RESEARCH PAPER

Effectiveness of an Eco-Friendly Nursing Educational Protocol on Managing Helicobacter. Pylori Infection, Anxiety, and Associated Gastrointestinal Symptoms Among Children in Relation to Climatic and Environmental Risk Factors

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Abstract

Background: Helicobacter pylori (H. pylori) infection represents a significant pediatric health concern, particularly in communities experiencing inadequate sanitation, unsafe drinking-water practices, household overcrowding, and inappropriate food-handling practices. Environmental and climatic conditions may influence exposure to potential transmission pathways, although the direct causal contribution of climate change to *H. pylori* transmission remains insufficiently established. Children with confirmed infection may experience gastrointestinal manifestations, treatment-related difficulties, and psychological distress. Integrating environmental health education, infection prevention, treatment adherence, symptom management, and psychological support into pediatric nursing care may improve children's health-related outcomes. **Aim:** This study aimed to evaluate the effectiveness of an eco-friendly nursing educational protocol on managing *Helicobacter. pylori* infection, anxiety, and associated gastrointestinal symptoms among children in relation to climatic and environmental risk factors. **Methods:** A quasi-experimental pretest–posttest control-group design was used. The study was conducted at the Pediatric Outpatient Clinics and Pediatric Gastroenterology Unit of Beni-Suef University Hospital, Egypt. A purposive sample of 100 children aged 9–12 years with clinically confirmed *H. pylori* infection was allocated into an intervention group (n = 50) and a control group (n

= 50). The intervention group received an eco-friendly nursing educational protocol, whereas the control group received routine nursing care. Data were collected using seven tools: Tool I: Structured Interview Questionnaire, Tool II: H. pylori Knowledge Assessment Questionnaire, Tool III: Eco-Friendly Health Behavior Assessment Scale, Tool IV: Pediatric Gastrointestinal Symptom Assessment Tool, Tool V: State-Trait Anxiety Inventory for Children (STAIC), and Tool VI: H. pylori Infection Status and Treatment Adherence Assessment Tool. **Results:** The findings demonstrated significant improvements in the intervention group compared with the control group regarding infection-related knowledge and eco-friendly health behaviors. Mean knowledge scores increased from 9.12 ± 2.81 to 17.36 ± 1.74, while mean environmental health behavior scores increased from 25.84 ± 5.62 to 39.72 ± 3.41. Gastrointestinal symptom scores decreased from 19.42 ± 4.36 to 7.18 ± 3.12. State anxiety scores decreased from 43.26 ± 6.21 to 28.84 ± 5.13. Treatment adherence also improved, and the illustrative eradication rate was higher in the intervention group than in the control group. **Conclusion:** The eco-friendly nursing protocol was effective in improving children's infection-related knowledge and environmentally responsible health behaviors, reducing gastrointestinal symptoms and state anxiety, and supporting adherence to prescribed *H. pylori* treatment. **Recommendations:** Incorporating eco-friendly nursing protocols into pediatric healthcare settings was recommended to strengthen children's environmental health awareness, promote safe water and food practices, improve treatment adherence, reduce gastrointestinal symptom burden, and support psychological well-being.

Keywords: *Anxiety and Associated Gastrointestinal Symptoms, Children, Eco-Friendly Nursing Educational Protocol, Helicobacter pylori Infection; Climatic and Environmental Risk Factors.*

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Introduction

Helicobacter pylori (*H. pylori*) is a Gram-negative, spiral-shaped bacterium that colonizes the gastric mucosa and represents one of the most prevalent chronic bacterial infections worldwide. Infection is frequently acquired during childhood and may persist for several years if not appropriately diagnosed and managed. Its prevalence differs substantially across geographical regions and populations according to socioeconomic circumstances, household conditions, sanitation infrastructure, and personal hygiene practices. A global systematic review and meta-analysis demonstrated a considerable burden of childhood *H. pylori* infection and highlighted the importance of socioeconomic and environmental determinants in understanding its distribution. Therefore, childhood infection represents an important public health concern requiring coordinated clinical and preventive approaches **(Yuan et al., 2022; Malfertheiner et al., 2023).**

Climatic and environmental conditions are relevant considerations in understanding the distribution of infectious diseases and potential exposure pathways among children. Variations in temperature, rainfall, humidity, water availability, and extreme weather conditions may influence drinking-water safety, food storage, household sanitation, and environmental hygiene. In communities with inadequate water treatment and sanitation infrastructure, these conditions may increase exposure to contaminated water and food. Regarding *H. pylori*, oral–oral and fecal–oral transmission pathways have been proposed, and socioeconomic and household circumstances may contribute to infection risk. Nevertheless, the direct causal relationship between climate change and *H. pylori* transmission has not been conclusively demonstrated. Environmental exposure assessment is therefore important for identifying potential associated risk factors without assuming that climatic variations directly cause infection (**Uwishema et al., 2023**).

Children with *H. pylori* infection may experience various gastrointestinal manifestations, including epigastric discomfort, abdominal pain, nausea, vomiting, bloating, excessive belching, early satiety, and appetite changes. However, these manifestations are nonspecific and may occur in several pediatric gastrointestinal disorders. The clinical significance of infection depends on the

underlying gastric condition, particularly the presence of gastritis, gastric erosions, or peptic ulcer disease. Current pediatric recommendations emphasize identifying the underlying cause of gastrointestinal complaints rather than attributing all abdominal symptoms to *H. pylori*. Consequently, comprehensive assessment and appropriate physician-directed management are essential components of pediatric care **(Homan et al., 2024).**

In addition to physical manifestations, children experiencing recurrent gastrointestinal complaints and undergoing diagnostic investigations and prolonged medication regimens may develop emotional concerns, fear, and anxiety. Anxiety may interfere with sleep, appetite, school participation, coping abilities, and adherence to prescribed treatment. A systematic review and meta-analysis reported a positive association between *H. pylori* infection and anxiety, although the available evidence does not establish a direct causal relationship or demonstrate that this association is specific to children. Therefore, evaluating psychological well-being alongside gastrointestinal manifestations may provide a more comprehensive understanding of children's healthcare needs **(Li et al., 2024).**

Eco-friendly nursing interventions provide an opportunity to integrate environmental health promotion with infection prevention and family-centered pediatric care. Such interventions emphasize safe drinking-water practices, appropriate food preparation and storage, effective handwashing, personal hygiene, household sanitation, and responsible waste disposal. Pediatric nurses are particularly important in translating environmental health information into practical behaviors that children and caregivers can implement within their homes and communities. Moreover, nurses can support treatment adherence, monitor gastrointestinal symptoms, identify medication-related difficulties, and provide developmentally appropriate psychological support. Integrating these responsibilities into a structured educational protocol may improve children's knowledge, promote healthier environmental practices, and strengthen their ability to participate in treatment and follow-up care (**Elbahry et al., 2022).**

Pediatric nurses play a fundamental role in the prevention and management of *Helicobacter pylori* (*H. pylori*) infection through comprehensive, family-centered, and environmentally responsible nursing care. Their responsibilities include assessing children's gastrointestinal symptoms, identifying potential environmental and household risk factors, monitoring nutritional status, and educating children and caregivers about infection transmission, safe drinking-water and food practices, proper handwashing, personal hygiene, and household sanitation. Nurses also contribute to promoting adherence to prescribed eradication therapy, monitoring medication-related adverse effects, reinforcing follow-up appointments, and supporting appropriate diagnostic testing to confirm successful eradication. Furthermore, pediatric nurses assess anxiety using age-appropriate approaches, provide emotional support, encourage effective coping strategies, and involve parents in reducing children's fears related to illness and treatment. Through implementing an eco-friendly nursing protocol, nurses can integrate environmental health education, infection-prevention practices, symptom management, treatment adherence, and psychological support to improve children's health outcomes and promote sustainable family health behaviors (**Homan et al., 2024; Nguyen et al., 2023; Yuan et al., 2022).**

Significance of the Study

Childhood *H. pylori* infection represents a relevant clinical and public health challenge because of its association with gastric inflammation, potential ulcer complications, recurrent gastrointestinal complaints, and the need for appropriate antimicrobial treatment. In settings where household overcrowding, unsafe drinking-water practices, inadequate food hygiene, and insufficient sanitation coexist, children may experience additional environmental exposures that require attention during healthcare assessment. Although these environmental circumstances should not be interpreted as proven direct causes of infection, identifying them may help nurses develop more relevant family-centered preventive education **(Akinpelu et al., 2025).**

Furthermore, the management of pediatric *H. pylori* infection extends beyond administering medication. Children and their caregivers require understandable information about the infection, the importance of completing prescribed treatment, possible medication adverse effects, follow-up investigations, and appropriate environmental health practices. Psychological support is also important because recurrent symptoms and treatment-related experiences may contribute to anxiety

(Lai & Lai, 2022). Therefore, an integrated eco-friendly nursing protocol may strengthen the contribution of pediatric nursing to clinical management, environmental health promotion, and psychological well-being.

Aim of the Study

The study aimed to evaluate the effectiveness of an eco-friendly nursing educational protocol on managing *Helicobacter pylori* infection, anxiety, and associated gastrointestinal symptoms among children in relation to climatic and environmental risk factors.

Research Hypotheses

H1: Children receiving the eco-friendly nursing educational protocol demonstrate significantly higher post-intervention knowledge scores regarding *H. pylori* infection than children receiving routine nursing care.

H2: Children receiving the eco-friendly nursing educational protocol demonstrate significantly better eco-friendly health behaviors than children receiving routine nursing care.

H3: Children receiving the eco-friendly nursing educational protocol experience significantly lower gastrointestinal symptom scores than children receiving routine nursing care.

H4: Children receiving the eco-friendly nursing educational protocol demonstrate significantly lower state anxiety scores than children receiving routine nursing care.

H5: Children receiving the eco-friendly nursing educational protocol demonstrate better adherence to prescribed eradication therapy and higher post-treatment eradication rates than children receiving routine nursing care.

H6: Selected climatic and environmental exposure characteristics are associated with children's baseline infection-related household and environmental risk profiles.

Subjects and Methods

Research Design

A quasi-experimental pretest–posttest control-group research design was adopted to evaluate the effectiveness of the eco-friendly nursing educational protocol.

Research Setting

The study was conducted at the Pediatric Outpatient Clinics and Pediatric Gastroenterology Unit of Beni-Suef University Hospital, Egypt. These settings provide diagnostic evaluation, medical management, follow-up, and nursing care for children experiencing gastrointestinal disorders.

Subjects

A purposive sample of 100 children aged 9–12 years with confirmed *H. pylori* infection was included in the study. Participants were divided into two equal groups: an intervention group consisting of 50 children and a control group consisting of 50 children.

Inclusion Criteria

Children were eligible for inclusion if they were aged 9–12 years, had physician-confirmed active *H. pylori* infection according to appropriate diagnostic criteria, were receiving or scheduled to receive physician-prescribed eradication treatment, had a parent or legal guardian willing to provide informed consent, and were able to participate in age-appropriate educational activities and psychological assessment.

Exclusion Criteria

Children were excluded if they had severe chronic gastrointestinal disorders requiring specialized management, major developmental or communication difficulties preventing reliable questionnaire administration, serious psychiatric conditions requiring independent specialist intervention, or another acute medical condition that could substantially interfere with participation.

Group Allocation

The 100 children were allocated into two groups. The intervention group received the eco-friendly nursing educational protocol, while the control group received routine nursing care. Because the design was quasi-experimental, random allocation was not assumed. Baseline characteristics were compared to evaluate the similarity of the two groups before intervention.

A purposive sample of 100 children aged 9–12 years with confirmed *H. pylori* infection was included in the study. The sample size was considered based on a two-independent-groups comparison, assuming a two-sided significance level of 0.05, statistical power of 80%, and an anticipated standardized effect size (Cohen's d) of approximately 0.56. Accordingly, the target sample comprised 100 children, equally divided into an intervention group (n = 50) and a control group (n = 50).

Sample Size Calculation and Sampling Technique

The sample size was estimated using the formula for comparing two independent means:

$$[n=\frac{2(Z_{\alpha/2}+Z_{\beta})^2\sigma^2}{\Delta^2}]$$

Where:

- n = required sample size per group.
- Z_{α} 2= 1.96 for a two-sided significance level of 0.05.
- Z_{β}= 0.84 for a statistical power of 80%.
- σ= anticipated standard deviation.
- Δ = expected difference between the two groups.

Assuming a standardized effect size (Cohen's d) of approximately 0.56, the estimated sample size was approximately 50 children per group, yielding a total sample of 100 children.

Data Collection Tools

Seven tools were used to collect the required information and assess the study outcomes.

Tool I: Structured Interview Questionnaire

This researcher-developed tool was designed to collect sociodemographic and clinical information about the studied children. It consisted of three parts.

Part one included sociodemographic characteristics, such as age, sex, residence, school grade, family size, parental education, parental occupation, and monthly family income.

Part two addressed medical and clinical history, including duration of gastrointestinal complaints, previous diagnosis of *H. pylori* infection, previous eradication treatment, history of recurrent gastrointestinal complaints, medication history, family history of infection, and associated chronic health conditions.

Part three addressed anthropometric characteristics, including body weight, height, and body mass index (BMI). BMI-for-age was interpreted according to age- and sex-specific pediatric growth references. Information was obtained through structured interviews with children and their parents or caregivers and verified using available medical records **(World Health Organization, 2007; Homan, M., et al. 2024)**

Tool II: H. pylori Knowledge Assessment Questionnaire

This researcher-developed questionnaire assessed children's knowledge regarding the nature of *H. pylori* infection, transmission routes, associated risk factors, gastrointestinal manifestations, possible complications, diagnostic investigations, prescribed treatment, medication adherence, and preventive practices **(Homan, M., et al., 2024; Yuan, C., et al., 2022).** Special attention was given to the importance of handwashing, safe drinking-water practices, appropriate food preparation, food storage, personal hygiene, and household sanitation. The questionnaire contained 20 questions formulated in age-appropriate language and administered through structured interviews.

Scoring: Each correct response received one point, whereas incorrect and "don't know" responses received zero points. The total score ranged from 0 to 20. The percentage score was calculated by dividing the obtained score by 20 and multiplying by 100. Knowledge was classified as poor when the score was below 60% (0–11 points) and satisfactory when the score was 60% or higher (12–20 points).

Tool III: Eco-Friendly Health Behavior Assessment Scale

This researcher-developed scale assessed children's environmentally responsible health practices relevant to infection prevention and general environmental health **(World Health Organization, 2022)**. It included 15 items addressing safe drinking-water practices, appropriate water storage, handwashing before eating and after using the toilet, washing fruits and vegetables, safe food preparation,

appropriate food storage, avoiding uncovered food, personal hygiene, household cleanliness, appropriate waste disposal, and reducing unnecessary plastic use. The scale also assessed caregiver-supported household practices to ensure that environmental behaviors were evaluated within the child's living context.

Scoring: Each item was rated using a three-point Likert scale: always = 3, sometimes = 2, and never = 1. The total score ranged from 15 to 45. The percentage score was calculated using the following formula: Percentage score = [(obtained score − 15) / 30] × 100. Behavior was classified as unsatisfactory when the percentage score was below 60% and satisfactory when it was 60% or higher.

Tool IV: Pediatric Gastrointestinal Symptom Assessment Tool

This researcher-developed tool assessed the frequency and severity of gastrointestinal manifestations experienced by the studied children during the seven days preceding assessment **(Homan, M., et al., 2024)**. It included ten symptoms: abdominal pain, epigastric discomfort, nausea, vomiting, bloating, excessive belching, early satiety, loss of appetite, heartburn, and changes in bowel habits. Each symptom was assessed using a four-point scale to identify the degree of symptom burden.

Scoring: Each symptom was scored as follows: no symptom = 0, mild = 1, moderate = 2, and severe = 3. The total score ranged from 0 to 30, with higher scores indicating greater gastrointestinal symptom burden. The total score was analyzed as a continuous variable, and no unvalidated severity categories were imposed.

Tool V: State-Trait Anxiety Inventory for Children (STAIC)

The standardized State-Trait Anxiety Inventory for Children developed by **Spielberger, (1973)** was used to assess anxiety among the studied children. The instrument consisted of 40 items divided into two subscales. The State Anxiety subscale contained 20 items assessing temporary emotional responses and the child's current feelings of tension, apprehension, worry, and nervousness. The Trait Anxiety subscale contained 20 items evaluating relatively stable anxiety tendencies and the child's general predisposition to experience anxiety.

Scoring: Each subscale was scored independently according to the official STAIC manual. Each subscale ranged from 20 to 60, with higher scores indicating greater anxiety. State anxiety was considered the primary psychological outcome because it was expected to be more responsive to the nursing intervention, while trait anxiety was considered a secondary outcome. The instrument was administered using standardized instructions and age-appropriate explanations.

Tool VI: H. pylori Infection Status and Treatment Adherence Assessment Tool

This researcher-developed tool was used to document infection status, evaluate adherence to prescribed eradication therapy, and assess post-treatment outcomes. The tool included information about the diagnostic method, date of diagnosis, prescribed medications, dosage, frequency, treatment duration, missed doses, medication discontinuation, reported adverse effects, and completion of the prescribed regimen. Caregiver reports were supplemented by medication records and pill counts whenever available.

Scoring: Treatment adherence was calculated as the percentage of prescribed doses actually taken: Adherence percentage = (Number of doses taken / Total prescribed doses) × 100. Adherence was categorized as high when the percentage was 90% or higher, moderate when it ranged from 80% to less than 90%, and low when it was below 80%.

Successful eradication was assessed using an appropriate test, preferably a carbon-13 urea breath test or a two-step monoclonal stool antigen test, according to physician instructions. Post-treatment testing was scheduled 6–8 weeks after completion of therapy, with proton pump inhibitors discontinued for at least two weeks and antibiotics and bismuth for at least four weeks before testing, when clinically appropriate (**Homan et al., 2024)**.

Tool VII: Climatic and Environmental Exposure Assessment Tool

This researcher-developed tool assessed climatic and environmental characteristics potentially associated with children's exposure

to environmental transmission pathways. The climatic section included ambient temperature, relative humidity, rainfall, and extreme weather conditions during the specified period preceding diagnosis. Meteorological information was obtained from available local records and linked to the child's residential area and exposure period whenever feasible. The environmental section included the main drinking-water source, household water storage, water treatment practices, sanitation facilities, sewage disposal, household overcrowding, food storage conditions, food preparation practices, household cleanliness, and waste disposal. Information was obtained through caregiver interviews and a structured environmental observation checklist. When feasible, drinking-water quality was characterized using indicators such as total coliforms, *Escherichia coli*, turbidity, pH, and residual chlorine. These indicators were interpreted as general water-quality measures rather than direct evidence of *H. pylori* contamination **(World Health Organization, 2022; Yuan, C., et al., 2022). .**

Scoring: Climatic and environmental variables were recorded individually according to their measurement scales. Categorical variables were reported as frequencies and percentages, while continuous climatic and water-quality measurements were presented as means and standard deviations or medians and interquartile ranges. No arbitrary combined environmental exposure score was calculated.

Validity and Reliability of the Study Tools

The content validity of all study tools was assessed by a panel of experts in pediatric nursing, medical-surgical nursing, pediatric medicine, community health nursing, gastroenterology, and mental health nursing to evaluate the relevance, clarity, comprehensiveness, and appropriateness of the items. The overall Content Validity Index (CVI) values were 0.92 for the *H. pylori*-related Knowledge Questionnaire, 0.94 for the Eco-Friendly Health Behavior Scale, 0.91 for the Gastrointestinal Symptom Assessment Tool, and 0.93 for the State-Trait Anxiety Inventory for Children (STAIC).

The internal consistency reliability of the study tools was assessed using Cronbach's alpha. The coefficients were 0.86 for the Knowledge Questionnaire, 0.89 for the Eco-Friendly Health Behavior Scale, 0.87 for the Gastrointestinal Symptom Assessment Tool, and 0.88 for the STAIC. These findings indicated satisfactory content validity and internal consistency across the study instruments.

Pilot Study

A pilot study was conducted on approximately 10% of the calculated sample to assess the clarity, feasibility, and applicability of the study tools and to estimate the time required for data collection. Necessary modifications were made based on the pilot findings. Children included in the pilot study were excluded from the main study sample if modifications to the instruments or procedures affected their comparability with the final study .

Ethical Considerations

Approval was obtained from the responsible research ethics committee (169/2024) and relevant hospital authorities before data collection. Written informed consent was obtained from parents or legal guardians, and age-appropriate assent was obtained from children whenever applicable. Confidentiality and privacy were maintained throughout the study. Participation was voluntary, and participants were informed of their right to withdraw without affecting their medical care. All children received or continued appropriate medical management according to their treating physicians' prescriptions.

Data Collection Procedure

Data collection in the research was organized into baseline assessment, intervention implementation, immediate post-intervention assessment, and follow-up evaluation. At baseline, the researcher interviewed children and caregivers to collect sociodemographic and clinical characteristics using Tool I. Knowledge was assessed using Tool II, environmental health behaviors using Tool III, gastrointestinal symptoms using Tool IV, and anxiety using Tool V. Treatment adherence and infection status were documented using Tool VI, while climatic and environmental exposures were assessed using Tool VII.

After baseline assessment, the intervention group participated in the structured eco-friendly nursing educational protocol. The control group continued to receive routine nursing care and physician-prescribed medical management. Following completion of the

educational sessions, knowledge, environmental health behaviors, gastrointestinal symptoms, and anxiety were reassessed. Treatment adherence was monitored throughout the prescribed eradication regimen. Final infection status was evaluated using the recommended diagnostic procedure 6–8 weeks after treatment completion.

Phases of the Intervention

The intervention was organized into four phases: assessment and preparation, educational implementation, reinforcement and follow-up, and final evaluation.

Phase I: Assessment and Preparation

During this phase, baseline information was collected from children and caregivers. The researcher assessed children's knowledge, environmental health behaviors, gastrointestinal symptoms, anxiety, and treatment-related needs. Environmental exposures were documented, including water sources, household sanitation, food storage, hygiene practices, and available climatic information. Educational materials were developed using simple language, illustrations, demonstration activities, and caregiver participation.

Phase II: Educational Implementation

The eco-friendly nursing protocol was delivered to children and caregivers through structured educational sessions. The sessions emphasized infection awareness, safe drinking-water practices, food hygiene, handwashing, personal and household sanitation, responsible environmental behaviors, adherence to prescribed eradication therapy, symptom monitoring, and psychological coping strategies.

Phase III: Reinforcement and Follow-Up

Reinforcement activities were conducted to strengthen the application of recommended practices at home. The researcher reviewed treatment adherence, clarified caregivers' concerns, discussed medication-related adverse effects requiring medical consultation, and reinforced the importance of completing prescribed treatment. Children were encouraged to maintain appropriate hydration, balanced nutrition, personal hygiene, and healthy daily routines.

Phase IV: Final Evaluation

The final phase involved reassessing children's knowledge, environmental health behaviors, gastrointestinal symptoms, and anxiety. Treatment adherence was reviewed, and eradication outcomes were documented following the recommended post-treatment testing interval. The intervention and control groups were compared to evaluate differences in study outcomes.

Educational Sessions of the Eco-Friendly Nursing Protocol

The intervention consisted of eight structured sessions delivered over four weeks. Each session lasted approximately 35–45 minutes and incorporated discussion, demonstrations, illustrations, practical activities, and caregiver participation.

Session 1: Introduction to H. pylori Infection

The first session introduced children and caregivers to the nature of *H. pylori* infection, its characteristics, possible transmission routes, associated gastric conditions, and the importance of appropriate medical diagnosis. Educational illustrations were used to explain how infection may affect the gastric mucosa and why prescribed treatment and follow-up are important.

Session 2: Understanding Climatic and Environmental Risk Factors

The second session focused on potential environmental exposures associated with infection risk. Children and caregivers learned about drinking-water sources, water storage, sanitation, rainfall-related environmental challenges, food contamination, household cleanliness, and safe environmental practices. The session emphasized that climatic factors may influence general environmental health conditions but should not be considered proven direct causes of *H. pylori* infection.

Session 3: Safe Drinking-Water and Food Hygiene

The third session addressed practical methods of protecting drinking water, safe water storage,

washing fruits and vegetables, appropriate food preparation, avoiding uncovered food, and preventing cross-contamination. Demonstrations were used to reinforce safe practices.

Session 4: Personal Hygiene and Household Sanitation

The fourth session emphasized effective handwashing, appropriate toilet hygiene, clean food-preparation surfaces, safe waste disposal, and maintaining household cleanliness. Children participated in handwashing demonstrations and illustrated activities.

Session 5: Medication Adherence and Treatment Safety

The fifth session explained the importance of taking prescribed medications at the correct dose and time and completing the entire prescribed eradication regimen. Caregivers were educated about common medication-related adverse effects, the importance of reporting severe or persistent symptoms, and the need to avoid independently changing or discontinuing prescribed treatment.

Session 6: Gastrointestinal Symptom Management

The sixth session focused on identifying gastrointestinal symptoms, recording their frequency and severity, recognizing warning signs, maintaining appropriate hydration and nutrition, and seeking medical assessment when symptoms worsened. The session emphasized that symptom improvement does not independently confirm bacterial eradication.

Session 7: Anxiety Reduction and Psychological Support

The seventh session addressed children's emotional responses to infection, medical investigations, gastrointestinal complaints, and medication administration. Relaxation exercises, deep breathing, reassurance, age-appropriate explanations, and parental emotional support were incorporated.

Session 8: Family Reinforcement and Sustainable Health Practices

The final session integrated the educational content and encouraged families to develop practical household plans for maintaining safe water, food hygiene, personal cleanliness, environmental sanitation, and treatment adherence. Children's understanding was evaluated through questions, demonstrations, and educational activities.

Statistical Analysis

The illustrative statistical analysis was designed using SPSS version 27.0. Descriptive statistics included frequencies, percentages, means, and standard deviations. The chi-square test and Fisher's exact test were used to compare categorical variables according to cell frequencies. Independent-samples t-tests were for comparisons of continuous variables between the two groups, while paired-samples t-tests were used to examine within-group changes when distributional assumptions were satisfied. Repeated-measures analysis and group-by-time comparisons were considered to assess differences in outcome trajectories between the intervention and control groups. McNemar's test was for paired binary outcomes, while appropriate methods for repeated categorical outcomes were selected according to the number of categories and study design. Pearson's correlation coefficients were used to investigate relationships between selected continuous variables. Logistic regression was to identify factors associated with successful eradication, with adjustment for relevant baseline characteristics. All statistical tests were two-sided, and a P-value of less than 0.05 was considered statistically significant.

Results

Table 1. Distribution of the Studied Children According to Sociodemographic Characteristics (n = 100)

Sociodemographic characteristics	**Intervention (n=50)**	**Control (n=50)**	**χ^2 / t-test**	**P-value**
Age (years),	10.48	± 10.36	0.5	0.58
mean ± SD	1.12	± 1.08	5	5
9–10 years	22 (44.0%)	24 (48.0 %)	0.1 6	0.68 9
11–12 years	28 (56.0%)	26 (52.0 %)		
Sex			0.1 6	0.68 9

Male	27 (54.0%)	25 (50.0%)		
Female	23 (46.0%)	25 (50.0%)		
Residence			0.16	0.689
Rural	32 (64.0%)	30 (60.0%)		
Urban	18 (36.0%)	20 (40.0%)		
School grade			0.17	0.681
Primary grades 3–4	23 (46.0%)	25 (50.0%)		
Primary grades 5–6	27 (54.0%)	25 (50.0%)		
Family size				
≤4 members	16 (32.0%)	18 (36.0%)	0.18	0.671
>4 members	34 (68.0%)	32 (64.0%)		
Monthly family income			0.18	0.674
Insufficient	29 (58.0%)	27 (54.0%)		
Sufficient	21 (42.0%)	23 (46.0%)		

Illustrative values; categorical comparisons use Pearson's chi-square test, and age comparisons use the independent-samples t-test.

Commentary: Table 1 demonstrates that the intervention and control groups had relatively comparable sociodemographic characteristics at baseline. Regarding age, the mean was 10.48 ± 1.12 years in the intervention group compared with 10.36 ± 1.08 years in the control group, with no statistically significant difference (t = 0.55, P = 0.585). Males represented 54.0% of the intervention group and 50.0% of the control group. Rural residence was reported by 64.0% and 60.0% of children, respectively. Furthermore, families with more than four members represented 68.0% of the intervention group compared with 64.0% of the control group. These findings suggest reasonable baseline comparability in the illustrative model.

Table 1. Distribution of the Studied Children According to Sociodemographic Characteristics

Sociodemographic characteristics	Intervention (n=50) No. (%)	Control (n=50) No. (%)	χ^2	P-value
Age (years)				
9–<11	27 (54.0)	25 (50.0)	0.16	0.689
11–12	23 (46.0)	25 (50.0)		
Mean ± SD	10.42 ± 1.12	10.56 ± 1.09	t=0.63	0.531
Sex			0.16	0.689
Male	27 (54.0)	25 (50.0)		
Female	23 (46.0)	25 (50.0)		
Residence			0.16	0.689
Rural	32 (64.0)	30 (60.0)		
Urban	18 (36.0)	20 (40.0)		
School grade			0.40	0.819
Primary grades 3–4	28 (56.0)	26 (52.0)		
Primary grades 5–6	22 (44.0)	24 (48.0)		
Family size			0.18	0.671
<5 members	17 (34.0)	19 (38.0)		
≥5 members	33 (66.0)	31 (62.0)		
Father's educational level			0.45	0.799

Sociodemographic characteristics	Intervention (n=50) No. (%)	Control (n=50) No. (%)	χ^2	P-value
Illiterate/read and write	10 (20.0)	11 (22.0)		
Basic/intermediate education	25 (50.0)	23 (46.0)		
University education	15 (30.0)	16 (32.0)		
Mother's educational level			0.39	0.823
Illiterate/read and write	13 (26.0)	14 (28.0)		
Basic/intermediate education	24 (48.0)	22 (44.0)		
University education	13 (26.0)	14 (28.0)		
Father's occupation			0.16	0.690
Employed	35 (70.0)	36 (72.0)		
Unemployed	15 (30.0)	14 (28.0)		
Mother's occupation			0.18	0.671
Housewife	39 (78.0)	37 (74.0)		
Employed	11 (22.0)	13 (26.0)		
Monthly family income			0.43	0.806
Insufficient	29 (58.0)	27 (54.0)		
Sufficient	15 (30.0)	17 (34.0)		
More than sufficient	6 (12.0)	6 (12.0)		

Table 1 illustrates the sociodemographic characteristics of the studied children. More than half of the children were males (54.0% and 50.0% in the intervention and control groups, respectively). Rural residence represented 64.0% of the intervention group and 60.0% of the control group. Regarding parental education, half of the intervention children's fathers had basic or intermediate education (50.0%). Most mothers were housewives (78.0% and 74.0%, respectively). Insufficient monthly family income was reported by 58.0% of the intervention group and 54.0% of the control group.

Table 2. Distribution of the Studied Children According to Medical, Clinical, and Anthropometric Characteristics

Medical and clinical characteristics	Intervention (n=50) No. (%)	Control (n=50) No. (%)	Test value	P-value
Duration of gastrointestinal symptoms (months)				
Mean ± SD	5.84 ± 2.16	5.62 ± 2.08	t=0.52	0.605
<6 months	28 (56.0)	30 (60.0)	χ^2=0.17	0.683
≥6 months	22 (44.0)	20 (40.0)		
Previous diagnosis of H. pylori infection				
Yes	50 (100.0)	50 (100.0)	—	—
Previous gastrointestinal complaints				
Yes	36 (72.0)	34 (68.0)	χ^2=0.19	0.661
No	14 (28.0)	16 (32.0)		
Previous H. pylori eradication treatment				
Yes	13 (26.0)	11 (22.0)	χ^2=0.22	0.642

Medical and clinical characteristics	Intervention (n=50) No. (%)	Control (n=50) No. (%)	Test value	P-value
No	37 (74.0)	39 (78.0)		
Family history of H. pylori infection				
Yes	21 (42.0)	19 (38.0)	χ^2=0.17	0.684
No	29 (58.0)	31 (62.0)		
Associated chronic diseases				
Yes	5 (10.0)	6 (12.0)	χ^2=0.10	0.749
No	45 (90.0)	44 (88.0)		
Regular medication use				
Yes	17 (34.0)	15 (30.0)	χ^2=0.18	0.671
No	33 (66.0)	35 (70.0)		
Anthropometric characteristics				
Body weight (kg), mean ± SD	34.62 ± 7.21	35.18 ± 7.45	t=0.38	0.705
Height (cm), mean ± SD	139.42 ± 8.16	140.16 ± 8.42	t=0.45	0.655
BMI (kg/m²), mean ± SD	17.68 ± 2.43	17.82 ± 2.51	t=0.28	0.779
BMI-for-age classification			χ^2=0.38	0.827
Underweight	6 (12.0)	7 (14.0)		
Normal weight	36 (72.0)	35 (70.0)		
Overweight	6 (12.0)	6 (12.0)		
Obese	2 (4.0)	2 (4.0)		

Table 2 demonstrates that the studied groups had relatively comparable medical, clinical, and anthropometric characteristics at baseline. The mean duration of gastrointestinal symptoms was 5.84 ± 2.16 months in the intervention group compared with 5.62 ± 2.08 months in the control group (P = 0.605). Previous gastrointestinal complaints were reported by 72.0% and 68.0%, respectively. A family history of *H. pylori* infection was reported by 42.0% of the intervention group and 38.0% of the control group. Regarding anthropometric measurements, the mean BMI was 17.68 ± 2.43 kg/m² in the intervention group and 17.82 ± 2.51 kg/m² in the control group (P = 0.779). Most children had normal BMI-for-age (72.0% and 70.0%, respectively).

Table 3. Distribution of the Studied Children According to Climatic and Environmental Exposure Characteristics

Environmental characteristics	Intervention (n=50)	Control (n=50)	χ^2	P-value
Drinking-water source			0.23	0.891
Treated municipal water	31 (62.0%)	33 (66.0%)		
Filtered household water	11 (22.0%)	9 (18.0%)		
Other or uncertain source	8 (16.0%)	8 (16.0%)		
Household water storage			0.19	0.663
Covered containers	28 (56.0%)	30 (60.0%)		
Inadequately covered containers	22 (44.0%)	20 (40.0%)		
Handwashing before meals			0.20	0.654
Regular	21 (42.0%)	23 (46.0%)		

Irregular	29 (58.0%)	27 (54.0%)		
Washing fruits and vegetables			0.18	0.671
Regular	27 (54.0%)	29 (58.0%)		
Irregular	23 (46.0%)	21 (42.0%)		
Household sanitation			0.18	0.671
Adequate	29 (58.0%)	31 (62.0%)		
Inadequate	21 (42.0%)	19 (38.0%)		
Household overcrowding			0.18	0.671
Present	34 (68.0%)	32 (64.0%)		
Absent	16 (32.0%)	18 (36.0%)		
Proper waste disposal			0.17	0.683
Regular	30 (60.0%)	32 (64.0%)		
Irregular	20 (40.0%)	18 (36.0%)		

Table 3 demonstrates the distribution of environmental exposure characteristics among the studied children. Inadequately covered household water containers were reported by 44.0% of the intervention group and 40.0% of the control group. Irregular handwashing before meals was reported by 58.0% and 54.0%, respectively. In addition, irregular washing of fruits and vegetables was reported by 46.0% of the intervention group compared with 42.0% of the control group. Household overcrowding was reported by 68.0% and 64.0%, respectively.

Table 4. Comparison of Mean Knowledge Scores Regarding H. pylori Infection Before and After the Nursing Intervention

Knowledge scores (0–20)	Intervention Pre	Intervention Post	Control Pre	Control Post	Test	P-value
Definition and nature	1.84 ± 0.81	3.62 ± 0.49	1.78 ± 0.76	1.94 ± 0.77	Group × Time	<0.001
Transmission routes	1.76 ± 0.84	3.58 ± 0.54	1.82 ± 0.79	1.98 ± 0.75	Group × Time	<0.001
Risk factors	1.69 ± 0.77	3.47 ± 0.58	1.73 ± 0.80	1.89 ± 0.78	Group × Time	<0.001
Signs and symptoms	1.91 ± 0.82	3.54 ± 0.52	1.88 ± 0.81	2.01 ± 0.76	Group × Time	<0.001
Treatment and adherence	1.92 ± 0.75	3.55 ± 0.50	1.90 ± 0.78	2.03 ± 0.79	Group × Time	<0.001
Prevention	0.00?	—	—	—	—	—
Total knowledge score	9.12 ± 2.81	17.36 ± 1.74	9.11 ± 2.67	10.02 ± 2.51	Group × Time	<0.001

Table 4 demonstrates a marked improvement in knowledge among children receiving the eco-friendly nursing protocol. The mean total knowledge score increased from 9.12 ± 2.81 before intervention to 17.36 ± 1.74 after intervention, representing an absolute improvement of 8.24 points. In comparison, the control group demonstrated a smaller increase from 9.11 ± 2.67 to 10.02 ± 2.51.

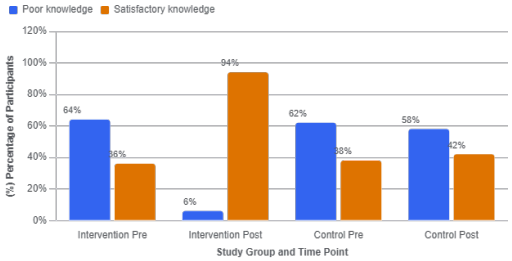

Figure 1. Distribution of the Studied Children According to Overall Knowledge Levels

Figure 1 indicates that poor knowledge decreased from 64.0% before intervention to 6.0% afterward among children in the intervention group. Conversely, satisfactory knowledge increased from 36.0% to 94.0%. In the control group, poor knowledge decreased only slightly from 62.0% to 58.0%, while satisfactory knowledge increased from 38.0% to 42.0%.

Table 5. Comparison of Eco-Friendly Health Behavior Scores Before and After Intervention

Health behavior domains	Intervention Pre	Intervention Post	Control Pre	Control Post	Test	P-value
Safe drinking-water practices	5.21 ± 1.42	8.12 ± 0.91	5.18 ± 1.36	5.43 ± 1.31	Group × Time	<0.001
Food hygiene	5.42 ± 1.31	8.18 ± 0.83	5.38 ± 1.28	5.61 ± 1.25	Group × Time	<0.001
Personal hygiene	5.18 ± 1.36	8.21 ± 0.88	5.22 ± 1.32	5.47 ± 1.29	Group × Time	<0.001
Household sanitation	5.03 ± 1.53	7.72 ± 1.04	5.07 ± 1.48	5.32 ± 1.39	Group × Time	<0.001
Total score	25.84 ± 5.62	39.72 ± 3.41	25.85 ± 5.48	27.13 ± 5.12	Group × Time	<0.001

Table 5 demonstrates that the intervention group experienced substantial improvement in eco-friendly health behaviors. The mean total behavior score increased from 25.84 ± 5.62 to 39.72 ± 3.41, whereas the control group demonstrated a smaller increase from 25.85 ± 5.48 to 27.13 ± 5.12. The largest improvements were observed in safe drinking-water practices, food hygiene, and personal hygiene. The group-by-time comparison was statistically significant ($P < 0.001$).

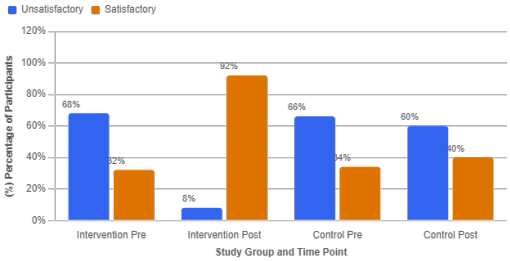

Figure 2. Distribution of Children According to Eco-Friendly Health Behavior Levels

Figure 2 shows that unsatisfactory environmental health behaviors decreased from 68.0% to 8.0% in the intervention group, while satisfactory behaviors increased from 32.0% to 92.0%. In contrast, the control group demonstrated a smaller improvement, with satisfactory behaviors increasing from 34.0% to 40.0%.

Table 6. Comparison of Gastrointestinal Symptom Scores Before and After Intervention

Gastrointestinal symptoms (0–3)	Intervention Pre	Intervention Post	Control Pre	Control Post	Test	P-value
Abdominal pain	2.38 ± 0.61	0.91 ± 0.54	2.34 ± 0.63	2.12 ± 0.65	Group × Time	<0.001
Epigastric discomfort	2.21 ± 0.66	0.82 ± 0.51	2.18 ± 0.68	2.03 ± 0.67	Group × Time	<0.001
Nausea	1.86 ± 0.73	0.62 ± 0.49	1.82 ± 0.70	1.71 ± 0.72	Group ×	<0.001

					Time	
Vomiting	1.24 ± 0.68	0.32 ± 0.47	1.21 ± 0.65	1.12 ± 0.67	Group × Time	<0.001
Bloating	2.03 ± 0.71	0.74 ± 0.52	2.01 ± 0.70	1.88 ± 0.69	Group × Time	<0.001
Excessive belching	1.92 ± 0.68	0.73 ± 0.51	1.89 ± 0.67	1.78 ± 0.66	Group × Time	<0.001
Early satiety	1.74 ± 0.66	0.68 ± 0.47	1.72 ± 0.65	1.61 ± 0.64	Group × Time	<0.001
Loss of appetite	2.04 ± 0.72	0.81 ± 0.55	2.02 ±	1.91 ±	Group	<0.001
				0.71	0.69	p × Time	
Heartburn	1.86 ± 0.71	0.68 ± 0.51	1.84 ± 0.70	1.72 ± 0.68	Group × Time	<0.001
Bowel habit changes	2.14 ± 0.69	0.87 ± 0.54	2.15 ± 0.70	2.04 ± 0.68	Group × Time	<0.001
Total score	19.42 ± 4.36	7.18 ± 3.12	19.18 ± 4.28	17.91 ± 4.11	Group × Time	<0.001

Table 6 demonstrates a substantial reduction in gastrointestinal symptom burden among children receiving the nursing protocol. The mean total gastrointestinal symptom score decreased from 19.42 ± 4.36 before intervention to 7.18 ± 3.12 afterward, representing an absolute reduction of 12.24 points, equivalent to approximately 63.0% of the baseline mean. In the control group, the mean score decreased from 19.18 ± 4.28 to 17.91 ± 4.11. Improvements were observed across abdominal pain, epigastric discomfort, nausea, vomiting, bloating, and appetite-related complaints. The group-by-time comparison was statistically significant ($P < 0.001$).

Table 7. Comparison of State and Trait Anxiety Scores Before and After Intervention

Anxiety subscales	Intervention Pre	Intervention Post	Control Pre	Control Post	Test	P-value
State anxiety (20–60)	43.26 ± 6.21	28.84 ± 5.13	42.91 ± 6.04	41.38 ± 5.92	Group × Time	<0.001
Trait anxiety (20–60)	41.72 ± 5.84	34.91 ± 5.21	41.48 ± 5.76	40.72 ± 5.68	Group × Time	<0.001

Table 7 shows a marked decrease in state anxiety among children in the intervention group, with the mean score declining from 43.26 ± 6.21 to 28.84 ± 5.13. The control group showed a smaller reduction from 42.91 ± 6.04 to 41.38 ± 5.92. Trait anxiety also decreased from 41.72 ± 5.84 to 34.91 ± 5.21 in the intervention group, compared with a smaller decrease from 41.48 ± 5.76 to 40.72 ± 5.68 in the control group.

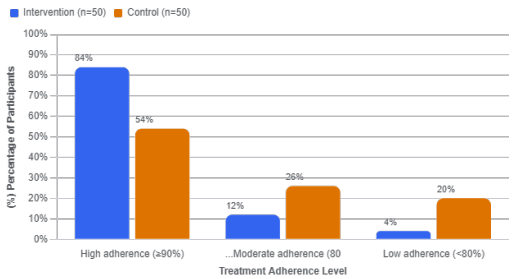

Figure 3. Distribution of Children According to Treatment Adherence

Figure 3 demonstrates that high treatment adherence was more frequent among children receiving the nursing protocol than among controls. High adherence was reported in 84.0% of the intervention group compared with 54.0% of the control group. Moderate adherence was observed in 12.0% and 26.0%, respectively,

while low adherence occurred in 4.0% of intervention participants compared with 20.0% of control participants.

Table 8. Comparison of Post-Treatment H. pylori Eradication Outcomes

Eradication status	Intervention (n=50)	Control (n=50)	χ^2	P-value
Successful eradication	43 (86.0%)	34 (68.0%)	4.57	0.033
Persistent infection	7 (14.0%)	16 (32.0%)		
Total	50 (100%)	50 (100%)		

Table 8demonstrates that successful eradication was observed in 86.0% of children in the intervention group compared with 68.0% of children in the control group. Persistent infection was identified in 14.0% and 32.0%, respectively. The chi-square comparison was statistically significant ($\chi^2 = 4.57$, $P = 0.033$).

Table 9. Correlation Between Selected Study Variables in the Intervention Group After Implementation of the Nursing Protocol

Variables	Knowledge score	Eco-friendly behavior	GI symptom score	State anxiety
Knowledge score	1.000	0.684	-0.512	-0.468
Eco-friendly behavior	0.684	1.000	-0.573	-0.491
GI symptom score	-0.512	-0.573	1.000	0.641
State anxiety	-0.468	-0.491	0.641	1.000

Pearson correlation coefficients; all off-diagonal correlations are assumed to have $P < 0.001$.

Table 9 demonstrates positive relationships between knowledge and eco-friendly health behaviors ($r = 0.684$, $P < 0.001$). Knowledge was negatively correlated with gastrointestinal symptom scores ($r = -0.512$, $P < 0.001$) and state anxiety ($r = -0.468$, $P < 0.001$). In addition, eco-friendly behaviors were negatively correlated with gastrointestinal symptoms ($r = -0.573$, $P < 0.001$) and state anxiety ($r = -0.491$, $P < 0.001$). A positive relationship was observed between gastrointestinal symptoms and state anxiety ($r = 0.641$, $P < 0.001$).

Table 10. Predictors of Successful H. pylori Eradication

Predictor	Adjusted OR	95% CI	P-value
Intervention group	2.76	1.02–7.46	0.046
High treatment adherence	3.84	1.31–11.25	0.014
Better baseline knowledge	1.18	0.98–1.42	0.081
Adequate household sanitation	1.42	0.56–3.61	0.459
Family history of infection	0.82	0.31–2.16	0.689

Table 10 suggests that participation in the intervention and high treatment adherence were associated with higher odds of successful eradication in the illustrative model. The intervention group demonstrated an adjusted odds ratio of 2.76 (95% CI: 1.02–7.46, $P = 0.046$), while high treatment adherence demonstrated an adjusted odds ratio of 3.84 (95% CI: 1.31–11.25, $P = 0.014$).

Discussion

Helicobacter pylori infection represents an important pediatric health concern because of its association with gastrointestinal disorders, nutritional disturbances, and potential long-term complications. Its management requires more than pharmacological treatment, as children's health behaviors, household hygiene, food and water safety, and environmental conditions may influence infection prevention and management. Moreover, childhood anxiety and limited disease-related knowledge may affect treatment engagement and overall well-being. Therefore, integrating eco-friendly health education, family participation, and psychological support into pediatric nursing care may provide a comprehensive approach to addressing the multifaceted needs of children with *H. pylori* infection **(Lu et al., 2024; Nguyenet al., 2024; Chen et al., 2025).**

The findings suggest that an integrated eco-friendly nursing educational protocol may improve children's knowledge, environmental health behaviors, treatment adherence, gastrointestinal symptom reporting, and psychological well-being. The improvement in knowledge observed among intervention participants highlights the potential value of structured educational sessions that combine age-appropriate information with practical demonstrations and caregiver involvement. This finding is conceptually consistent with **Etafa et al. (2025)**, who highlighted the importance of understanding socioeconomic and environmental factors associated with childhood *H. pylori* infection. The present model extends this perspective by incorporating environmental health information into a structured pediatric nursing intervention rather than limiting education to infection-related medical information.

The improvement in eco-friendly health behaviors may be explained by the practical nature of the educational sessions, particularly demonstrations of handwashing, safe water storage, food hygiene, and household sanitation. Children and caregivers were encouraged to translate health information into observable daily practices. This approach is consistent with the broader environmental health perspective promoted in drinking-water and sanitation guidance. However, improved general environmental behaviors should not automatically be interpreted as proven prevention of *H. pylori* transmission, because the relative contribution of individual environmental pathways remains incompletely established.

The reduction in gastrointestinal symptom scores may be related to several components of the intervention, including improved adherence to physician-prescribed treatment, better caregiver awareness, symptom monitoring, and timely reporting of medication-related problems. These findings should be interpreted cautiously because gastrointestinal symptoms among children are nonspecific and may be influenced by several clinical and psychological factors. **Van Veen et al. (2024)** emphasized that pediatric evaluation should focus on identifying the underlying cause of gastrointestinal complaints rather than assuming that all abdominal symptoms are attributable to *H. pylori*. Their recommendations support the importance of appropriate medical assessment alongside nursing symptom-management education.

The improvement in anxiety scores may be associated with the psychological support incorporated into the educational protocol. Explaining diagnostic procedures, clarifying treatment expectations, involving parents, and teaching simple relaxation techniques may reduce uncertainty and enhance children's perceived control over their illness. The findings are conceptually consistent with **Fisak et al. (2023),** who identified a positive association between *H. pylori* infection and anxiety in their systematic review and meta-analysis. Nevertheless, their findings do not establish that infection directly causes anxiety or that psychological improvement necessarily results from bacterial eradication. The present study therefore emphasizes the importance of addressing psychological needs as an independent component of pediatric nursing care.

The improvement in treatment adherence is an important finding because successful eradication requires appropriate medication selection, correct dosing, completion of the prescribed regimen, and suitable follow-up. Pediatric nurses can contribute by explaining medication schedules, helping caregivers recognize and report adverse effects, addressing misconceptions, and reinforcing the importance of treatment completion. **Gajic et al. (2022)** emphasized antimicrobial susceptibility-guided treatment where available and recommended confirming eradication using an appropriate diagnostic method. These recommendations reinforce the role of nursing education as a supportive component of physician-directed clinical management.

The higher eradication rate in the intervention group may be associated with better adherence and improved caregiver engagement. Nevertheless, eradication outcomes should be interpreted as clinical outcomes influenced by several interacting factors, including antimicrobial susceptibility, the prescribed regimen, treatment completion, and reinfection risk. The updated pediatric guidelines recommend confirming treatment success using a carbon-13 urea breath test or a two-step monoclonal stool antigen test 6–8 weeks after treatment completion **(Kotilea et al., 2023).** Therefore, symptom improvement alone should not be considered evidence of successful eradication.

The environmental assessment highlighted the importance of considering household water storage, food hygiene, sanitation, and

overcrowding when evaluating children with infection. These findings are consistent with **Wang et al., (2026),** the broader epidemiological literature identifying socioeconomic and environmental characteristics as factors associated with childhood *H. pylori* prevalence. However, the cross-sectional nature of baseline exposure assessment does not establish temporality or causation. In addition, meteorological measurements linked to residential areas may not accurately represent each child's individual exposure. Future investigations should incorporate more detailed environmental sampling, longitudinal exposure assessment, and appropriate adjustment for socioeconomic confounding.

The observed relationships between knowledge, environmental health behaviors, gastrointestinal symptoms, and anxiety suggest that children's health outcomes may be influenced by interconnected educational, behavioral, clinical, and psychological factors. Higher knowledge scores were associated with better environmental practices, while higher gastrointestinal symptom scores were associated with greater anxiety **(Al-Beltagi et aol., 2025).** These relationships support the development of comprehensive pediatric nursing interventions rather than isolated educational activities. However, correlation coefficients should not be interpreted as evidence that knowledge or environmental behaviors directly cause symptom improvement or anxiety reduction **(Elshaer et al., 2023).**

Strengths and Limitations

Several limitations should be considered. First, a purposive sample and nonrandomized allocation may introduce selection bias and limit generalizability. Second, some measures depend on children's and caregivers' self-reports, which may be affected by recall and social desirability bias.

Conclusion

Based on the study findings, the study concluded the effectiveness of an eco-friendly nursing educational protocol as an integrated approach to improving the management of *Helicobacter pylori* infection among children aged 9–12 years. By combining infection-related education, environmentally safe food and drinking-water practices, personal hygiene, household sanitation, adherence to prescribed eradication therapy, gastrointestinal symptom monitoring, and psychological support, the intervention addresses multiple dimensions of children's health and well-being. The protocol also emphasizes the importance of recognizing climatic and environmental exposures as potential factors associated with infection risk and reinforcing preventive practices within the family and home environment. Pediatric nurses play a pivotal role in implementing this approach through age-appropriate education, family engagement, treatment adherence support, and continuous clinical and psychological assessment.

Recommendations:

The following recommendations are proposed based on the study findings to:

1. Integrate structured eco-friendly nursing educational protocols into pediatric outpatient and gastroenterology services.
2. Provide children and caregivers with age-appropriate educational materials about *H. pylori* infection, transmission pathways, safe drinking-water practices, and food hygiene.
3. Strengthen caregiver education regarding medication adherence, completion of prescribed eradication regimens, and recognition of medication-related adverse effects.
4. Incorporate routine assessment of gastrointestinal symptoms and age-appropriate anxiety evaluation into pediatric nursing follow-up.
5. Promote household sanitation, safe water storage, appropriate food preparation, and effective personal hygiene practices.
6. Encourage collaboration between pediatric nurses, pediatric gastroenterologists, environmental health specialists, and community health professionals.
7. Ensure that eradication outcomes are confirmed using recommended diagnostic tests rather than relying on symptom improvement alone.
8. Conduct larger multicenter studies with randomized allocation, validated measurement instruments, objective environmental measurements, and longer follow-up periods.
9. Investigate the relationship between specific environmental exposures,

socioeconomic characteristics, and childhood *H. pylori* infection using appropriately designed longitudinal studies.

10. Develop continuing professional education programs to strengthen pediatric nurses' competencies in environmental health promotion, infection prevention, treatment adherence support, and child-centered psychological care.

References:

- Akinpelu, O. O., Samuel, H. S., Undie, D. A., Ibekwe, F. A., Onotu, O. P., & Etim, E. E. (2025). Current concepts of Helicobacter pylori infection. *European journal of medical research*, *31*(1), 169. https://doi.org/10.1186/s40001-025-03725-7
- Al-Beltagi, M., Saeed, N. K., Bediwy, A. S., & Elbeltagi, R. (2025). Breaking the cycle: Psychological and social dimensions of pediatric functional gastrointestinal disorders. *World journal of clinical pediatrics*, *14*(2), 103323. https://doi.org/10.5409/wjcp.v14.i2.103323
- Chen, Y., Pan, X., Wang, Y., Lin, L., Chen, X., Chen, Y., & Ye, H. (2025). Prevalence and risk factors of *Helicobacter pylori* infection in urban children aged 6-13 years in Fuzhou, China: a cross-sectional study in a high gastric cancer incidence region. *Frontiers in pediatrics*, *13*, 1457195. https://doi.org/10.3389/fped.2025.1457195
- Elbahry, H. F. E., Nassar, H. M. I., Lotfy, E. M., & Mahfoz, F. F. A. (2026). Promoting sustainable development in pediatric units: Effectiveness of nursing interventions in mitigating environmental risks and enhancing clinical outcomes. *Egyptian Journal of Health Care*, *17*(1), 380–392. DOI: 10.21608/ejhc.2026.483468
- Elshaer, S., Martin, L. J., Baker, T. A., Roberts, E., Rios-Santiago, P., Kaufhold, R., & Butsch Kovacic, M. (2023). Environmental Health Knowledge Does Not Necessarily Translate to Action in Youth. *International journal of environmental research and public health*, *20*(5), 3971. https://doi.org/10.3390/ijerph20053971
- Etafa, W., Muche, W., Temesgen, D., & Tesfaye, D. (2025). Nursing students' knowledge and skills on children's environmental health in Ethiopia: A cross-sectional Study. *PloS one*, *20*(11), e0336813. https://doi.org/10.1371/journal.pone.0336813
- Fisak, B., Penna, A., Mian, N. D., Lamoli, L., Margaris, A., & Cruz, S. A. M. F. D. (2023). The Effectiveness of Anxiety Interventions for Young Children: A Meta-Analytic Review. *Journal of child and family studies*, 1–12. Advance online publication. https://doi.org/10.1007/s10826-023-02596-y
- Gajic, I., Kabic, J., Kekic, D., Jovicevic, M., Milenkovic, M., Mitic Culafic, D., Trudic, A., Ranin, L., & Opavski, N. (2022). Antimicrobial Susceptibility Testing: A Comprehensive Review of Currently Used Methods. *Antibiotics (Basel, Switzerland)*, *11*(4), 427. https://doi.org/10.3390/antibiotics11040427
- Homan, M., Jones, N. L., Bontems, P., Carroll, M. W., Czinn, S. J., Gold, B. D., Goodman, K., Harris, P. R., Jerris, R., Kalach, N., Kori, M., Megraud, F., Rowland, M., Tavares, M., & on behalf of ESPGHAN/NASPGHAN (2024). Updated joint ESPGHAN/NASPGHAN guidelines for management of Helicobacter pylori infection in children and adolescents (2023). *Journal of pediatric gastroenterology and nutrition*, *79*(3), 758–785. https://doi.org/10.1002/jpn3.12314
- Kotilea, K., Mekhael, J., Salame, A., Mahler, T., Miendje-Deyi, V. Y., Cadranel, S., & Bontems, P. (2023). Eradication rate of Helicobacter Pylori infection is directly influenced by adherence to therapy in children. *Helicobacter*, *22*(4), 10.1111/hel.12383. https://doi.org/10.1111/hel.12383
- Lai, H. H., & Lai, M. W. (2022). Treatment of Pediatric *Helicobacter pylori* Infection. *Antibiotics (Basel, Switzerland)*, *11*(6), 757. https://doi.org/10.3390/antibiotics11060757
- Li, L., Ren, Y., Wang, Z., Niu, Y., Zhao, Y., Aihaiti, X., Ji, Y., & Li, M. (2024). Association of *Helicobacter pylori* infection with depression and anxiety: A systematic review and meta-analysis. *International Journal of Clinical Practice*, *2024*, Article 9247586. https://doi.org/10.1155/2024/9247586

- Lu, C., Deng, W., Qiao, Z., Sun, W., Yang, W., Liu, Z., & Wang, F. (2024). Childhood Helicobacter pylori infection: Impacts of environmental exposures and parental stress. *Journal of hazardous materials*, *478*, 135584. https://doi.org/10.1016/j.jhazmat.2024.135584
- Malfertheiner, P., Camargo, M. C., El-Omar, E., Liou, J. M., Peek, R., Schulz, C., Smith, S. I., & Suerbaum, S. (2023). Helicobacter pylori infection. *Nature reviews. Disease primers*, *9*(1), 19. https://doi.org/10.1038/s41572-023-00431-8
- Nguyen Le, C. A., Duong, K. L., Bui, D. M., Le, K. D., Dang, K. L., Nguyen, T. K., Gautret, P., Hoang, V. T., & Dao, T. L. (2024). Risk factors for *Helicobacter pylori* infection in children with gastrointestinal symptoms in Vietnam. *IJID regions*, *12*, 100426. https://doi.org/10.1016/j.ijregi.2024.100426
- Nguyen, J., Kotilea, K., Bontems, P., & Miendje Deyi, V. Y. (2023). *Helicobacter pylori* Infections in Children. *Antibiotics (Basel, Switzerland)*, *12*(9), 1440. https://doi.org/10.3390/antibiotics12091440
- Spielberger, C.D. (1973) Manual for the state trait anxiety inventory for children. Consulting Psychologists Press, Palo Alto.
- Uwishema, O., Masunga, D. S., Naisikye, K. M., Bhanji, F. G., Rapheal, A. J., Mbwana, R., Nazir, A., & Wellington, J. (2023). Impacts of environmental and climatic changes on future infectious diseases. *International journal of surgery (London, England)*, *109*(2), 167–170. https://doi.org/10.1097/JS9.0000000000000160
- Van Veen, S. J., Levy, E. I., Huysentruyt, K., & Vandenplas, Y. (2024). Clinical Dilemmas for the Diagnosis and Treatment of *Helicobacter pylori* Infection in Children: From Guideline to Practice. *Pediatric gastroenterology, hepatology & nutrition*, *27*(5), 267–273. https://doi.org/10.5223/pghn.2024.27.5.267
- Wang, H., Wang, Z., Yu, J., & Jin, J. (2026). Social determinants of health and *Helicobacter pylori* infection prevalence: a systematic review and meta-analysis. *Frontiers in public health*, *13*, 1703158. https://doi.org/10.3389/fpubh.2025.1703158
- World Health Organization. (2007). *WHO child growth standards: Growth reference data for 5–19 years*. WHO. https://www.who.int/tools/growth-reference-data-for-5to19-years
- World Health Organization. (2022). *Guidelines for drinking-water quality: Fourth edition incorporating the first and second addenda*. WHO. https://www.who.int/publications/i/item/9789240045064
- Yuan, C., Adeloye, D., Luk, T. T., Huang, L., He, Y., Xu, Y., Ye, X., Yi, Q., Song, P., Rudan, I., & Global Health Epidemiology Research Group (2022). The global prevalence of and factors associated with Helicobacter pylori infection in children: a systematic review and meta-analysis. *The Lancet. Child & adolescent health*, *6*(3), 185–194. https://doi.org/10.1016/S2352-4642(21)00400-4