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Effects of an intervention using an information platform on psychology and related outcomes in patients with gastric cancer and *Helicobacter pylori*-positive peptic ulcer bleeding: A randomized controlled trial

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Abstract: Background: Gastric cancer in China is a rapidly growing public health concern, characterized by increasing incidence rates and a high propensity for metastasis and recurrence, which severely threaten patients' survival and well-being. The combination of *Helicobacter pylori*-positive peptic ulcer bleeding with gastric cancer may further aggravate the disease and affect prognosis. **Objective:** The aim of this study was to determine the effectiveness of an intervention that provided an information platform to patients with gastric cancer and *H. pylori*-positive peptic ulcer bleeding. **Methods:** One hundred and twenty-four patients with gastric cancer and *H. pylori*-positive bleeding peptic ulcer treated at Nanjing First Hospital between January and December 2024 were randomly divided into intervention or control groups. The intervention group was provided with the information platform, while the control group received standard discharge guidance. The patients were then requested to complete a questionnaire that included: 1. The level of *H. pylori*-related knowledge; 2. Medication compliance; 3. *H. pylori* eradication rate, ulcer healing rate, and total effective rate; 4. Clinical symptom scores; 5. Psychological status and quality of life. **Results:** After 1 month following a 14-day intervention, compared to the control group, the intervention group had higher levels of *H. pylori*-related knowledge, medication compliance, *H. pylori* eradication rate and ulcer healing rate, and total effective rate (all $p < 0.05$). The intervention group had lower scores for the Self-Rating Anxiety Scale, Self-Rating Depression Scale, and demoralization compared to the control group. The intervention group exhibited significantly reduced scores in abdominal distention, abdominal pain, and belching compared to the control group, while there was no significant difference in acid reflux scores between the two groups. Notably, the intervention group exhibited higher scores on the MOS 36-item Short Form Health Survey, indicating better quality of life. The differences were statistically significant: the Self-Rating Anxiety Scale and Self-Rating Depression Scale (all $p < 0.001$), demoralization ($p = 0.006$), and the MOS 36-item Short Form Health Survey ($p < 0.001$). **Conclusion:** Information platform-based interventions represent a feasible strategy for managing gastric cancer and *H. pylori*-positive peptic ulcer bleeding in patients, and therefore merit broader clinical adoption.

Keywords: effectiveness; gastric cancer; *Helicobacter pylori*; information platforms; psychology

1. Introduction

Gastric cancer in China is a rapidly growing public health concern, characterized by increasing incidence rates and a high propensity for metastasis and recurrence, which severely threaten patients' survival and well-being [1]. *Helicobacter pylori* (*H. pylori*) is classified as a Group I carcinogen by the World Health Organization (WHO) [2]. Long-term infection significantly increases the risk of gastric cancer, and eradication treatment can reduce this risk. The combination of *H. pylori*-positive peptic ulcer bleeding (PUB) and gastric cancer may further aggravate the disease and affect prognosis [2]. Peptic ulcers typically present with symptoms such as abdominal distention, epigastric pain, acid reflux, and belching, which can significantly impair patients' psychological well-being and overall quality of life [3]. The national consensus report on the treatment of *H. pylori* infection shows that the bacteria should be eradicated in patients with *H. pylori*-positive PUB [4]. In China, current guidelines recommend bismuth-containing quadruple therapy (proton pump inhibitor (PPI) + bismuth + two antibiotics) as the primary empirical treatment for eradicating *H. pylori*, with a treatment duration of 14 days [4]. On the other hand, patients' understanding of the disease and their adherence to treatment have a significant impact on treatment outcomes. It is, therefore, essential to adopt effective methods in the clinical treatment process to improve patients' awareness of the disease and their adherence to treatment.

The use of interventions based on an information platform in the medical field has not only improved the efficiency and accuracy of the interventions, but has also improved the psychological state and quality of life of patients [5]. For example, an intervention using the WeChat platform was reported to have significant effects on improving the medication adherence and eradication rate of patients with *H. pylori* infection [6–9]. However, whether or not the application of information platforms effectively improves treatment outcomes, psychological state, and quality of life of patients with gastric cancer and *H. pylori*-positive PUB remains uncertain. In this study, we developed a WeChat mini program based on an information platform. Compared with the traditional WeChat Mini Program, it covered medication treatment, psychological intervention, lifestyle adjustment, and regular follow-up and monitoring, which provided patients with comprehensive and personalized medical services. The aim of the current study was to determine the effectiveness of these interventions based on information platforms in patients with gastric cancer and *H. pylori*-positive PUB.

2. Data and methods

2.1. General data

2.1.1. Sample size estimation

The sample size was estimated based on a comparison of two independent proportions using a two-sided test. Assuming an α level of 0.05 and a power ($1 - \beta$) of 90% (i.e., $\beta = 0.1$), with expected *H. pylori* eradication rates of 90% in the intervention group and 70% in the control group, the required sample size was calculated

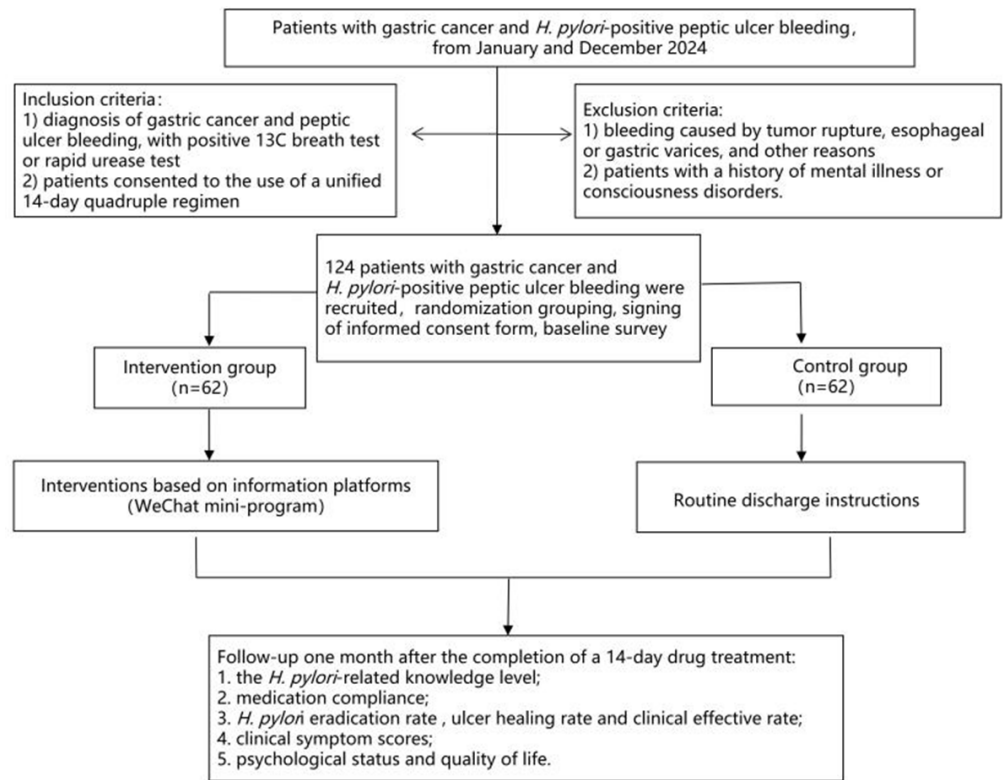


Figure 1.

using G * Power version 3.1. To account for an anticipated 5% dropout rate, the total required sample size was adjusted to $N = 124$ participants.

A total of 124 patients with gastric cancer and *H. pylori*-positive PUB treated in the gastroenterology ward of the First Hospital of Nanjing were enrolled in the study between January and December 2024. The inclusion criteria were as follows: (1) diagnosis of gastric cancer and peptic ulcer bleeding, with a positive carbon-13 urea breath test or rapid urease test [1,10]. (2) Patient consent to receive a unified 14-day quadruple regimen (two antibiotics plus a PPI and bismuth agent) to eradicate *H. pylori*. Exclusion criteria: (1) bleeding caused by tumor rupture, esophageal or gastric varices, or other reasons; (2) patients with a history of mental illness or consciousness disorders. The study received ethical approval from the Medical Ethics Committee of Nanjing First Hospital, and the technical approach is illustrated in **Figure 1**.

2.2. Intervention methods

2.2.1. Intervention methods for the control group

Patients in the control group received conventional discharge guidance, which reflected the standard care protocol at our institution. This guidance was delivered as a one-time verbal session by the primary ward nurse, lasting approximately 15–20 min, prior to the patient's discharge. The session covered the following four main areas: (a) Disease and lifestyle education: Patients were informed about the causes of their conditions, the importance of lifestyle adjustments (e.g., diet, smoking, and alcohol cessation), and the rationale behind *H. pylori* eradication. (b) Medication instructions: Patients were advised to strictly follow the prescribed medication regimen, cautioned

against unilateral dose adjustments, and warned about avoiding potentially harmful drugs. (c) Regular monitoring: The importance of observing symptoms, adhering to scheduled follow-up appointments, and undergoing post-treatment testing to confirm *H. pylori* eradication was explained. (d) Emergency plan: Patients received instructions on how to manage acute symptoms and were provided with emergency contact details. This standard care did not include any further structured, proactive follow-up or support from the healthcare team after discharge.

2.2.2. Intervention methods of the intervention group

Patients in the intervention group received a 14-day, multi-module intervention program delivered via a specially developed WeChat mini-program, and retained access to the platform for the full 1-month study period. The intervention was designed by a multidisciplinary team and consisted of three core modules.

Module 1: Scheduled reminders and adherence support system

This module provided proactive, scheduled support to reinforce education and adherence. Key features included the following:

- a) Daily scheduled medication reminders to ensure timely completion of the 14-day quadruple therapy.
- b) Twice-weekly knowledge question and Answer push notifications on topics related to *H. pylori* and gastric health to reinforce key educational content.
- c) A scheduled reminder for the 1-month follow-up appointment sent 1 week prior to the scheduled date.

Module 2: Structured online cognitive behavioral therapy for symptom and mood management

A brief, structured, four-session online cognitive behavioral therapy (CBT) program was designed by a psychologist from the multidisciplinary team and delivered via the WeChat mini-program using short texts, graphics, and audio clips. The program was adapted from established principles of Internet-Based CBT for managing psychological distress in patients with chronic illness. The session-by-session protocol was as follows:

Session 1 (Days 1–3): Psychoeducation and the mind–body connection. This session focused on helping patients understand the link between their physical symptoms (e.g., abdominal pain) and psychological distress (e.g., anxiety), and introduced the basic cognitive model (the relationship between thoughts, emotions, and behaviors).

Session 2 (Days 4–6): Identifying and challenging negative thoughts. This session taught patients skills to identify automatic negative thoughts related to their cancer diagnosis, treatment side effects, or prognosis (e.g., catastrophizing about pain). Simple thought-recording and cognitive restructuring exercises were provided.

Session 3 (Days 7–10): Behavioral activation and problem-solving. Patients were encouraged to schedule small, pleasurable, or meaningful activities to counteract behavioral withdrawal and low mood. A simple four-step problem-solving framework was also introduced to address practical challenges related to treatment.

Session 4 (Days 11–14): Coping and relapse prevention. This session focused on helping patients develop a personalized coping plan to manage future stressors and

symptom fluctuations. It included a 5-min guided audio relaxation exercise (progressive muscle relaxation).

Module 3: On-demand multidisciplinary team support

Patients could initiate contact with the clinical team at any time via a secure messaging function within the mini-program. A specialist nurse monitored the information platform's messaging system on weekdays (9 a.m. to 5 p.m.) and provided responses within 24 h. Questions were triaged based on content: general queries were handled by the nurse, questions regarding medication side effects were forwarded to the team pharmacist, and messages indicating severe psychological distress were referred to the team's psychologist for a brief supportive intervention or referral to formal counseling.

2.3. Observation items and evaluation criteria

After 1 month of treatment, a carbon-13 urea breath test or rapid urease test and gastroscopy were performed to evaluate the therapeutic effect. The patient was surveyed through questionnaires published on an information platform. The contents of the questionnaires were discussed in the sections below.

2.3.1. The *H. pylori*-related knowledge level scale

The content covered fundamental knowledge about *H. pylori*, including its hazards, transmission methods, prevention, and treatment. The scale consisted of 23 items, each with three response options: "yes," "no," and "do not know." Higher scores indicated that the patient had a greater level of cognitive understanding. The scale was adapted from the reference literature, and its internal consistency was assessed by estimating Cronbach's alpha [11].

2.3.2. Morisky medication adherence scale

The study used the Chinese version of the Morisky Medication Adherence Scale [12]. The scale has been localized and revised from the original eight-item Morisky scale and has been shown to meet psychometric standards with strong reliability and validity. The scale consisted of eight items, with the first seven questions offering "yes" or "no" as response options. A "yes" answer scored one point, while a "no" answer scored 0 points. The fifth question was scored in reverse. The eighth question had five response options: "never," "occasionally," "sometimes," "often," and "always," which were scored as 1.00, 0.75, 0.50, 0.25, and 0, respectively. The maximum score for the scale was 8 points, with a score <6 indicating low medication adherence, a score between 6 and 7 indicating moderate adherence, and a score of 8 indicates high adherence.

2.3.3. *H. pylori* eradication rate, ulcer healing rate, and total effective rate

a) *H. pylori* eradication rate

A carbon-13 urea breath test or rapid urease test was performed after 4 weeks of drug discontinuation. If the result was negative, *H. pylori* eradication was considered to have occurred.

b) Ulcer healing rate

Ulcer healing was divided into scar, healing, and active stages.

Ulcer healing rate (%) = (total cases – active stage cases)/total cases × 100%.

c) Total effective rate

Clinical cure: Symptoms had disappeared, ulcer scars had healed, and no *H. pylori* was detected.

Significant effect: Main symptoms absent, ulcer at H2 stage, and *H. pylori* eradicated.

Effective: Symptoms alleviated, ulcer at H1 stage, and *H. pylori* reduced.

Invalid: No improvement in symptoms, endoscopy, or ^{13}C breath test.

Total effective rate = (Clinical cure + Significant effect + Effective cases) / Total Cases $\times 100\%$ [13].

2.3.4. Clinical symptom score

This score was used to evaluate the patients' abdominal distention, abdominal pain, acid reflux, and belching before and 2 weeks after treatment. The range of the score was 0–4 points, with higher scores indicating more severe symptoms. This scale has been reported to have good reliability and validity [14,15].

2.3.5. Self-rating anxiety and self-rating depression scores

These scores were used to evaluate the psychological state of depression and anxiety before and after nursing care. The scores ranged from 0 to 100, with higher scores indicating a higher degree of depression, anxiety, and lower scores a better psychological state. Numerous studies have shown these scales have good reliability and validity [16–18].

2.3.6. Demoralization scale

This scale consisted of 24 items, each scored as 0–4, with the total scores ranging from 0 to 96. Higher scores indicated greater levels of demoralization. The Chinese version of the scale has been shown to have acceptable reliability and validity [19].

2.3.7. The MOS 36-item short form health survey (SF-36)

This scale was used to evaluate the quality of life of patients and included eight dimensions: general health, physiological function, vitality, emotional function, pain, mental health, and social function. The total score was 100, with higher scores indicating a better quality-of-life. The Cronbach's alpha coefficient of the original scale was 0.920 [20].

2.4. Statistical analyses

Data were analyzed using SPSS 25.0 statistical software. Categorical data were described by frequency and percentage, and analyzed using the Chi-square test. Normally distributed continuous data were described by " $\bar{x} \pm s$," and compared between groups using the independent samples *t*-test. Non-normally distributed data were described by median (lower quartile, upper quartile) and analyzed using the rank sum test. The statistical significance level was set at $\alpha = 0.05$.

3. Results

3.1. Baseline characteristics

We found no significant differences in sex, age, education level, treatment duration, ulcer classification, clinical symptom score, *H. pylori*-related knowledge score,

self-rating anxiety (SAS) score, self-rating depression (SDS) score, demoralization score, and SF-36 score between the two groups ($p > 0.05$; **Table 1**). Furthermore, there were no significant differences in the baseline characteristics of the gastric cancer cohort, including cancer stage (AJCC 8th edition), course of disease (months), and primary treatment modality (curative vs. palliative) ($p > 0.05$; **Table 1**). In both groups, the majority of patients had Stage II or III cancer and were undergoing curative-intent treatment, which primarily consisted of post-operative adjuvant chemotherapy.

3.2. *H. pylori*-related knowledge level score and medication compliance

The score of *H. pylori*-related knowledge in the intervention group was (15.24 ± 3.78), which was significantly greater ($p < 0.001$) than that in the control group (11.23 ± 3.13). The medication compliance score in the intervention group was (6.18

Table 1. Basic data of patients between the two groups.

Variables	Intervention group (<i>n</i> = 62)	Control group (<i>n</i> = 62)	Statistic	<i>p</i> -value
Gender			$\chi^2 = 2.073$	0.150
Male, <i>n</i> (%)	25 (40.3)	33 (53.2)		
Female, <i>n</i> (%)	37 (59.7)	29 (46.8)		
Age (years)	52.87 ± 4.98	53.98 ± 5.22	$t = -1.212$	0.228
Degree of education			$\chi^2 = 0.152$	0.985
Primary school and below, <i>n</i> (%)	9 (14.5)	10 (16.1)		
Junior middle school, <i>n</i> (%)	16 (25.8)	17 (27.4)		
High school or technical secondary school, <i>n</i> (%)	7 (11.3)	7 (11.3)		
Junior college or above, <i>n</i> (%)	30 (48.4)	28 (45.2)		
Per capita monthly income			$\chi^2 = 0.815$	0.846
<1000 RMB, <i>n</i> (%)	9 (14.5)	7 (11.3)		
1000–3000 RMB, <i>n</i> (%)	9 (14.5)	12 (19.4)		
3000–5000 RMB, <i>n</i> (%)	26 (41.9)	27 (43.5)		
>5000 RMB, <i>n</i> (%)	18 (29.0)	16 (25.8)		
Course of disease (months, $\bar{x} \pm s$)	7.2 ± 3.5	7.6 ± 3.8	$t = -0.610$	0.543
Cancer stage (<i>n</i> , %)			$\chi^2 = 0.197$	0.978
Stage I	7 (11.3)	6 (9.7)		
Stage II	13 (21.0)	12 (19.4)		
Stage III	24 (38.7)	26 (41.9)		
Stage IV	18 (29.0)	18 (29.0)		
Treatment modality (<i>n</i> , %)			$\chi^2 = 0.156$	0.693
Curative treatment	43 (69.4)	45 (72.6)		
Palliative treatment	19 (30.6)	17 (27.4)		
Treatment times			$\chi^2 = 2.220$	0.330
0, <i>n</i> (%)	25 (40.3)	20 (32.3)		
1, <i>n</i> (%)	18 (29.0)	15 (24.2)		
≥ 2 , <i>n</i> (%)	19 (30.6)	27 (43.5)		
Disease type			$\chi^2 = 0.995$	0.608
Complex ulcer with hemorrhage, <i>n</i> (%)	15 (24.2)	13 (21.0)		
Gastric ulcer with bleeding, <i>n</i> (%)	39 (62.9)	37 (59.7)		

Table 1. (Continued).

Variables	Intervention group (n = 62)	Control group (n = 62)	Statistic	p-value
Duodenal ulcer with bleeding, n (%)	8 (12.9)	12 (19.4)		
Forrest classification			$\chi^2 = 3.292$	0.510
Ia, n (%)	10 (16.1)	18 (29.0)		
Ib, n (%)	18 (29.0)	16 (25.8)		
IIa, n (%)	20 (32.3)	18 (29.0)		
IIb, n (%)	8 (12.9)	5 (8.1)		
IIc, n (%)	6 (9.7)	5 (8.1)		
III, n (%)	0	0		
Clinical symptom scores				
Abdominal distention, $M (P_{25}, P_{75})$	3 (2, 3)	3 (2, 4)	$Z = -0.839$	0.401
Acid reflux, $M (P_{25}, P_{75})$	3 (3, 3)	3 (2, 4)	$Z = -0.011$	0.991
Abdominal pain, $M (P_{25}, P_{75})$	3 (3, 3)	3 (3, 3)	$Z = -1.210$	0.226
Belching, $M (P_{25}, P_{75})$	3 (2, 3)	2 (2, 3)	$Z = -1.154$	0.248
<i>H. pylori</i> -related knowledge level ($\bar{\chi} \pm s$)	8.11 $\pm$ 1.52	8.16 $\pm$ 1.76	$t = -0.169$	0.866
SAS ($\bar{\chi} \pm s$)	56.66 $\pm$ 9.12	55.77 $\pm$ 8.97	$t = 0.548$	0.585
SDS ($\bar{\chi} \pm s$)	52.34 $\pm$ 7.63	53.16 $\pm$ 9.21	$t = -0.540$	0.590
Demoralization ($\bar{\chi} \pm s$)	23.32 $\pm$ 4.05	24.21 $\pm$ 5.27	$t = -1.054$	0.294
SF-36 ($\bar{\chi} \pm s$)	52.52 $\pm$ 6.31	53.27 $\pm$ 6.77	$t = -0.638$	0.525

Notes: χ^2 : Chi-square test; Z: Mann–Whitney *U*-test; *t*: *t*-test.

± 1.68), which was also significantly greater ($p < 0.05$) than that in the control group (5.62 ± 1.23 , **Table 2**).

3.3. Treatment efficacy: *H. pylori* eradication rate, ulcer healing rate, total effective rate, and clinical symptom scores

The *H. pylori* eradication rate in the intervention group was 91.9%, which was significantly greater than that in the control group (67.7%) ($p < 0.01$). Similarly, the rate of ulcer healing was higher in the intervention group than in the control group (93.5% vs. 74.2%; $p < 0.01$). As shown in **Table 3**, the total effective rate in the intervention group was significantly greater than that in the control group (95.2% vs. 69.4%, respectively; $p < 0.001$) (**Table 3**).

In the intervention group, the median clinical symptom scores (P_{25} , P_{75}) for abdominal distention, abdominal pain, and belching were significantly lower than those in the control group (*Z* values were -4.177 , -6.346 , and -7.128 , respectively, all $p < 0.001$), while there was no significant difference in acid reflux scores between the two groups ($Z = -0.578$, $p = 0.563$) (**Table 4**).

Table 2. *H. pylori*-related knowledge level score and medication compliance between the two groups ($\bar{\chi} \pm s$).

Group	Intervention group (n = 62)	Control group (n = 62)	<i>t</i>	p-value
<i>H. pylori</i> -related knowledge score	15.24 $\pm$ 3.78	11.23 $\pm$ 3.13	6.434	<0.001
Medication compliance	6.18 $\pm$ 1.68	5.62 $\pm$ 1.23	2.118	0.036

Note: *t*: *t*-test.

Table 3. *H. pylori* eradication rate, ulcer healing rate, and total effective rate between the two groups n (%).

Group	Intervention group ($n = 62$)	Control group ($n = 62$)	χ^2	p -value
<i>H. pylori</i> eradication rate	57 (91.9%)	42 (67.7%)	11.273	0.001
Ulcer healing rate	58 (93.5%)	46 (74.2%)	8.585	0.003
Total effective rate	59 (95.2%)	43 (69.4%)	14.146	<0.001

Note: χ^2 : Chi-square test.

Table 4. Clinical symptom scores between the two groups $M(P_{25}, P_{75})$.

Group	Intervention group ($n = 62$)	Control group ($n = 62$)	Z	p -value
Abdominal distention	2 (1, 2)	2 (2, 3)	-4.177	<0.001
Abdominal pain	2 (1, 2)	3 (2, 3)	-6.346	<0.001
Acid reflux	2 (1, 2)	2 (1, 2)	-0.578	0.563
Belching	1 (1, 2)	2 (2, 3)	-7.128	<0.001

Notes: Z : Mann-Whitney U -test.

Table 5. Psychological status and quality of life between the two groups ($\bar{x} \pm s$).

Group	Intervention group ($n = 62$)	Control group ($n = 62$)	t	p -value	Cohen's d
SAS	33.61 $\pm$ 6.42	40.98 $\pm$ 8.22	-5.564	<0.001	0.98
SDS	32.44 $\pm$ 5.89	37.08 $\pm$ 7.72	-3.763	<0.001	0.68
Demoralization	19.66 $\pm$ 4.47	22.23 $\pm$ 5.62	-2.818	0.006	0.51
SF-36	77.16 $\pm$ 9.29	69.48 $\pm$ 8.93	4.693	<0.001	0.95

Note: t : t -test.

3.4. Psychological status and quality-of-life

At the 1-month follow-up, the intervention group demonstrated significantly lower scores than the control group across all measured psychological outcomes. Specifically, scores for anxiety (SAS: 33.61 $\pm$ 6.42 vs. 40.98 $\pm$ 8.22; $p < 0.001$; Cohen's $d = 0.98$), depression (SDS: 32.44 $\pm$ 5.89 vs. 37.08 $\pm$ 7.72; $p < 0.001$; Cohen's $d = 0.68$), and demoralization (19.66 $\pm$ 4.47 vs. 22.23 $\pm$ 5.62; $p = 0.006$; Cohen's $d = 0.51$) were all significantly lower, with effect sizes ranging from medium to large. Consequently, quality of life (SF-36) was significantly higher in the intervention group (77.16 $\pm$ 9.29 vs. 69.48 $\pm$ 8.93; $p < 0.001$), with a large effect size (Cohen's $d = 0.95$) (Table 5).

4. Discussion

The management of patients with concurrent gastric cancer and *H. pylori*-positive PUB necessitates an integrated approach that addresses both somatic and psychological burdens. This study evaluated the effects of a structured digital health intervention, delivered via a WeChat mini-program, on clinical, behavioral, and psychological outcomes. The intervention combined automated reminders, structured CBT, and on-demand multidisciplinary support. Our findings indicate that this

integrated model holds promise for enhancing holistic patient care in this complex clinical context.

4.1. Limitations of the study

Before interpreting the findings, it is imperative to acknowledge several limitations. First, the lack of blinding for participants and outcome assessors introduces a high risk of performance and detection bias, particularly for subjective patient-reported outcomes such as psychological measures and symptom scores. Second, the 1-month intervention and follow-up period, while sufficient to demonstrate initial effects, is too short to assess the long-term sustainability of the benefits, especially for psychological constructs like demoralization and for clinical outcomes such as ulcer recurrence. Third, the single-center design and relatively modest sample size limit the generalizability of our findings. Finally, although baseline characteristics were balanced, the inherent heterogeneity of the cancer cohort and the limited statistical power preclude robust subgroup or sensitivity analyses to control for potential confounding variables such as cancer stage.

4.2. Principal findings and interpretation

4.2.1. Clinical and behavioral outcomes

Consistent with previous studies on digital health tools [21–23], the WeChat-based intervention significantly enhanced patients' *H. pylori*-related knowledge and medication adherence. These behavioral improvements provide a plausible explanation for the superior clinical outcomes observed in the intervention group, including significantly higher *H. pylori* eradication, ulcer healing, and total effective rates. This cascade of effects—where improved understanding and adherence lead to better clinical results—is well-supported in the literature [24]. The intervention also led to significant improvements in key clinical symptoms, including abdominal distention, pain, and belching, likely through its integrated approach to education and symptom monitoring. The lack of a significant effect on acid reflux scores may reflect its more complex pathophysiology and suggests that this particular symptom might require longer or more targeted intervention strategies.

4.2.2. Psychological outcomes and proposed mechanisms

A particularly notable finding was the significant improvement in psychological outcomes—including anxiety, depression, and demoralization—within the 1-month timeframe. This rapid effect is noteworthy given that some literature suggests meaningful changes in complex states like demoralization often require longer interventions [25,26]. We hypothesize that this can be attributed to three interconnected mechanisms of the digital platform:

Timeliness (just-in-time support): The platform provided proactive, high-frequency support, allowing for early identification and intervention at critical emotional inflection points—such as during symptom flares or bouts of medication-related anxiety. This «just-in-time» intervention likely helped prevent the accumulation and entrenchment of negative emotional states, disrupting the cycle of psychological distress before it became severe [27,28]. This mechanism is consistent with the con-

cept of just-in-time adaptive intervention, which emphasizes its role in early identification and intervention, especially at key emotional turning points, to prevent the accumulation of negative emotions and a vicious cycle [29].

Integration (holistic care): Psychological support was not a standalone offering but was seamlessly woven into the fabric of routine clinical management. The structured online CBT equipped patients with practical skills to manage illness-related distress [28], while the ability to access multidisciplinary support for both clinical and emotional concerns directly addressed the mind–body connection. This created a cohesive support system where psychological and physical health were managed synergistically, rather than in separate silos. A review of cancer despondency syndrome emphasized that integrating psychological care into routine oncology care is key to effectively managing despondency [30]. Our intervention model embodies this principle.

Accessibility (reduced barriers): Through the ubiquitous WeChat platform, the intervention significantly lowered barriers to seeking help. It eliminated geographical and time constraints and reduced the potential stigma associated with accessing traditional formal mental health services. This accessible, integrated care model reflects innovations in other complex disease areas; for example, emerging mobile health apps for advanced cancer pain similarly combine therapy (CBT) for pain with opioid support, enabling real-time symptom monitoring and intervention through daily education and adaptive services [31]. In both cases, by embedding professional support into a familiar and private mobile interface, engagement with key intervention components was significantly improved, ensuring support was provided when and where patients needed it most.

By synergizing these three features, the intervention plausibly enhanced patients' sense of self-efficacy and personal control—core psychological resources that directly counter the helplessness and hopelessness characteristic of demoralization [30]. It empowered patients to transition from passive recipients of care to active managers of their health, facilitating rapid psychological improvement [32]. While we attribute these effects to the specific mechanisms of the intervention, we also acknowledge the potential contribution of non-specific therapeutic factors, such as increased contact and attention from the clinical team.

4.3. Conclusions and implications

In summary, this study provides evidence that a multifaceted, WeChat-based information platform intervention is a feasible and effective strategy for improving a comprehensive range of outcomes in patients with gastric cancer and *H. pylori*-positive PUB. The intervention successfully integrated clinical management with behavioral and psychological support, leading to superior outcomes within a short period.

Future research should prioritize multicenter, long-term trials with larger samples to validate the sustainability and generalizability of these findings. Where feasible, employing blinded outcome assessment would strengthen the validity of subjective endpoints. Further investigation into the specific contributions of the core intervention components and formal cost-effectiveness analyses are needed to optimize this model for broader implementation.

Author contributions: YT designed and refined the entire study. YT and BG entered data, integrated, analyzed, and wrote the entire article. AW and JQ were responsible for the clinical study, LF contributed significantly to WeChat mini program development, YT and BG collected data in the clinic. All authors have read and suggested revisions to the article, agreeing to the final text.

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Ethics approval: This study was approved by the Ethics Department of Nanjing First Hospital, Nanjing Medical University, Nanjing, China (Approval No.KY20250407-KS-03) and registered at the Chinese Clinical Trial Registry (ChiCTR2500102353). All of the participants were volunteers, and informed consent was obtained. The participants were also informed that their identity and privacy would be respected and kept confidential.

Data availability statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Conflict of interest: The authors declare that they have no competing interests.

Abbreviations

CBT	cognitive behavioral therapy
<i>H. pylori</i>	<i>Helicobacter pylori</i>
PUB	peptic ulcer bleeding

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