

Knowledge, Attitude, and Practice of the Gastroenterology Department Patients Towards Chronic Gastritis in Shanxi Region: A Cross-Sectional Study

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Background: Chronic gastritis affects more than half of the global population to varying extents.

Objectives: This study aimed to investigate the knowledge, attitude, and practice (KAP) of patients admitted to the gastroenterology department in the Shanxi region concerning chronic gastritis.

Methods: This study was conducted in Shanxi between April and July 2023. The participants were enrolled when they consulted at the clinic. Demographic characteristics and KAP scores were collected through a self-administered questionnaire. KAP scores >60% were considered good. Structural equation modeling (SEM) was utilized to examine the relationships among the dimensions of knowledge, attitude, and practice.

Results: A total of 416 valid questionnaires were collected. The median knowledge score was 28 (0–60) (with possible values of 0–60), the median attitude score was 60 (28–77) (with possible values of 16–80), and the median practice score was 45 (12–60) (with possible values of 12–60). Hence, 133, 379, and 343 participants had knowledge, attitude, and practice scores, respectively, above the 60% threshold. Significant positive correlations were found between knowledge and attitude ($r=0.300$, $P<0.001$), knowledge and practice ($r = 0.297$, $P<0.001$), and attitude and practice ($r=0.353$, $P=0.004$) through correlation analysis. Structural Equation Modeling (SEM) revealed that knowledge directly and significantly influenced attitude ($\beta=0.643$, $P<0.001$), as well as practice ($\beta=0.095$, $P=0.034$), and attitude had a direct effect on practice ($\beta=0.094$, $P=0.009$).

Conclusion: Insufficient knowledge, positive attitudes, and proactive practices concerning chronic gastritis were observed in patients in the gastroenterology department. Prioritizing patient education and addressing patient attitudes during clinical consultations can enhance healthcare practices and improve the management of chronic gastritis.

Keywords: knowledge, attitude, practice, *Helicobacter pylori*, chronic gastritis, cross-sectional study

Introduction

Chronic gastritis, characterized by persistent inflammation of the gastric mucosa with inflammatory cell infiltration, affects more than half of the global population to varying extents. Its prevalence is notably high in China, where around 30% of the population experiences this condition.^{1–3} One well-known contributor to gastritis is *Helicobacter pylori* (*Hp*), a bacterium widely recognized for its role in gastritis, which has a significant incidence rate.⁴ In fact, *Hp*-induced gastritis accounts for over 80% of all gastritis cases, and if the infection persists, it can progress to chronic atrophic gastritis through a well-established sequence that originates from acute-on-chronic inflammation.⁵ In China, the prevalence of *Hp* infection is approximately 56%.⁶ Importantly, the pattern of progression toward gastric cancer in this context follows a sequence, starting with *Hp* infection, leading to acute gastritis, chronic non-atrophic gastritis, chronic atrophic gastritis,

metaplasia (small intestinal and colonic), dysplasia, and ultimately culminating in gastric cancer.⁷ Therefore, it is crucial to address and manage chronic gastritis, especially when associated with *Hp* infection, to reduce the risk of its advancement to more severe conditions, including chronic atrophic gastritis and, ultimately, gastric cancer. Since there are no systematic screening programs for *Hp* infection, individuals must be aware of the symptoms suggestive of *Hp* infection and consult in a timely manner. Still, the knowledge level can vary among regions of the world, provinces, or cities, depending upon the national and local policies regarding healthcare literacy. Although knowledge can be improved through educational interventions or activities, the exact knowledge level must be evaluated, and the gap must be identified to be able to design such interventions.

A Knowledge, Attitude, and Practices (KAP) survey is a research tool employed to assess a group's KAP concerning a specific subject. This methodology serves as a means to understand what is known, believed, and translated into actions. In the field of health literacy, the KAP model is grounded in the concept that knowledge has a positive impact on attitudes, which, in turn, influences behaviors.^{8–10} Given the specialized focus of the gastroenterology department on gastrointestinal issues, conducting a KAP survey among patients seeking treatment is a logical choice. Patients with these conditions typically turn to this department for treatment, as their symptoms directly relate to the gastrointestinal tract.^{11,12} Additionally, an epidemiological survey study on digestive system diseases conducted in Shanxi Province revealed that among 864 individuals undergoing *Hp* immunoglobulin G (HpIGg) tests, the positivity rate for HpIGg was 48.96%. Of the 603 individuals who underwent gastroscopy, 203 cases of chronic gastritis were identified, indicating a seemingly high prevalence rate.¹³ This approach allows for a targeted and professional evaluation of patients' knowledge, attitudes, and practices, facilitating a more focused understanding of their responses. No previous studies evaluated the KAP of chronic gastritis in Shanxi Province. The available studies from other countries generally suggest poor KAP toward chronic gastritis.^{14,15} Studies also revealed gaps in the appropriate eating habits of Chinese students¹⁶ and patients with chronic gastritis.¹⁷

Hence, this study aimed to investigate the KAP of patients in the gastroenterology department regarding chronic gastritis.

Methods

Study Design and Participants

This cross-sectional investigation was carried out between April and July 2023 at Shanxi Bethune Hospital (Shanxi region). The participants consisted of patients seeking medical care at the gastroenterology department (convenience sampling).

The inclusion and exclusion criteria were confirmed by the investigators or members of the study team before enrolling the participant. Inclusion criteria: 1) Age range between 18 and 80 years; 2) Seeking medical care at the gastroenterology department; 3) Normal cognitive function. Exclusion criteria: 1) Severe heart, lung, liver, kidney, or other significant diseases, as well as mental illness; 2) A history (past or ongoing) of liver disease, inflammatory bowel disease, or definite tumors; 3) Unexplained acute abdominal pain; 4) Cognitive impairment or inability to complete the questionnaire autonomously; 5) Refusal to participate in the questionnaire; 6) Non-local residents.

The study received approval from the Shanxi Bethune Hospital Medical Ethics Committee (YXLL-2023-112) and obtained informed consent from all participants. The study was performed following the tenets of the Declaration of Helsinki and its later amendments.

Questionnaire

The self-administered questionnaire was developed based on the relevant literature¹⁵ and the Guideline for Primary Care of Chronic Gastritis (2019). After the initial design, the questionnaire was reviewed by three senior clinical experts and one pathologist specializing in gastritis for over 10 years to guarantee content validity. Their input was used to enhance content validity by eliminating unclear phrasing and redundant questions. Reliability and construct validity were tested post hoc in all participants. Cronbach's α was 0.941, indicating a good internal consistency.

The final questionnaire was in Chinese and consisted of four sections: demographic characteristics, knowledge, attitude, and practice. The knowledge section comprised 31 questions, where a response of "understand" was awarded 2 points, "partially understand" received 1 point, and all other responses received 0 points for questions 1–30, resulting in

a total score out of 60 points. Question 31 was, in fact, a simple trap question (1+1=3?) to ascertain that the participants actually read the questions. A wrong answer to the trap question led to questionnaire rejection. In the attitude section, 18 questions were rated on a five-point Likert scale. Questions 17 and 18 were not used for scoring. Questions 2, 3, 6, and 14 were reverse scored (from strongly agree=1 to strongly disagree=5), while the others were directly scored (from strongly agree=5 to strongly disagree=1). The total score in this section ranged from 16 to 80 points. The practice section included 13 questions, where ‘yes’ was scored as 5 points, “no” received 1 point for questions 1–7, question 8 was not scored, and questions 9–13 utilized a five-point Likert scale; all were positively scored (from always=5 to never=1), yielding a total score range of 12–60 points. Achieving scores exceeding 60% of the maximum in each section indicated sufficient knowledge, a positive attitude, and proactive practices.^{18–20}

Sample Size

The formula

$$n = \left(\frac{Z_{1-\alpha/2}}{\delta} \right)^2 \times p \times (1 - p)$$

can be used to calculate the sample size of cross-sectional surveys. In the formula, n represents the sample size for each group, α represents the type I error (which is typically set at 0.05), $Z_{1-\alpha/2}=1.96$, δ represents the allowable error (typically set at 0.05), and p is set at 0.5 (as setting it at 0.5 maximizes the value and ensures a sufficiently large sample size). Hence, the calculated minimum sample size was 384.

Statistical Analysis

Statistical analysis was performed using SPSS 26.0 (IBM Corp., Armonk, N.Y., USA) and AMOS 22.0 (Amos Development Corporation, Chicago, IL, USA). Continuous variables were tested for normality using the Shapiro–Wilk test. Continuous data with a normal distribution were presented as mean \pm standard deviation (SD) and compared using analysis of variance (ANOVA) or independent sample t -tests; otherwise, they were presented as median (interquartile range) and analyzed using the Kruskal–Wallis H-test or the Mann–Whitney U -test. Categorical variables were expressed as n (%). Spearman correlation analysis was employed to assess the relationships between knowledge, attitude, and practice scores. Structural equation modeling (SEM) was utilized to examine the relationships among the dimensions of knowledge, attitude, and practice, with specific hypotheses: 1) knowledge has a direct impact on attitude; 2) knowledge directly influences practice; 3) attitude directly affects practice. A confirmatory factor analysis (CFA) was performed to assess validity. Two-sided $P < 0.05$ was considered statistically significant.

Results

Initially, a total of 524 questionnaires were gathered for this study. Of these, 5 individuals declined to participate, 8 had brief response times, 35 showed duplicated IP addresses, and 60 answered the trap question incorrectly. Ultimately, there were 416 valid questionnaires, with a validity rate of 79.39%. Among these, 245 (58.89%) were male, 181 (43.51%) fell in the 18–35 age group, 291 (69.95%) resided in urban areas, and 30.05% in suburban/rural regions. Furthermore, 306 (73.56%) possessed junior college or undergraduate qualifications. Occupationally, 363 (87.26%) were employed in fields other than the medical sector. Additionally, 360 (86.54%) reported no underlying diseases, 269 (64.66%) were non-smokers, and 220 (52.88%) reported alcohol consumption (Table 1).

The median knowledge score was 28 (interquartile range: 0–60) (with possible values of 0–60; 46.7%, insufficient knowledge), the median attitude score was 60 (interquartile range: 28–77; 77.9%, positive attitude) (with possible values of 16–80), and the median practice score was 45 (interquartile range: 12–60) (with possible values of 12–60; 75.0%, proactive practice). A total of 133/379/343 participants had good knowledge/attitude/practice. Females were more inclined to exhibit a positive attitude ($P=0.001$), and the age group of 36–45 years displayed a higher level of knowledge ($P=0.013$). Residence in urban areas was associated with a more positive attitude ($P=0.002$) and proactive practice ($P=0.036$). Those employed in the medical field significantly demonstrated superior knowledge, attitude, and practice ($P < 0.001$, $P=0.013$, and $P=0.007$, respectively) (Table 1).

Table 1 Demographic Characteristics

Variables	N (%)	Knowledge, mean \pm SD	P	Attitude, mean \pm SD	P	Practice, mean \pm SD	P
Total Score		28 (0–60)		60 (28–77)		45 (12–60)	
Gender			0.133		0.005		0.130
Male	245 (58.89)	28 (0–60)		59 (28–75)		45 (12–60)	
Female	171 (41.11)	29 (0–60)		61 (46–77)		46 (18–57)	
Age			0.024		0.468		0.249
18–35 years	181 (43.51)	28 (0–60)		59 (28–77)		45 (12–60)	
36–45 years	170 (40.87)	30 (0–60)		60.5 (37–77)		46 (18–60)	
46 years and above	65 (15.62)	20 (0–60)		60 (37–75)		44 (17–55)	
Residence			0.026		0.003		0.011
Urban	291 (69.95)	28 (0–60)		61 (32–77)		46 (17–60)	
Suburban/Rural	125 (30.05)	28 (0–60)		59 (28–76)		44 (12–60)	
Education			0.200		0.004		0.558
High School and Below	64 (15.38)	24.5 (0–60)		58 (33–75)		45 (22–60)	
Junior college/Undergraduate	306 (73.56)	28 (0–60)		60 (28–77)		46 (12–60)	
Graduate and Above	46 (11.06)	29.5 (0–60)		64 (48–77)		45.5 (27–54)	
Occupation			<0.001		0.009		0.008
Medical Field	53 (12.74)	45 (1–60)		62 (44–74)		47 (24–60)	
Other Fields	363 (87.26)	26 (0–60)		60 (28–77)		45 (12–60)	
Underlying Disease			0.541		0.697		0.286
Yes	56 (13.46)	22.5 (1–60)		60.5 (33–75)		44.5 (19–60)	
No	360 (86.54)	29 (0–60)		60 (28–77)		46 (12–60)	
Smoke			0.649		0.814		0.447
Yes	147 (35.34)	28 (0–60)		60 (32–75)		45 (17–60)	
No	269 (64.66)	28 (0–60)		60 (28–77)		46 (12–60)	
Alcohol Consumption			0.650		0.222		0.335
Yes	220 (52.88)	28 (0–60)		60 (32–75)		45 (17–60)	
No	196 (47.12)	28 (0–60)		60 (28–77)		46 (12–60)	

The breakdown of knowledge dimensions revealed that the questions with the highest percentage of participants selecting the “Understand” option were “Chronic gastritis refers to chronic inflammation of the gastric mucosa caused by various reasons, essentially damaging the gastric mucosa” (K1) at 49.52% and “Chronic gastritis is prone to recurrent attacks” (K2) at 44.71%. Conversely, the questions with the highest percentage of participants selecting the “Do not Understand” option were “Hp infection is associated with extra-gastric disorders such as unexplained iron-deficiency anemia, primary immune thrombocytopenia, and vitamin B deficiency” (K19) at 52.40% and “A positive Hp antibody test does not necessarily indicate Hp infection” (K13) at 52.16% ([Supplemental Table 1](#)).

In the attitude dimension, a significant 47.12% disagreed with the idea that chronic gastritis is a common disease that does not require special attention (A2). In terms of prompt treatment of *Hp* infection (A5), 32.45% strongly agreed, while 43.75% disagreed with the notion that having an *Hp* infection does not necessarily require treatment (A6). Furthermore, 40.87% of participants agreed with the new strategy of “family-based control of Hp infection” (A7). Regarding increasing public awareness and knowledge, 41.11% agreed it’s necessary for chronic gastritis (A10), and 43.99% agreed for *Hp* infection (A11). Moreover, 45.43% agreed that prevention of chronic gastritis is more important than treatment (A13). Regarding attitudes toward the risk of non-atrophic gastritis (A17), 33.65% felt nervous, 39.66% were anxious, 5.77% were afraid, and 20.91% remained indifferent. Similarly, for the risk of atrophic gastritis (A18), 32.93% felt nervous, 39.42% were anxious, 8.65% were afraid, and 18.99% remained indifferent ([Supplemental Table 2](#)).

Participants’ practices revealed that a significant 71.63% claimed their ability to rigorously adhere to habits such as using separate meal servings and utensils if they were to contract *Hp* (P2). In terms of seeking prompt medical

Table 2 Correlation Analysis

	Knowledge	Attitude	Practice
Knowledge	1		
Attitude	0.300 (P<0.001)	1	
Practice	0.297 (P<0.001)	0.353 (P<0.001)	1

attention for digestive symptoms, 77.88% sought care within 3 months (P7). Regarding treatment choices (P8), preferences varied: 17.55% opted for gastro-mucosal protective agents (P8.1), 11.54% for *Hp* eradication (P8.2), 9.86% for acid-suppressing medications (P8.3), 9.62% for digestive aids (P8.4), 10.82% for traditional Chinese medicine (P8.5), and 31.97% embraced lifestyle changes (P8.6), such as quitting smoking and drinking. Intriguingly, 42.55% chose not to pursue any treatment (P8.7). In contrast, 31.91% admitted to frequently indulging in spicy and irritating foods (P11), and 50.93% often consumed pickled, smoked, and fried foods (P12). Moreover, a significant majority of patients, accounting for 62.72%, affirmed their practice of managing stress through exercise and other means (P13) (Supplemental Table 3).

Correlation analysis revealed significant positive correlations between knowledge and attitude ($r=0.300$, $P < 0.001$), knowledge and practice ($r=0.297$, $P<0.001$), as well as attitude and practice ($r=0.353$, $P=0.004$) (Table 2). The Structural Equation Model (SEM) presented a well-fitting model and demonstrated that knowledge had a direct and positively significant impact on attitude ($\beta=0.643$, $P<0.001$), as well as on practice ($\beta=0.095$, $P=0.034$). Additionally, the attitude had a direct effect on practice ($\beta=0.094$, $P=0.009$) (Figure 1 and Table 3).

The post hoc CFA analysis showed a good construct validity of the questionnaire (Supplemental Table 4).

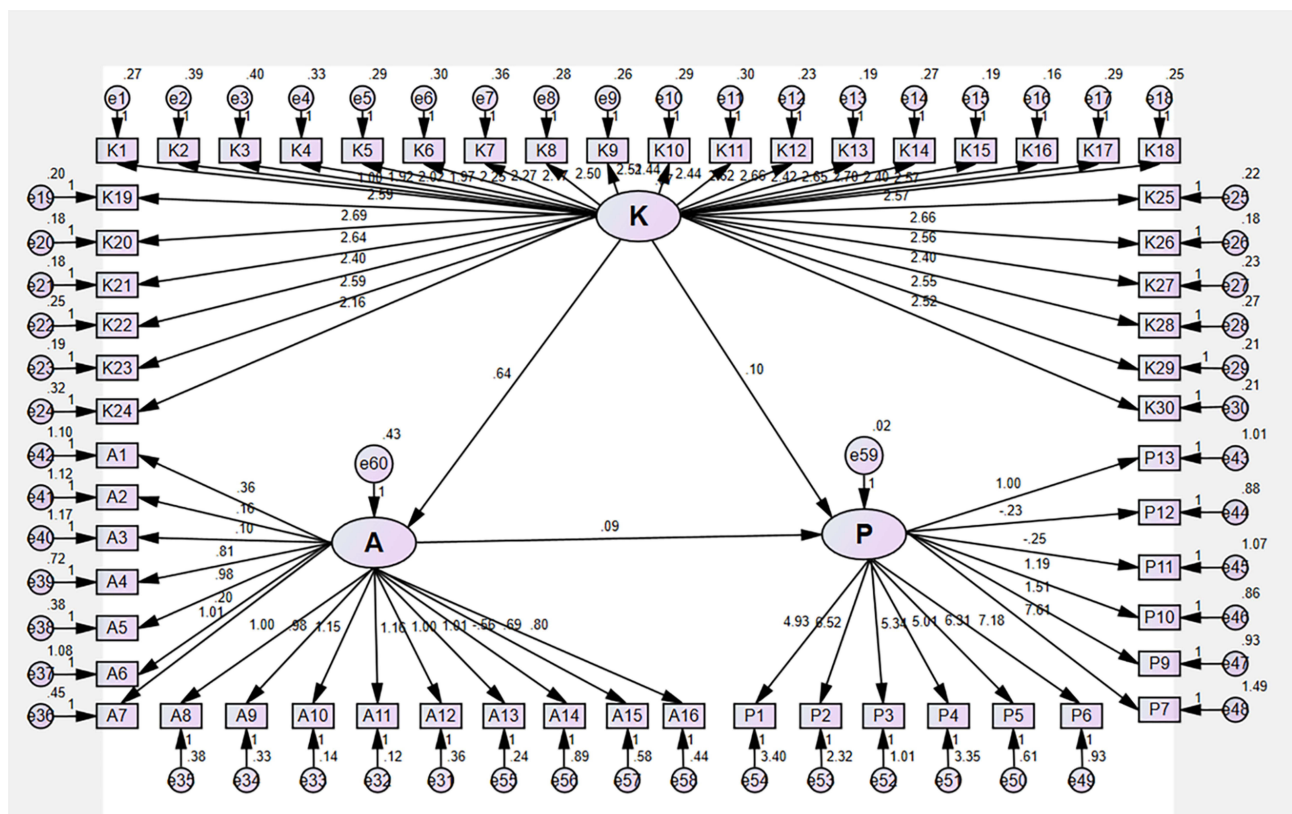


Figure 1 SEM.

Table 3 SEM Results

			Estimate	S.E.	C.R.	P
A	<←	K	0.643	0.139	4.615	<0.001
P	<←	A	0.094	0.036	2.601	0.009
P	<←	K	0.095	0.045	2.116	0.034

Discussion

Patients in the gastroenterology department exhibited insufficient knowledge, a positive attitude, and proactive practices regarding chronic gastritis. It is advisable to prioritize patient education programs to enhance their knowledge levels, considering the significant impact of knowledge on both patient attitudes and healthcare practices. Furthermore, addressing patients' attitudes and concerns during clinical consultations is crucial, given the direct influence of attitudes on healthcare practices. The integration of these recommendations is expected to result in improved patient outcomes and increased effectiveness in the management of chronic gastritis.

To the best of our knowledge, this is the first study to comprehensively explore the KAP of patients in the gastroenterology department concerning chronic gastritis. Previous studies have shed light on disparities in KAP among at-risk populations regarding *Hp*,¹⁵ low *Hp* knowledge, and treatment compliance issues in the United States,²¹ limited public awareness of *Hp* in Singapore,²² and deviations from guidelines among primary care physicians.^{23,24} In contrast, this research provides unique insights into the KAP of patients in the gastroenterology department, offering a focused perspective that contributes to the existing body of knowledge.

The occurrence and development of gastric cancer is a chronic process involving multiple factors in its pathogenesis. *Helicobacter pylori* infection is the primary cause, and the progression from chronic non-atrophic gastritis to chronic atrophic gastritis, intestinal metaplasia, dysplasia/intraepithelial neoplasia, and gastric cancer transformation is the classical pathological process of gastric cancer.²⁵ Eradicating *H. pylori* infection can fundamentally eliminate the risk of cancer before gastric mucosal atrophy occurs. When it progresses to atrophic changes, eradication treatment can only prevent the progression of atrophy and may partially reverse the atrophic changes, thus reducing the risk of gastric cancer occurrence. The awareness level among the surveyed population regarding the association between *H. pylori* infection and chronic gastritis, the need for pathological assistance in diagnosing gastric endoscopy results, and the possibility of local resection treatment for high-grade dysplasia and early gastric cancer using digestive endoscopy is generally low. These points of awareness are crucial in the outpatient examination and clinical treatment of patients as they directly impact the patient's willingness to undergo gastric endoscopy and the timing of treatment.

The study's findings reveal variations in knowledge, attitude, and practice scores among patients attending a gastroenterology clinic. The knowledge scores suggest the potential for enhancing the knowledge base, indicating a need for targeted educational interventions to ensure that patients are well-informed. The positive attitude scores underscore the importance of nurturing and further developing this positive disposition among patients to enhance their care and outcomes. However, the practice scores reveal discrepancies between attitude and actual clinical practice, emphasizing the need for interventions aimed at aligning practice with positive attitudes and knowledge. To achieve these objectives, evidence-based educational strategies and training programs should be implemented, drawing upon established best practices and guidelines.^{26,27} Furthermore, continuous monitoring and assessment of patients' knowledge, attitudes, and practices should be integral to ongoing quality improvement initiatives, ensuring a sustained and progressive impact on clinical practice.

One significant finding of this study revolves around the substantial gender disparity in attitudes, with females consistently exhibiting more positive outlooks, aligning with prior research indicating women's higher propensity for healthcare-seeking behaviors and adherence to medical guidance.²⁸ Consequently, healthcare providers must pay particular attention to the attitudes and concerns of male patients to ensure equitable care and support, a phenomenon reaffirmed by existing studies.²⁹ Similarly, participants aged 36–45 demonstrated superior knowledge levels, likely due to accumulated life experience or extended exposure to healthcare information, underscoring the importance of tailoring educational materials for different age groups and enhancing clinical practice.³⁰ Moreover, urban residents displayed

more positive attitudes and proactive practices, attributed to their improved access to healthcare resources, heightened health literacy, and increased exposure to health campaigns, reinforcing the need for targeted outreach and education in suburban and rural areas.^{31,32} Finally, individuals employed in the medical field exhibited superior knowledge, attitudes, and practices, emphasizing the vital role healthcare professionals play as advocates and role models in health-related matters and highlighting the potential benefits of encouraging them to engage actively in patient education and advocacy to enhance clinical practice.^{33,34}

In the domain of knowledge assessment, it became evident that certain questions, particularly those related to *Hp* infection, posed significant challenges for the participants. This observation emphasizes the urgent need to enhance patient education and information dissemination.³⁵ It is crucial for healthcare providers to focus their efforts on delivering clear and easily understandable explanations, especially for complex subjects.³⁶ The notable knowledge gaps, particularly concerning *Hp* infection, further underscore the critical necessity for an improved approach to patient education and information sharing, as highlighted in previous research.³⁷ To effectively address these knowledge gaps, healthcare providers should prioritize providing clear and accessible explanations to foster better patient understanding.

Several noteworthy findings emerge within the domains of attitude and practice. A significant portion of participants expressed disagreement with the idea that chronic gastritis is a common ailment not warranting special consideration, indicating widespread awareness among patients regarding the importance of addressing this condition.³⁸ Importantly, a substantial percentage expressed their willingness to actively encourage their family members to undergo testing for *Hp* infection, signifying a profound sense of responsibility and a tendency towards proactive engagement in healthcare matters. These findings within the attitude and practice dimensions deserve particular attention and are supported by previous research.^{39,40}

The diversity observed in treatment preferences serves as a compelling reminder of the necessity to provide a range of treatment options and engage patients in shared decision-making concerning their healthcare. Moreover, it underscores the utmost importance of actively addressing patients' individual preferences and concerns during clinical consultations.⁴¹ The observed positive correlations between knowledge, attitude, and practice scores illuminate the intricate interplay among these facets in healthcare decision-making processes, a phenomenon corroborated by existing research.^{42,43} Furthermore, the SEM results yield valuable insights by revealing the direct and favorable impact of knowledge on attitudes and practices, underscoring the central role of patient education in augmenting both attitudes and practices concerning chronic gastritis and *Hp* infection.⁴⁴

A very notable aspect of this study is that the surveyed population lacks sufficient understanding of the relationship between chronic gastritis and gastric cancer, as well as the recognition of high-grade dysplasia and early gastric cancer being treatable through local resection with digestive endoscopy and the necessity of pathological examination for auxiliary diagnosis. These cognitive aspects are crucial in patients' outpatient examinations and clinical treatments, as they directly influence patients' willingness to undergo gastroscopy and the timing of treatment. There is a need to consciously strengthen education in these areas.

This study had several limitations. The use of self-administered questionnaires may introduce response bias, and the study's focus on a specific region limits the generalizability of findings to other populations or geographic areas. Additionally, the study relied on self-reported data, which may not always accurately reflect participants' actual knowledge, attitudes, and practices. As with any survey-based research, there is a possibility of non-response bias, as those who chose not to participate may have different KAP profiles than those who did. In addition, the participants working in the medical field had higher knowledge scores than the others, but the exact occupation of the participants was not collected. Reliability and construct validity were not tested before conducting the study. Still, post hoc testing revealed high internal consistency. Finally, 85% of the participants had a college education or above, possibly impacting the KAP levels.

In conclusion, patients in the gastroenterology department demonstrated insufficient knowledge, a positive attitude, and proactive practices regarding chronic gastritis. The study's findings hold significant relevance for areas with demographic and healthcare characteristics akin to those in the Shanxi region. The demonstrated link between knowledge, attitudes, and practices in managing chronic gastritis can guide healthcare strategies in similar regions. Emphasizing patient education within gastroenterology departments, particularly in regions with a high prevalence of chronic gastritis, is vital. By enhancing patient knowledge about chronic gastritis, healthcare professionals can effectively shape patient attitudes and practices toward

better management of the condition. This strategy should be incorporated into both clinical consultations and patient education programs, highlighting the necessity of a comprehensive understanding and management of chronic gastritis. Furthermore, the development of educational interventions, customized to meet the unique needs and fill the knowledge gaps of the patient population can lead to improved health outcomes.

Data Sharing Statement

All data generated or analyzed during this study are included in this published article and its [Supplementary Information Files](#).

Ethical Statement

The study received approval from the Shanxi Bethune Hospital Medical Ethics Committee (YXLL-2023-112) and obtained informed consent from all participants.

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Disclosure

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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