

# Increased quality of bowel preparation via smartphone WeChat application: a multicenter randomized controlled trial

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## Abstract

**Introduction:** High-quality bowel preparation is an essential precondition for colonoscopy. Few studies have evaluated the smartphone WeChat application as a means of improving the quality of bowel preparation.

**Aim:** To assess the effect of patient education by using smartphone WeChat application aids on the quality of bowel preparation.

**Material and methods:** A multicenter prospective, endoscopist-blinded, randomized, controlled study was conducted. Patients were randomly assigned to three groups. A total of 478 patients in groups A were accepted for smartphone WeChat application, 477 in groups B were accepted for conventional education plus smartphone WeChat application while group C (473 patients) was a control group. The primary outcome was the quality of the bowel preparation according to the Boston Bowel Preparation Scale (BBPS). The secondary outcomes included polyp detection rate (PDR), cecal intubation rate, insertion and withdrawal time, anxiety score, self-rated sleep quality, and willingness to undergo another colonoscopy.

**Results:** Total BBPS score was significantly higher in groups B and C than in the control group ( $7.5 \pm 1.2$ ,  $7.5 \pm 1.3$  vs.  $6.5 \pm 1.2$ ,  $p < 0.001$ ). PDR in group A (40.2%, 192/478) and group B (41.7%, 199/477) was higher than that in the control group ( $p = 0.003$ ) and mean number of polyps per patient was higher too ( $p = 0.015$ ). Moreover, a shorter cecal insertion time was recorded in group A and group B than in the control group ( $8.8 \pm 3.9$ ,  $8.9 \pm 3.8$  vs.  $10.5 \pm 4.2$  min,  $p < 0.001$ ). Intervention groups showed lower anxiety scores and better quality sleep and were more likely to be willing to repeat colonoscopy.

**Conclusions:** Patient instruction via smartphone WeChat application efficiently improved bowel preparation for colonoscopy.

**Key words:** colonoscopy, polyp detection rate, smartphone application, bowel preparation.

## Introduction

Colonoscopy is the gold standard for finding and removing precancerous colonic lesions [1]. Quality of bowel preparation is related to the rate of detection of polyps and adenomas [2, 3]. However, it has been

reported that approximately 30% of patients fail to achieve adequate bowel preparation in many countries and regions [4–6].

Several strategies have been used to improve the bowel preparation by optimizing patient instruction. There is strong evidence that a wide range of ed-

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educational methods, including booklet [7], telephone [8, 9], message reminders [10, 11], and online videos [12, 13], have been used to assist patient education with different effectiveness. But in fact, the rate of patients with adequate bowel preparation remains unsatisfactory, based on the small sample size and low study reproducibility [14–16].

In recent years, applications of smartphone applets have become an increasingly popular source of communication between users and information providers. Applications of artificial intelligence techniques are beginning to emerge in gastrointestinal endoscopy [17]. However, to the best of our knowledge, no prospective studies have assessed the role of the smartphone WeChat application in patient education before colonoscopy. Then, we performed a prospective, a multicenter randomized controlled study to assess the effectiveness of a smartphone applet for patient instructions of bowel preparation.

## Aim

We aimed to assess the effect of patient education by using smartphone WeChat application aids on the quality of bowel preparation.

## Material and methods

### Study design and patients

A multicenter prospective, endoscopist-blinded, randomized, controlled study was conducted at three hospitals between January 2020 and November 2020. The inclusion criteria of this study were as follows: 1) patients aged 18 to 75 years who underwent colonoscopy, 2) no prior colonoscopy, 3) the patient's signed informed consent. Patients who met any of the following criteria were excluded: colorectal cancer patients with obvious obstruction, patients' associated conditions such as renal, cardiac, or respiratory failure, brain dysfunction, pregnancy or lactation, gastrointestinal hemorrhagic diseases, unable to use smartphone WeChat application. This study was approved by the institutional review board of the ethics committee and all authors had access to the study data and reviewed and approved the final manuscript. Trial identifier: ChiCTR2000028884.

### Randomization and assignments

After informed consent was obtained, patients were randomized to one of three groups (groups A,

B and C) using a computer-generated randomization table. Patients in group A were accepted for the smartphone WeChat application. Patients in group B were accepted for conventional education plus the smartphone WeChat application, while patients in group C (control group) received conventional education only. For each group of patients, the randomized procedure was performed by operator A. Operator B provided education on bowel preparation and use of the smartphone WeChat application. Two participants in each endoscopy center completed the randomization process. In this trial, all endoscopists were blinded to the allocation.

### Bowel preparation and colonoscopy

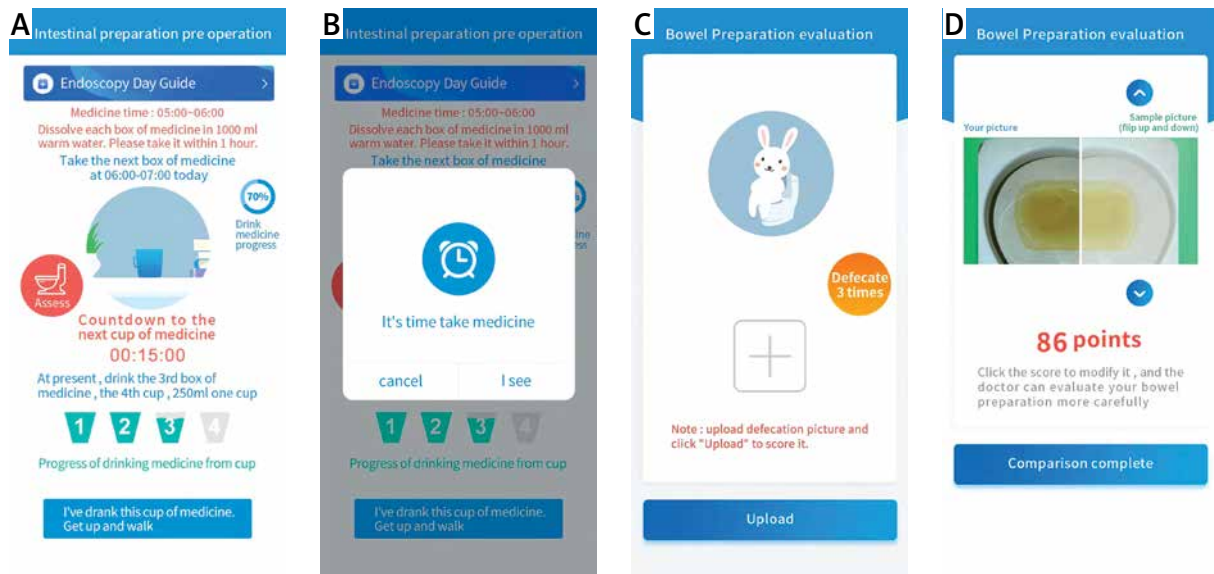
All patients received the following dietary instructions: 1) Follow low fiber diet 2 days before the procedure. 2) Fasting for 10 h before colonoscopy. Step 1: 1 l split dose of polyethylene glycol used after dinner in the evening before colonoscopy. Step 2: 3 l split dose of polyethylene used 5 h before colonoscopy. Colonoscopy (GIF Q260, Olympus Optical Co., Ltd, Tokyo, Japan) was used in three endoscopy centers. All colonoscopy examinations were performed by experienced colonoscopists with more than 1000 procedures. Successful endoscopy was defined as terminal ileum intubation confirmed through a photo.

### The intervention: smartphone WeChat application

We created a novel smartphone application to try to improve the quality of bowel preparation. The smartphone WeChat application account mainly provides three functions: colonoscopy education, colonoscopy drug reminder, bowel preparation automatic score. The examination education is mainly in the form of texts, pictures and videos to teach patients the knowledge needed before and after colonoscopy, remind patients to take medicine according to the prescribed medicine plan, regularly send patients accurate information such as taking medicine, and fasting food and water. In bowel preparation, patients can upload their own fecal water photos, after which the system will evaluate the effect of bowel preparation by scoring the fecal water photos (Photo 1).

### Definitions

Time was defined as follows. The insertion time was defined as the interval between the start of the



**Photo 1.** Educational tools provided to patients with the smartphone WeChat application. **A** – Process of taking medication, **B** – time alerts, **C** – upload fecal water photos, **D** – evaluation of fecal water image scores

procedure and arrival at the cecum. Withdrawal time was referred to the examination time from cecum to anus except the time used for polypectomy, biopsy, or any other endoscopic treatment. The quality of bowel preparation was evaluated by the Boston bowel preparation score (BBPS) [18]. Colon regions were roughly divided into three broad regions as follows: the right (cecum and ascending colon), the transverse colon (liver curvature, transverse colon and splenic curvature), and the left (descending colon, sigmoid colon and rectum). The colon regions were rated from 0 to 3. A score of 0 indicated that the colonic mucosa was not prepared and could not be seen due to solid feces. A score of 3 indicated that the colonic mucosa could be seen clearly, without residual staining, small fragments of stool or opaque liquid. The quality of bowel preparation was determined to be either “adequate” or “inadequate,” and based on previous validation studies, inadequate was defined as BBPS < 6 [18, 19]. Anxiety (“How anxious are you?”) on a 5-point Likert scale (very low = 1, low = 2, moderate = 3, high = 4, and very high = 5).

### Endpoints

The primary outcome was to assess the quality of bowel preparation during examination by the BBPS. Secondary endpoints included colonoscopy outcomes, consisting of polyp detection rate (PDR), cecal intubation rate, cecal intubation time, withdrawal time, self-reported sleep quality, anxiety

score, and willingness to revisit another colonoscopy.

### Sample size and statistical analysis

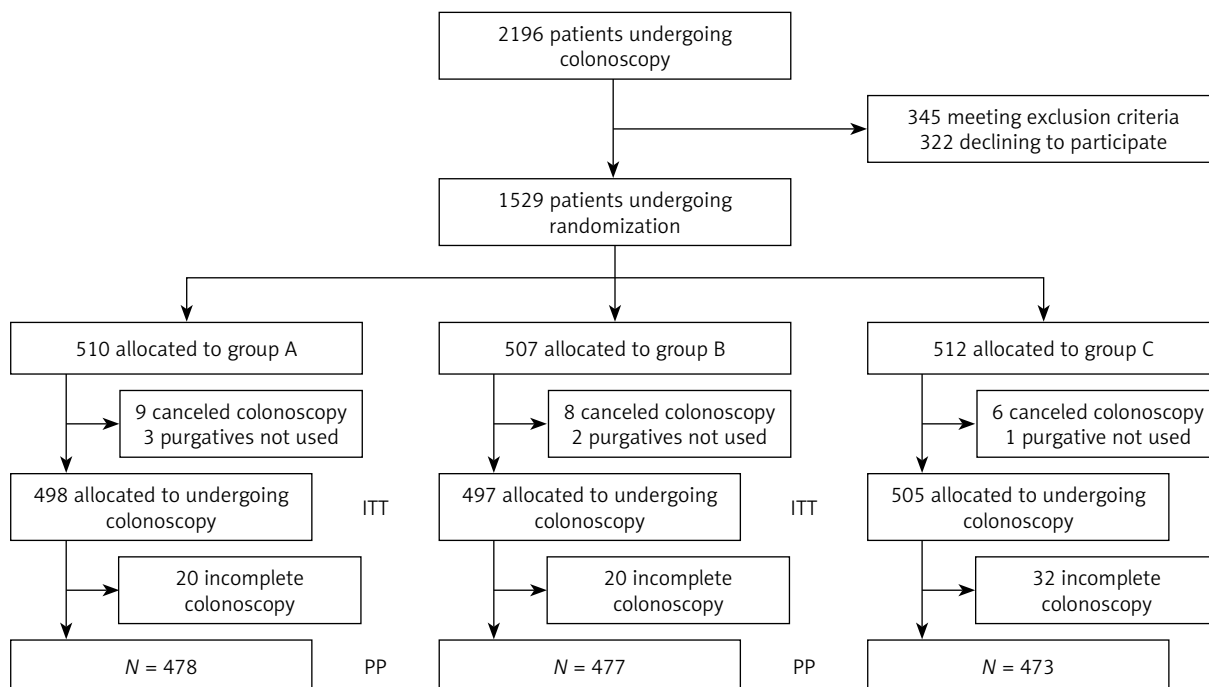
Based on our past experience, we believe the rate of adequate bowel preparation in our three endoscopic centers is about 75%. To detect the difference with an  $\alpha$ -error of 0.05 and  $\beta$ -error of 0.1, we calculated that at least 400 patients in each group were needed on the basis of an expected efficiency of 85% in the observation group. To account for possible drop out secondary to cancellation of the procedure, about 500 patients were planned to be enrolled in each group.

Baseline characteristics were evaluated by intention-to-treat (ITT) analysis. Primary outcomes and secondary outcomes were analyzed on a per-protocol basis. The  $\chi^2$  test was used to assess categorical variables when appropriate. Continuous variables were described as means with SD and analyzed with one-way ANOVA. A  $p$ -value of < 0.05 indicated statistical significance. SPSS software, version 18.0, was used for data processing.

## Results

### Patient characteristics

A total of 2196 patients underwent colonoscopy. Of these, 345 met exclusion criteria and 322 refused



**Figure 1.** Flow chart of study design

ITT – intention-to-treat analysis, PP – per-protocol analysis.

to participate. 1529 patients were randomized to three groups. A total of 29 individuals canceled colonoscopy appointments or did not take any purgatives, so no arrangements were made. ITT analysis of other patients included in the study: 498 in group A (smartphone WeChat application group), 497 in group B (conventional education plus smartphone WeChat application), and 505 in the control group (Figure 1). There was no significant difference in baseline characteristics among the three groups (Table I).

### Outcomes

Excluding incomplete colonoscopy, a total of 478 patients in group A, 477 in group B and 473 in group C had colonoscopy and underwent PP analysis. The technical difficulty of incomplete colonoscopy for one reason did not differ significantly, but poor bowel preparation for the other reason did differ significantly among the three groups ( $p = 0.043$ ) (Table II). The success rate of cecal intubation was 96.0% (478/498) of patients in group A, 96.0% (477/497) in group B, and 93.7% (473/505) in the control group, with no significant differences between them ( $p = 0.140$ ). Among patients with successful insertion, the rate of adequate bowel preparation (BBPS  $\geq 6$ ) was significantly different among the three groups,

with a mean BBPS score of  $7.5 \pm 1.2$  in group A,  $7.5 \pm 1.3$  in group B, and  $6.5 \pm 1.2$  in group C ( $p < 0.001$ ).

BBPS scores of patients with cecal intubation were compared as shown in Figure 2. Compared with the control group, group A and group B showed significantly better bowel preparations at each segment ( $2.6 \pm 0.5$ ,  $2.4 \pm 0.6$  vs.  $2.2 \pm 0.6$ ,  $p < 0.001$  for left colon;  $2.4 \pm 0.6$ ,  $2.6 \pm 0.6$  vs.  $2.2 \pm 0.5$ ,  $p < 0.001$  for transverse;  $2.5 \pm 0.6$ ,  $2.5 \pm 0.7$  vs.  $2.2 \pm 0.6$ ,  $p < 0.001$  for right colon). There was no significant difference in total BBPS score and right colon BBPS score between group A and group B, but there was a significant difference in left colon and transverse colon BBPS score.

The cecal insertion time in group A and group B was shorter than that in the control group ( $8.8 \pm 3.9$ ,  $8.9 \pm 3.8$  vs.  $10.5 \pm 4.2$  min,  $p < 0.001$ ). The mean withdrawal times were similar among the three groups. PDR in group A (40.2%, 192/478) and group B (41.7%, 199/477) was higher than that in the control group ( $p = 0.003$ ) and mean polyp rate per case was higher too ( $p = 0.015$ ).

### Patient compliance and tolerance

As shown in Table III, significantly higher proportions of patients in group A and group B rated sleep quality as excellent or good (58.6%, 56.0% vs. 50.6%,

**Table I.** Baseline data of three groups

Parameter	Group A (n = 498)	Group B (n = 497)	Group C (Control group) (n = 505)	P-value
Sex (male/female)	348/150	330/167	346/159	0.490
Age [years] mean ± SD	46.7 ±13.5	47.1 ±14.1	47.4 ±13.2	0.681
BMI [kg/m <sup>2</sup> ] mean ± SD	24.0 ±3.3	24.1 ±3.4	23.9 ±3.4	0.681
History of abdominopelvic surgery, n (%)	81 (16.3)	96 (19.3)	86 (17.0)	0.420
Constipation, n (%)	74 (14.9)	71 (14.3)	76 (15.0)	0.939
Co-morbidity, n (%):				
Hypertension	45 (9.0)	44 (8.9)	49 (9.7)	0.887
Coronary artery disease	10 (2.0)	11 (2.2)	9 (1.8)	0.888
Diabetes	12 (2.4)	13 (2.6)	12 (2.4)	0.966
Others	7 (1.4)	6 (1.2)	6 (1.2)	0.944
Colonoscopy, n (%):				0.168
Ordinary colonoscopy	119 (23.9)	120 (24.1)	144 (28.5)	
Painless colonoscopy	379 (76.1)	377 (75.9)	361 (71.5)	
Interval from appointment to colonoscopy [days]	7.0 ±0.9	7.0 ±0.8	7.1 ±0.9	0.878
Incomplete colonoscopy, n (%):				
Technical difficulty	11 (2.2)	11 (2.2)	12 (2.4)	0.98
Very poor preparation	9 (1.8)	9 (1.8)	20 (4.0)	0.043

SD – standard deviation.

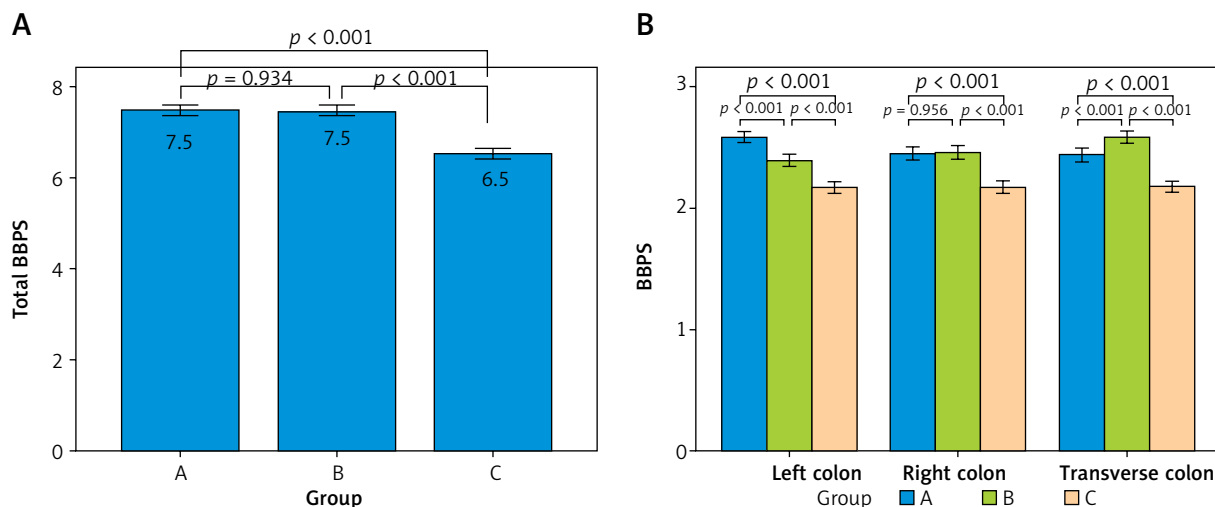
**Table II.** Comparison of colonoscopy outcomes

Parameter	Group A (n = 478)	Group B (n = 477)	Group C (control group) (n = 473)	P-value
Cecal intubation rate, n (%)	478 (96.0)	477 (96.0)	473 (93.7)	0.140
Cecal intubation time, mean ± SD [min]	8.8 ±3.9	8.9 ±3.8	10.5 ±4.2	< 0.001
Withdrawal time, mean ± SD [min]	8.3 ±3.9	8.4 ±3.8	8.5 ±4.2	0.672
Rate of adequate bowel preparation, n (%) (BBPS 6 or higher)	426 (89.1)	424 (88.9)	397 (83.9)	0.025
BBPS score, mean ± SD:				
Total	7.5 ±1.2	7.5 ±1.3	6.5 ±1.2	< 0.001
Right colon	2.5 ±0.6	2.5 ±0.7	2.2 ±0.6	< 0.001
Transverse colon	2.4 ±0.6	2.6 ±0.6	2.2 ±0.5	< 0.001
Left colon	2.6 ±0.5	2.4 ±0.6	2.2 ±0.6	< 0.001
PDR findings, n (%)	192 (40.2)	199 (41.7)	150 (31.7)	0.003
Mean polyp per patient, mean ± SD	0.6 ±1.0	0.6 ±0.9	0.5 ±0.8	0.015

BBPS – Boston Bowel Preparation Scale, SD – standard deviation, PDR – polyp detection rate.

respectively,  $p = 0.039$ ). We found a significant difference in the 5-point Likert anxiety scores ( $1.6 \pm 0.9$ ,  $1.7 \pm 0.9$  vs.  $2.2 \pm 1.0$ ,  $p < 0.001$ ) between groups. Compared with the control group, patients in both in-

tervention groups ( $p = 0.021$ ) were more likely to be willing to repeat the bowel preparation. In addition to the general bowel preparation for colonoscopy, there were no expected adverse events in this study.



**Figure 2.** The quality of bowel preparation was assessed using the Boston Bowel Preparation Scale (BBPS). **A** – The total score of BBPS in three groups. **B** – BBPS scores according to each segment of the colon

**Table III.** Comparison of patients’ subjective feelings and tolerance during bowel preparation

Parameter	Group A (n = 478)	Group B (n = 477)	Group C (Control group) (n = 473)	P-value
Quality of sleep, n (%):				0.039
Excellent or good	280 (58.6)	267 (56.0)	239 (50.5)	
Fair or bad	198 (41.4)	210 (44.0)	234 (49.5)	
Patient’s willingness to repeat bowel preparation, n (%)	340 (72.1)	347 (72.7)	307 (64.9)	0.021
Anxiety score, mean ± SD (1 = very low, 5 = very high)	1.6 ± 0.9	1.7 ± 0.9	2.2 ± 1.0	< 0.001

SD – standard deviation.

## Discussion

Colonoscopy is crucial to diagnosis and treatment of precancerous colonic lesions [20]. Proper bowel preparation is crucial to the efficacy of colonoscopy. Adequate bowel cleansing can increase the polyp detection rate and reduce complications [7, 21]. Inadequate bowel preparation can lead to prolonged procedure time, incomplete examination, increased cost, possibly complications and patient anxiety, but the most important is misdiagnosis [22, 23]. Current studies focus on different types of interventions to improve the quality of patient education and bowel preparation before colonoscopy [8, 24–26]. Although some interventions are effective ways to transmit information related to bowel preparation, they are not intuitive, cannot be used as a reference, are easy to forget, need to be reminded repeatedly, and require multiple communication. Then the medical

staff need to spend extra time to communicate with patients, thus increasing the cost and working time.

In this era of information technology with internet integration, the smartphone WeChat application is favored by people due to being free, mobile, convenient, and efficient, with ubiquitously accessible internet. They can also quickly send voice messages, videos, pictures and texts through the internet, so it becomes an important source of health information.

Here we conducted a prospective, randomized, controlled trial at three centers. To our knowledge, this is the first study to confirm that the smartphone WeChat application can improve the quality of colonoscopy bowel preparation. Using the smartphone WeChat application also shortened cecal insertion time and increased the polyp detection rate. Patients with colonoscopy experience were excluded from this study because they may raise the likelihood of trial bias.

Our study has several strengths. First, it is the multicenter design randomized controlled trial with a large sample size to evaluate an educational intervention. Second, the smartphone WeChat application seems to provide a relatively economical and convenient channel to deliver bowel preparation instructions. After entering the small program identity verification, one can obtain the related information on colonoscopy for free, such as the precautions before and after painless colonoscopy examination, the dietary notes before colonoscopy, how to take bowel-clearing drugs, etc. Moreover, the small program will regularly send a medication alarm at regular intervals to remind patients to avoid forgetting. Last but not least, the app can also upload pictures of patients taking their own photos to evaluate their stools, and give them a score, so as to help patients to contrast their bowel preparation, which was not available in previous studies on smartphone applications [27–30]. In the present study, the proportion of patients with successful bowel cleansing was significantly higher in the intervention group than in the control group.

Our study has some limitations. First, only the detection rate of polyps was reported and no specific pathological classification was made. So, the adenoma detection rate was not obtained. All kinds of colonoscopic findings should be recorded in future studies. Second, some factors, such as salary levels and education level, which can influence the quality of bowel preparation, were not reported. Third, only one assessment method of quality of bowel preparation, the BBPS, which is simple and lacks accuracy, was used in this study. Other scales should be used in future studies to confirm our results.

In summary, our study demonstrates that a smartphone WeChat application on bowel preparation successfully improves the quality of patient colonoscopy bowel preparation. This intervention is very effective, easy to manage and especially economical, and hence may be worth popularizing.

## Conclusions

Patient instruction via the smartphone WeChat application efficiently improved bowel preparation for colonoscopy.

## Acknowledgments

Jing Wenand and Jia Feng contributed equally to this work.

## Conflict of interest

The authors declare no conflict of interest.

## References

1. Corley DA, Jensen CD, Marks AR, et al. Adenoma detection rate and risk of colorectal cancer and death. *N Engl J Med* 2014; 370: 1298-306.
2. Bogacki P, Gach T, Krzak J, et al. Panoramic colonoscopy in colorectal cancer screening – a randomized controlled trial. *Videosurgery Miniinv* 2021; 16: 289-96.
3. Zhao S, Wang S, Pan P, et al. Magnitude, risk factors, and factors associated with adenoma miss rate of tandem colonoscopy: a systematic review and meta-analysis. *Gastroenterology* 2019; 156: 1661-74.
4. Calderwood AH, Thompson KD, Schroy PC 3<sup>rd</sup>, et al. Good is better than excellent: bowel preparation quality and adenoma detection rates. *Gastrointest Endosc* 2015; 81: 691-9.
5. Woo DH, Kim KO, Jeong DE, et al. Prospective analysis of factors associated with inadequate bowel preparation for colonoscopy in actual clinical practice. *Intest Res* 2018; 16: 293-8.
6. Liu X, Luo H, Zhang L, et al. Telephone-based re-education on the day before colonoscopy improves the quality of bowel preparation and the polyp detection rate: a prospective, colonoscopist-blinded, randomized, controlled study. *Gut* 2014; 63: 125-30.
7. Fronehlich F, Wietlisbach V, Gonvers JJ, et al. Impact of colonic cleansing on quality and diagnostic yield of colonoscopy: the European Panel of Appropriateness of Gastrointestinal Endoscopy European multicenter study. *Gastrointest Endosc* 2005; 61: 368-84.
8. Spiegel BMR, Talley J, Shekelle P, et al. Development and validation of a novel patient educational booklet to enhance colonoscopy preparation. *Am J Gastroenterol* 2011; 106: 875-83.
9. Liu X, Luo H, Zhang L, et al. Telephone-based re-education on the day before colonoscopy improves the quality of bowel preparation and the polyp detection rate: a prospective, colonoscopist-blinded, randomised, controlled study. *Gut* 2014; 63: 125-30.
10. Sondhi AR, Kurlander JE, Waljee AK, et al. A telephone-based education program improves bowel preparation quality in patients undergoing outpatient colonoscopy. *Gastroenterology* 2015; 148: 657-8.
11. Park J, Kim TO, Lee NY, et al. The effectiveness of short message service to assure the preparation-to-colonoscopy interval before bowel preparation for colonoscopy. *Gastroenterol Res Pract* 2015; 2015: 628049.
12. Walter B, Klare P, Strehle K, et al. Improving the quality and acceptance of colonoscopy preparation by reinforced patient education with short message service: results from a randomized, multicenter study (PERICLES-II). *Gastrointest Endosc* 2019; 89: 506-13.
13. Back SY, Kim HG, Ahn EM, et al. Impact of patient audiovisual re-education via a smartphone on the quality of bowel preparation before colonoscopy: a single-blinded randomized study. *Gastrointest Endosc* 2018; 87: 789-99.

14. Pillai A, Menon R, Ousteky D, et al. Educational colonoscopy video enhances bowel preparation quality and comprehension in an inner City population. *J Clin Gastroenterol* 2018; 52: 515-8.
15. Gkolfakis P, Tziatzios G, Papanikolaou IS, et al. Strategies to improve inpatients' quality of bowel preparation for colonoscopy: a systematic review and meta-analysis. *Gastroenterol Res Pract* 2019; 2019: 5147208.
16. Guo B, Zuo X, Li Z, et al. Improving the quality of bowel preparation through an app for inpatients undergoing colonoscopy: a randomized controlled trial. *J Adv Nurs* 2019; 76: 1037-45.
17. Pontone S, Palma R, Panetta C, et al. Polyethylene glycol-based bowel preparation before colonoscopy for selected inpatients: a pilot study. *J Dig Dis* 2018; 19: 40-7.
18. Kudo SE, Mori Y, Misawa M et al. Artificial intelligence and colonoscopy: current status and future perspectives. *Dig Endosc* 2019; 31: 363-71.
19. Lai EJ, Calderwood AH, Doros G, et al. The Boston bowel preparation scale: a valid and valid and reliable instrument for colonoscopy-oriented research. *Gastrointest Endosc* 2009; 69: 620-5.
20. Bogacki P, Gach T, Krzak J, et al. Panoramic colonoscopy in colorectal cancer screening-a randomized controlled trial. *Video-surgery Miniinv* 2021; 16: 289-96.
21. Saltzman JR, Cash BD, Pasha SF, et al. Boston preparation before colonoscopy. *Gastrointest Endosc* 2015; 81: 781-94.
22. Harewood GC, Sharma VK, de Garmo P. Impact of colonoscopy preparation quality on detection of suspected colonic neoplasia. *Gastrointest Endosc* 2003; 58: 76-9.
23. Rex DK, Imperiale TF, Latinovich DR, et al. Impact of bowel preparation on efficiency and cost of colonoscopy. *Am J Gastroenterol* 2002; 97: 1696-700.
24. Senore C, Ederle A, Fantin A, et al. Acceptability and side effects of colonoscopy and sigmoidoscopy in a screening setting. *J Med Screen* 2011; 18: 128-34.
25. Tae JW, Lee JC, Hong SJ, et al. Impact of patient education with cartoon visual aids on the quality of bowel preparation for colonoscopy. *Gastrointest Endosc* 2012; 76: 804-11.
26. Prakash ST, Verma S, McGowan J, et al. Improving the quality of colonoscopy bowel preparation using an educational video. *Can J Gastroenterol* 2013; 27: 696-700.
27. Kavanthia NH, Berggreen P, Gerkin R. Outcomes of smart phone application assisted bowel preparation for colonoscopy. *DDW* 2013; 19-21: 143c.
28. Lorenzo-Zúñiga V, Moreno de Vega V, Marín I, et al. Improving the quality of colonoscopy bowel preparation using a smart phone application: a randomized trial. *Dig Endosc* 2015; 27: 590-5.
29. Cho J, Lee S, Shin JA, et al. The impact of patient education with a smartphone application on the quality of bowel preparation for screening colonoscopy. *Clin Endosc* 2017; 50: 479-85.
30. Kang X, Zhao L, Leung F, et al. Delivery of instructions via mobile social media app increases quality of bowel preparation. *Clin Gastroenterol Hepatol* 2016; 14: 429-35.

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