classified in group I (examined): persons with *H pylori* re-infection, and 175 patients were included in group Ⅱ (control): persons not re-infected. The period following *H pylori* eradication ranged from 3 to 8 years. The mean time after the eradication treatment was similar for both groups: 5.2 years for group I and 5.6 years for group Ⅱ.

Characteristics of both groups are presented in Table 1. Group I consisted of 47 women and 64 men aged 24-88. The control group included more women (n = 103) than men (n = 72). The range of age of the patients in this group was from 17 to 87 years old. No statistically significant differences between mean age and mean BMI between the groups were observed.

The status of *H pylori* was evaluated using the histological method and urease test (both positive) or urea breath test.

For all patients, a BMI value was calculated. An interview on dietary habits and socio-economic factors was performed by a dietician. The patients were interviewed retrospectively. A specially designed questionnaire was used. The first part of the questionnaire contained questions regarding the usual dietary habits during last year, while the second part referred to selected features relating to the patients' lifestyle. The questionnaire contained questions providing information, inter alia, on the applied diet, amounts, regularity and type of meals, frequency of consumption of products from various food groups, with particular attention paid to dairy products and fat, as well as salty products and dishes, along with additional salting. Consumption of products and dishes at least five times a week was regarded as frequent. For some products and dishes, the analysis covered moderate consumption with moderate frequency, i.e. twice to four times a week, and rare consumption, i.e. once a week or more seldom. For other products and dishes consumption frequency of up to four times a week was regarded rare. The second part of the questionnaire contained questions referring to the patients' job and additional employment, stress exposure and smoking. Among the examined factors only those that had an impact on the occurrence of *H pylori* infection were selected and discussed. In the statistical analysis of the differences between studied groups, a χ^2 test was applied, assuming differences of statistical significance for $P < 0.05$.

Table 1 Characteristics of the examined groups

	Group Ⅰ HP (+)			Group Ⅱ HP (-)		
	n	Mean	Range	*n*	Mean	Range
Age (yr)						
Women	47	63	24-88	103	62	17-87
Men	64	57	27-79	72	54	18-80
Total	111	60	24-88	175	58	17-87
BMI						
Women	47	24.8	16.3-32.5	103	24.8	15.6-48.9
Men	64	26.1	15.5-36.1	72	24.9	16.2-39.7
Total	111	25.5	15.5-36.1	175	24.9	15.6-48.9

RESULTS

Dietary factors that are likely to have an impact on *H pylori* infection are presented in Table 2.

Most of the dietary factors analysed in both groups showed no significant differences. Both the patients who had been re-infected and patients from the control group said they ate meals regularly.

Statistically significant differences were noted in case of the frequency of eating dairy products ($P < 0.0001$). The percentage of persons who often ate dairy products among patients with *H pylori* re-infection was much lower (41%) than in the control group (89%), and a higher proportion of the re-infected patients (32%) admitted to eating dairy products rarely, while in the control group this percentage was much lower (6%). A significant difference was also observed in the case of fermented milk drinks ($P < 0.0001$). Less than half (43%) of the re-infected patients consumed these products frequently, while among non-infected persons-almost all (95%) did.

Most patients from both groups ate vegetables frequently (74% in the group re-infected and 87% in the control group); but, the differences in the frequency of the consumption of these products were statistically significant ($P = 0.02$). The frequency of fruit consumption also showed differences; frequent consumption of these products was declared by fewer persons re-infected (58%) in comparison to the patients who were not re-infected (76%) ($P = 0.008$).

Selected aspects relating to the lifestyle of examined patients are presented in Table 3.

Patients with *H pylori* re-infection did not vary significantly from the control group in terms of the analysed lifestyle factors. Most of the patients did not work professionally, but declared frequent tiredness and high stress exposure. In both groups, the majority did not smoke.

Table 2 Comparison of selected dietary factors in the examined groups *n* (%)

Factors	Responses	Group Ⅰ HP (+) *n* = 111[1]	Group Ⅱ HP (-) *n* = 175[1]	Statistical significance (*P*)
Regularity of eating meals (3-5)	Yes	55 (52)	97 (56)	NS
	No	51 (48)	76 (44)	
Meals prepared on their own	Yes	53 (48)	105 (60)	0.02
	Sometimes	18 (16)	33 (19)	
	No	40 (36)	37 (21)	
Adding fat to stewed, fried and baked dishes	Yes	75 (68)	133 (77)	NS
	Sometimes	3 (2)	1 (1)	
	No	33 (30)	38 (22)	
Adding fat or dressing to salads	Yes	67 (61)	121 (69)	NS
	Sometimes	3 (3)	3 (2)	
	No	39 (36)	51 (29)	
Using fats to spread on bread	Yes	94 (85)	157 (90)	NS
	Sometimes	2 (2)	5 (3)	
	No	15 (13)	13 (7)	
Eating dairy products	Frequently	45 (41)	154 (89)	< 0.0001
	With moderate frequency	30 (27)	9 (5)	
	Rarely	36 (32)	11 (6)	
Eating fermented milk drinks (yoghurts, kefirs)	Frequently	48 (43)	166 (95)	< 0.0001
	Rarely	63 (57)	9 (5)	
Eating meat products and dishes	Frequently	82 (75)	120 (69)	NS
	With moderate frequency	19 (17)	40 (23)	
	Rarely	8 (7)	14 (8)	
Types of meat products and dishes eaten	Fatty	3 (3)	2 (1)	NS
	Medium-fatty	8 (8)	5 (3)	
	Lean	63 (60)	110 (66)	
	Varying	30 (29)	50 (30)	
Eating fish	Frequently	31 (28)	53 (30)	NS
	With moderate frequency	33 (30)	58 (33)	
	Rarely	47 (42)	64 (37)	
Eating vegetables	Frequently	82 (74)	152 (87)	0.02
	With moderate frequency	21 (19)	17 (10)	
	Rarely	8 (7)	6 (3)	
Eating fruit	Frequently	65 (58)	133 (76)	0.008
	With moderate frequency	24 (22)	23 (13)	
	Rarely	22 (20)	19 (11)	
Eating sweets	Frequently	26 (24)	47 (27)	NS
	With moderate frequency	28 (25)	46 (26)	
	Rarely	57 (51)	82 (47)	
Sweetening of drinks (coffee, tea)	Yes	79 (71)	115 (66)	NS
	Sometimes	2 (2)	5 (3)	
	No	30 (27)	55 (31)	
Alcoholic drinks consumption	Frequently	14 (13)	9 (5)	NS
	With moderate frequency	18 (16)	29 (17)	
	Rarely	79 (71)	136 (78)	
Eating salty dishes	Yes	35 (32)	52 (30)	NS
	Sometimes	15 (13)	20 (11)	
	No	61 (55)	103 (59)	
Additional salting of products and dishes eaten	Yes	21 (20)	39 (24)	NS
	Sometimes	7 (6)	9 (6)	
	No	79 (74)	113 (70)	

[1]Number of persons changed between 104-111 persons in group Ⅰ and 167-175 persons in group Ⅱ, which results from the fact that some patients did not provide an answer to some questions; NS-value statistically insignificant.

Table 3 Comparison of selected lifestyle factors in examined groups *n* (%)

Factors	Responses	Group Ⅰ HP (+) *n* = 111[1]	Group Ⅱ HP (-) *n* = 175[1]
Working	Yes	28 (25)	39 (23)
	No	83 (75)	134 (77)
Working overtime or on weekends	Yes	18 (78)	22 (60)
	Sometimes	1 (4)	3 (8)
	No	4 (18)	12 (32)
Additional work outside the main job	Yes	6 (8)	8 (7)
	No	65 (92)	110 (93)
Feeling tired	Very often	58 (53)	96 (55)
	Rather often	16 (14)	27 (16)
	Rather rarely	26 (24)	40 (23)
	Hardly ever	10 (9)	11 (6)
Self-assessed stress exposure	Very often	47 (43)	89 (51)
	Rather often	15 (13)	27 (16)
	Rather rarely	37 (34)	42 (24)
	Hardly ever	11 (10)	15 (9)
Smoking	Yes	36 (32)	54 (31)
	No	75 (68)	120 (69)

[1]Number of persons changed between 23-111 persons in group Ⅰ and 37-175 persons in group Ⅱ, which results from the fact that some patients did not provide an answer to some questions.

DISCUSSION

The question of how to lower the risk of *H pylori* re-infection is very important. This bacterium is the main cause of peptic ulcer disease (70%-90% of cases) and in 1% of infected persons, this leads to the development of gastric cancer[25]. Moreover, the treatment of *H pylori* is difficult, requires a two-week application of at least three medicines (proton pump inhibitors and two antibiotics) simultaneously, proves successful in only 80%-90% of cases and is connected with the risk of adverse effects of therapy with antibiotics (15%-30% of the treated)[26,27]. In some patients, *H pylori* re-infection occurs after eradication; but, factors responsible for this phenomenon have not yet been identified. It is presumed that these may be at least partly related to poor sanitary conditions and improper lifestyle, especially diet[12,28,29].

In the present research, the dietary and some socio-economic factors after successful eradication of *H pylori* infection were evaluated. The goal of this retrospective study was to point out potential differences in the dietary patterns of patients with *H pylori* re-infection (group Ⅰ) and in the control not-re-infected group (group Ⅱ).

We showed a significant difference in the frequency of consumption of fermented dairy products containing probiotic bacteria, mainly *Lactobacillus*, between the group with *H pylori* re-infection and the group without re-infection. This indicates that regular consumption of products containing probiotic bacteria might reduce the risk of *H pylori* re-infection.

There is some evidence from *in vitro* and clinical research that can support this hypothesis. Numerous probiotic strains inhibit the growth or adhesion of *H pylori* to epithelium cells in *in vitro* conditions. In

studies on animals infected with *H pylori*, it was also observed that probiotic bacteria lowered the intensity of inflammatory conditions in the stomach mucosa. Michetti *et al*[15] showed that the supernatant of a culture of *Lactobacillus* johnsoni La1 strain inhibited the growth of *H pylori* bacteria whether or not they were connected with epithelial cells. The supernatant was administered for 14 d to 20 volunteers infected with *H pylori* in a double-blind randomised study. The results of urea breath tests at the beginning and in the 6th week after the completion of the treatment were significantly lower than the initial results, which is most probably related to lowering the density of *H pylori* colonies. In a biopsy taken from the mucosa of the stomach, *H pylori* infection was still present[15].

Aiba *et al*[30] showed that *L. salivarius* inhibited the growth of *H pylori in vitro*, and, in an animal model, reduced the inflammatory process in the mucosa of infected mice. No such phenomena were observed in the case of *L. casei* and *L. acidophilus*.

Coconnier *et al*[16] observed that supernatant from the *L. acidophilus* LB culture contains anti-bacterial substances produced by this strain, which reduced the viability of *H pylori* bacteria and inhibited its adhesion to human cells *in vitro* and *in vivo*. Sgouras *et al*[31] used *L. casei* Shirota cells *in vitro* and *in vivo* and noted that the cells (not the supernatant) lowered the activity of *H pylori* urease. In research carried out on mice, after the application of the above strain, the density of *H pylori* colonies decreased, along with the intensity of the inflammation of the mucosa of the stomach[31].

Similar results were obtained in animal; for example, the density of colonisation of stomach mucosa by *H pylori* became lower, and inflammatory changes became smaller, after the administration of *L. rhamnosus*, *L. acidophilus* and *L. gasseri*[32,33]. Kabir *et al*[34] stated that administration of *L. salivarius* to mice infected with *H pylori* decreased the adhesion of pathogens to stomach mucosa cells.

So far, clinical tests have not been able to prove that use of probiotics leads to *H pylori* eradication[35,36]. Wendakoon *et al*[37] made an attempt to prove it in their study of patients with asymptomatic *H pylori* infection. The patients were given *L. acidophilus* and *L. casei* strains for 30 d, which inhibited *H pylori* growth *in vitro*; but, no eradication in any of the patients was observed.

Several clinical surveys showed that some strains of probiotic bacteria might increase the effectiveness of *H pylori* eradication. Canducci *et al*[38] noted higher *H pylori* eradication rate in patients who, in addition to triple therapy based on rabeprazole, clarithromycin and amoxicillin, were given a lyophilized and inactivated culture of *Lactobacillus* acidophilus. In a study by Sýkora *et al*[39] *H pylori*-positive children received the control treatment of omeprazole, amoxicillin and clarithromycin or the treatment consisted of the same antibiotics supplemented with fermented milk (trade name-Actimel) containing *L. casei* DN-114 001. Eradication success was significantly higher in the test group compared with the control group.

Application of probiotics during *H pylori* treatment might not only increase the eradication rate, but it might also decrease the adverse effects of antibiotic therapy. Park *et al*[40] showed that supplements containing probiotic bacteria strains, composed of *Bacillus subtilis* and *Streptococcus faecium*, enhanced the intention-to-treat eradication rate of *H pylori*, improved drug compliance and reduced side effects. Diarrhoea and overall side effects were more common in the group treated with antibiotics only in comparison to the group treated with antibiotics plus probiotics. De Bortoli *et al*[41] examined whether adding bovine lactoferrin and probiotics to the standard triple therapy for *H pylori* infection could improve the eradication rate and reduce side effects. The eradication rate was higher in more patients who underwent standard triple eradication therapy plus bovine lactoferrin and probiotics than in those who underwent standard therapy only. Moreover, fewer patients taking probiotics reported side effects. Improvement of the results of eradication therapy followed by the application of probiotics was also noted in Polish studies covering children with dyspeptic symptoms and confirmed *H pylori* infection[42]. In the group of children who were given probiotics (*L. acidophilus* and *L. rhamnosus*) in addition to standard therapy, not only was significantly higher eradication effectiveness demonstrated, but also a lower intensity of inflammation of the mucosa of the stomach and a lower rate of adverse effects of the therapy were noted.

The results of some studies do not confirm the positive impact of the use of probiotics on the eradication treatment ratio. No difference in eradication rate was observed in *H pylori*-positive patients receiving *L. reuteri* and a placebo[43]. Also Goldman *et al*[44], in their study of children in Buenos Aires, found no significant differences in *H pylori* eradication rates between the group treated with triple therapy plus probiotic food (yogurt containing *Bifidobacterium animalis* and *Lactobacillus casei*) and the control group.

Although not all papers confirm the improvement of treatment results for *H pylori* infection upon simultaneous treatment with antibiotics and probiotics, the meta-analysis performed by Tong *et al*[45], covering 14 randomized trials, suggests that supplementation with probiotics could be effective in increasing eradication rates of anti-*H pylori* therapy, and could be considered helpful for patients with previous eradication failure. Pooled *H pylori* eradication rates were 83.6% and 74.8% for patients with or without probiotics by intention-to-treat analysis. Furthermore, probiotics showed a positive impact on *H pylori* therapy-related side effects. The occurrence of total side effects was 24.7% and 38.5% for groups with or without probiotics.

Results found in most of the studies showed that the use of probiotics during eradication treatment was of benefit to patients. However, more large and well-designed studies of the use of probiotics in *H pylori* eradication treatment are necessary, including comparative and dose-ranging trials[46].

We also demonstrated a significantly higher

consumption of fruit and vegetables among persons who were not re-infected. This is probably related to the consumption of a higher number of anti-oxidants, especially vitamin C. Vitamin C, which is highly concentrated in stomach mucosa and gastric juice and probably lowers the risk of gastric cancer and influences the course of *H pylori* infection through a number of mechanisms[13,47]. It has a positive impact on the stimulation and activity of granulocytes, macrophages and lymphocytes and the production of immunoglobulins. The direct inhibitory impact of this vitamin on the growth of *H pylori* is now being examined.

Jarosz *et al*[13] showed that four weeks treatment of *H pylori* infected patients with chronic gastritis with a high dose of vitamin C caused *H pylori* eradication in 30% of cases. In those patients, a highly significant rise in gastric juice total vitamin C concentration was demonstrated, which persisted for at least four weeks after treatment. However, the mechanism whereby vitamin C treatment results in *H pylori* eradication is unclear.

Ruiz *et al*[48] found a causal association between *H pylori* infection and low ascorbic acid levels in the gastric juice. Their findings supported two hypotheses that explain this phenomenon: increased oxidation and a decreased secretion of ascorbic acid.

The results obtained from the Third National Health and Nutrition Examination Survey showed that ascorbic acid might affect the risk of *H pylori* infection[49]. In that survey, higher serum levels of ascorbic acid were associated with a decreased seroprevalence of *H pylori* and of the presence of pathogenic cagA-positive strain of *H pylori*.

The data of Park *et al*[50] demonstrated that vitamin C levels in whole blood, plasma, and gastric juice and the gastric juice pH in Korean children were closely related to the severity of *H pylori* infection and the histologic changes in the stomach. These data suggest that vitamin C may play a role in determining *H pylori* infection and its progression. Thus, vitamin C supplementation might be an important tool for the management of *H pylori* infection.

There were no differences between analysed lifestyle factors between patients with *H pylori* re-infection and the control group. However, the results of some surveys indicate the influence of socioeconomic status on *H pylori* infection[10-12]. Authors of a Polish study in Lodz observed a much higher prevalence of *H pylori* infection in children from poor living conditions[10]. In adults from Lublin, the *H pylori* infection was strongly affected by the lack of basic personal hygiene[12]. In the Czech Republic, the highest risk of *H pylori* infection was found in children of mothers with basic or lower education, living in crowded accommodations, without access to running warm water, and residing in smaller towns[11]. Low education and heavy smoking were most strongly associated with prevalence of *H pylori* infection in adults and adolescents. Smoking might also influence *H pylori* eradication rates. For example, a Colombian study in patients who smoked found that *H pylori* treatment was less effective[51]. Whereas data from Turkey supported the finding that personal and environmental conditions in adults did not affect *H pylori* infectivity[52]. Such factors as family income, living conditions, smoking, alcohol consumption and hygiene did not differ statistically between the *H pylori* positive and negative subjects. Smoking, alcohol consumption, number of children and pets in the household were also not associated with *H pylori* positivity among adolescents from Novosibirsk[53].

We studied only a few lifestyle factors without taking into account living conditions, personal hygiene and educational level that could influence *H pylori* re-infection. The lack of any relation between working, tiredness, stress exposure and *H pylori* re-infection could be caused by the fact that the majority of studied patients were retired. In our study, smoking did not influence of *H pylori* status, but not all surveys agree with our finding.

To summarise the results of some of the reviewed studies, the regular consumption of fermented milk products and fruit and vegetables might significantly reduce the risk of *H pylori* re-infection and this effect could be used in the prevention of the infection among persons in whom *H pylori* infection had been previously eradicated.

COMMENTS

Background

Helicobacter pylori (*H pylori*) infection is the main cause of peptic ulcer disease (70%-90% of cases) and in 1% of infected persons, leads to the development of gastric cancer. The treatment of *H pylori* infection is difficult and requires a two-week application of at least three medicines simultaneously. In some patients, *H pylori* re-infection occurs after eradication; but, factors responsible for this phenomenon have not yet been identified. It is presumed that these might be at least partly related to poor sanitary conditions and improper lifestyle, especially diet.

Research frontiers

H pylori re-infection affects ca. 1%-13% of patients annually; therefore, it is very important to find out how to lower the risk of *H pylori* re-infection. In this study, the dietary and some socio-economic factors after successful eradication of *H pylori* infection were evaluated. The goal of this retrospective study was to point out potential differences in the dietary patterns of patients with *H pylori* re-infection and in the control not-re-infected group.

Innovations and breakthroughs

The majority of the studies concerned the influence of dietary patterns on *H pylori* infection. The present research used a specially designed questionnaire to find out which factors lower the risk of *H pylori* re-infection.

Applications

The results suggest that the regular consumption of fermented milk products and fruit and vegetables might significantly reduce the risk of *H pylori* re-infection and this effect could be used in the prevention of re-infection among persons in whom the infection had been previously eradicated. The results could also be helpful in preparation of dietary guidelines for patients after *H pylori* eradication.

Terminology

Antioxidant: An antioxidant is a molecule (especially vitamins and microelements) capable of neutralizing free radicals which damage cells; Eradication: Eradication is the elimination or destruction of a thing or group (in this article it is bacteria-*H pylori*); Probiotics: Probiotics are live microorganisms which, when administered in adequate amounts, confer a health benefit on the host; Supernatant: Supernatant is a liquid remaining above the solid after chemical reaction.

Peer review

The main aspects of the paper are adequate. The discussion is complete and deals with different thoughts that are currently controversial. In summary, this is a good retrospective analysis of factors probably related with *H pylori* re-infection.

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