

## Assessment of the adequacy of bowel preparation in patients undergoing colonoscopy: a retrospective study

### Valutazione dell'adeguatezza della preparazione intestinale nei pazienti sottoposti a colonscopia: uno studio retrospettivo

Roberta Di Matteo,<sup>1</sup> Claudia Gota,<sup>2</sup> Claudia Bina,<sup>2</sup> Lorenzo Martino,<sup>2</sup> Rossana Perciante,<sup>2</sup> Giovanna Condino,<sup>2</sup> Simona Arcidiacono,<sup>3</sup> Menada Gardalini,<sup>1</sup> Antonella Cassinari,<sup>1</sup> Tatiana Bolgeo,<sup>1</sup> Antonio Maconi<sup>1</sup>

<sup>1</sup>SC Research Training Innovation Infrastructure, Integrated Activities, Research, Innovation Department (DAIRI), Azienda Ospedaliero-Universitaria SS. Antonio e Biagio e Cesare Arrigo, Alessandria; <sup>2</sup>Department of Internal Medicine and Emergency and Admissions, SS of High Complexity Digestive Endoscopy, SC Gastroenterology, Azienda Ospedaliero-Universitaria SS. Antonio e Biagio e Cesare Arrigo, Alessandria; <sup>3</sup>SC Directorate of Health Professions, Azienda Ospedaliero-Universitaria SS. Antonio e Biagio e C. Arrigo, Alessandria, Italy

**Key words:** colonoscopy, bowel cleansing, bowel preparation.

#### ABSTRACT

**Background:** a colonoscopy is crucial for detecting Colorectal Cancer (CRC), and its success is reliant on various factors, notably colon cleansing. Investigating the frequency of procedure interruptions due to inadequate bowel preparation and associated predictive factors could inform targeted interventions. This study aimed to retrospectively assess inadequate bowel preparation rates in outpatient and inpatient settings.

**Materials and Methods:** this observational, retrospective, and single-center study examines patient records from a single hospital in northern Italy. This investigation involves individuals who underwent colonoscopies from January 1, 2021, to December 31, 2021, regardless of whether they were receiving outpatient or inpatient care.

**Results:** this study included 1977 participants. The median age of all participants was 64 years, with ages ranging from 41 to 86. Among males, the median age was 65 years, varying from 56 to 74, whereas for females, it was 64 years, ranging from 55 to 74. The majority (78.7%) of participants came from their homes. The type of product used for colon preparation was evaluated in 1783 patients: 92% of them used an osmotic action product (55.7% high volume, 36.3% low volume). The adequacy of the colon preparation for the procedure, assessed using the Boston Bowel Preparation Scale, was found to be poor (score $\leq$ 5) for 24.2% of the participants, with 13.5% scoring 0.

**Conclusions:** the study suggests healthcare providers should enhance patient education for colonoscopy preparation, especially focusing on hospitalized patients with higher rates of inadequate preparation. Strategies should align with guidelines but also prioritize personalized approaches.

**Background:** la colonscopia è fondamentale per individuare il Cancro del Colon-Retto (CRC) e il suo successo dipende da vari fattori, in particolare dalla pulizia del colon. L'analisi della frequenza delle interruzioni della procedura dovute a una preparazione intestinale inadeguata e dei fattori predittivi associati potrebbe fornire informazioni su interventi mirati. Questo studio si proponeva di valutare retrospettivamente i tassi di preparazione intestinale inadeguata in ambito ambulatoriale e ospedaliero.

**Materiali e Metodi:** lo studio osservazionale, retrospettivo e monocentrico, ha preso in esame le cartelle cliniche di un unico ospedale del Nord Italia. L'indagine ha coinvolto i soggetti sottoposti a colonscopia nel periodo compreso tra il 1° gennaio 2021 e il 31 dicembre 2021, indipendentemente dal fatto che fossero in regime ambulatoriale o di ricovero.

**Risultati:** lo studio ha incluso 1977 partecipanti: L'età mediana di tutti i partecipanti era di 64 anni, con età comprese tra 41 e 86 anni. Tra i maschi, l'età mediana era di 65 anni, con una variazione da 56 a 74 anni, mentre per le donne era di 64 anni, con una variazione da 55 a 74 anni. La maggior parte dei partecipanti (78,7%) proveniva dal proprio domicilio. Il tipo di prodotto utilizzato per la preparazione del colon è stato valutato in 1783 pazienti: il 92% di essi ha utilizzato un prodotto ad azione osmotica (55,7% ad alto volume, 36,3% a basso volume). L'adeguatezza della preparazione del colon per la procedura, valutata con la Boston Bowel Preparation Scale, è risultata scarsa (punteggio $\leq$ 5) per il 24,2% dei partecipanti, con il 13,5% che ha ottenuto un punteggio pari a 0.

**Conclusioni:** lo studio suggerisce agli operatori sanitari di migliorare l'educazione dei pazienti alla preparazione alla colonscopia, concentrandosi in particolare sui pazienti ospedalizzati con tassi più elevati di preparazione inadeguata. Le strategie dovrebbero essere in linea con le linee guida, ma anche privilegiare approcci personalizzati.

## Introduction

A colonoscopy is a medical procedure used to diagnose and treat issues in the large intestine (colon, rectum, and anus) and the lower part of the small intestine (terminal ileum). It is considered the best method for detecting Colorectal Cancer (CRC) in both average-risk patients (those aged 50 years and older) and high-risk patients (those with a history of inflammatory bowel disease, a family history of colorectal cancer before the age of 60, hereditary polyposis, non-polypoid lesions, and surveillance after colorectal cancer resection).<sup>1</sup>

Therapeutic reasons for doing a colonoscopy include removing and destroying abnormal growths, treating bleeding lesions,<sup>2</sup> dealing with strictures, removing foreign bodies, relieving twisted or enlarged sections of the colon (volvulus or megacolon)<sup>3</sup> and providing palliative care for known tumors.

The success of this procedure depends on many factors, but colon cleansing is considered a key factor.<sup>4</sup> Agents for intestinal preparation can be classified in various ways, including the administered volume (low volume/high volume), osmolarity (isotonic/hypotonic/hypertonic), or main active ingredient (Polyethylene Glycol, PEG; sodium picosulfate, sodium phosphate).<sup>5</sup> Furthermore, it is crucial for patients, particularly the elderly and frail, to stay well hydrated during preparation. This helps reduce the risk of negative effects from laxative use, such as dehydration and electrolyte imbalances.<sup>6</sup>

The quality of bowel cleanliness is significantly linked to the rate of detecting colorectal adenomas.<sup>7,8</sup> Adequate Bowel Preparation (BP) ensures high procedural accuracy, optimal visualization of the colon mucosa, and increased adenoma detection rates.<sup>9</sup>

Inadequate bowel preparation is linked to various problems, including technical challenges during the procedure, higher risks of bowel perforation, interruptions in the procedure, delays in diagnosis, lower rates of detecting adenomas and carcinomas, increased healthcare risks, and costs.<sup>10</sup> Several studies have reported inadequate bowel preparation in 15-35% of colonoscopies.<sup>11-14</sup>

Understanding the number of procedures interrupted or not completed due to inadequate bowel preparation and its relationship with predictive factors could guide professionals in implementing targeted interventions. Therefore, the aim of this study was to assess the rate of inadequate bowel preparation in outpatient and inpatient settings through a retrospective investigation.

## Materials and Methods

This is an observational, retrospective, and single-center study, looking back at patient records from a single hospital in northern Italy. This investigation involved individuals who underwent colonoscopies from January 1, 2021, to December 31, 2021, regardless of whether they were receiving outpatient or inpatient care. When booking, some patients receive information.

During these sessions, they received detailed explanations about the nature of the procedure and the necessary preparations. Additionally, they were provided with written materials outlining the specifics of the examination, its execution, and the required preparation steps.

It would be desirable for all patients to receive pre-colonoscopy counseling from both a physician and a nurse, explaining the nature of the examination and the preparation required. Additionally, they

were provided with written information detailing the procedure, how it is performed, and the preparation methods.

The day prior to the procedure, patients were instructed to adhere to a low-residue diet, with clear guidelines on permitted and restricted foods and beverages. They were also given options for preparation methods, which were to be discussed further with their physician. These options included high-volume macrogol-based solutions (4 liters) and low or ultra-low-volume macrogol-based solutions (1-2 liters), in addition to other beverages, with or without bisacodyl. The intake of these preparations was divided into multiple doses, to be taken both on the day before and the day of the examination (using a split-dose regimen).

Hospitalized patients received tailored preparation protocols based on their individual clinical conditions.

## Participants

The study included the medical/nursing records of adults aged 18 years and older who underwent routine colonoscopy, regardless of the indication, but only after they provided signed informed consent.

## Instruments

To assess the quality of bowel preparation, we used the Boston Bowel Preparation Scale (BBPS) (Lai *et al.*, 2009). This scale categorizes cleanliness into four levels: score 0, which indicates solid or semi-solid residues that cannot be aspirated, and mucosa, which is not visible (poor); score 1, which indicates semi-solid or liquid residues that can be aspirated and mucosa that is slightly visible (fair); score 2, which indicates minimal solid residues, abundant aspirable clear liquid, and visible mucosa (good); score 3, which indicates the absence of solid residues, minimal aspirable clear liquid, and completely clean mucosa (excellent). Each colon segment (cecum-ascending, transverse, recto-sigmoid) is assigned a "segment score" ranging from 0 to 3. A maximum score of 9 indicates excellent cleanliness. Bowel preparation was considered adequate if the total score was  $\geq 6$ , with segmental scores of  $\geq 2$  in all colon segments.

## Ethical considerations

The research received approval from the Ethical Committees of all participating centers (approval number 507 dated 29/03/2022). Data collection commenced only after obtaining written consent from all participants. Before analysis, all data were anonymized to protect privacy.

## Statistical analysis

The data were processed anonymously and grouped together. We conducted a descriptive analysis of the entire study population, examining demographic and clinical characteristics as well as details about the colonoscopy preparation and procedure outcomes. For categorical variables, we reported counts and percentages, while quantitative data were summarized using the median and Interquartile Range (IQR), considering their distribution. We assessed distributions using appropriate graphs and the Kolmogorov-Smirnov normality test. To compare two groups, we used the Mann-Whitney test, and for comparisons involving multiple groups, we employed the Kruskal-Wallis test for quantitative data. Associations between categorical variables were examined using the Chi-square test, Fisher's

exact test, or Cramer's V. We considered a two-sided p-value of less than 0.05 to be statistically significant. All statistical analyses were performed using Statistical Package for Social Sciences (SPSS) (IBM Corp.; Armonk, USA) version 25 for Windows.

## Results

This study included 1977 participants: The median age of all participants was 64 years, with ages ranging from 41 to 86. Among males, the median age was 65 years, varying from 56 to 74, whereas for females, it was 64 years, ranging from 55 to 74. The majority (78.7%) of participants came from their homes. Details regarding demographic characteristics, origin, type of colonoscopy preparation, and its assessment are provided in Table 1.

The type of product used for colon preparation was evaluated in 1783 patients (data unavailable for 194 patients): 92% of them used an osmotic action product (55.7% high volume, 36.3% low volume).

The adequacy of the colon preparation for the procedure, assessed using the Boston Bowel Preparation Scale, was found to be poor (score  $\leq 5$ ) for 24.2% of the participants, with 13.5% scoring 0. About 29.6% had a good preparation (score 6-7), while 46.2% had a very good preparation (with a score of 9 for 31.7%). The median score was 7 (ranging from 6 to 9). Notably, inpatients had a lower median score of 6 (ranging from 1 to 8) compared to outpatients with a median score of 8 (ranging from 6 to 9),  $p < 0.001$ ; similarly, males had a lower median score of 6 (ranging from 3 to 9) compared to females with a median score of 8 (ranging from 6 to 9),  $p < 0.001$ . There was a higher percentage of patients with inadequate preparation (score  $\leq 5$ ) in the  $\geq 65$  age group (26.7%) compared to the  $< 65$  age group (21.8%),  $p = 0.011$ .

For most individuals who used enemas for colon cleansing, poor preparation was observed in 84.6% of cases. Patients using low-volume osmotic preparations had the highest score on the Boston scale ( $\geq 8$ ) at 56.0%, compared to those using high-volume products (48.6%) and enemas (5.1%),  $p < 0.001$  (Table 2).

Out of the total sample, 85.1% completed the procedure, while 1.7% did not undergo it at all (these patients were deemed unsuitable and were sent back without starting the examination, as indicated by a Boston scale score ranging from 0 to 2 for all subjects), and 13.2% started the procedure but had to interrupt it (Table 3). The primary reason for interruptions during the procedure ( $n = 260$ ) was the presence of fecal matter in patients who were scheduled for colonoscopy (53.5%).

When focusing on patients who used osmotic action products and enemas ( $n = 1776$ ), it was found that the preparation outcome was significantly worse ( $p < 0.001$ ) for those who used enemas compared to other products: about one-third, 32.3%, had to interrupt the examination, and 9.6% did not undergo it (Table 4).

Among the 1640 cases focusing exclusively on osmotic preparations, it was observed that low-volume preparations exhibited better performance than high-volume ones: 8.3% of procedures were

**Table 1.** Sample characteristics ( $n = 1977$ ).

Characteristics	Median (IQR) or N (%)
Age	64.0 (55-74)
Gender	
Male	1079 (54.6)
Female	898 (45.4)
Where the patient came from	
Home	1556 (78.7)
Hospital (hospitalization)	421 (21.3)
Product used for bowel cleansing ( $n = 1783$ )	
High volume osmotic action preparations	993 (55.7)
Low volume osmotic action preparations	647 (36.3)
Enemas	136 (7.6)
Cathartic action preparations (phosphates, picosulfates)	6 (0.3)
Other (supplements)	1 (0.1)
Boston bowel preparation scale	7 (6-9)

**Table 2.** Boston bowel preparation: primary product categories used ( $n = 1776$ ).

Score	High volume osmotic action	Low volume osmotic action	Enema	p
	(993) N (%)	(647) N (%)	(136) N (%)	
Poor ( $\leq 5$ )	191 (19.2)	96 (14.8)	115 (84.6)	$< 0.001$
Good* (6-7)	320 (32.2)	189 (29.2)	14 (10.3)	
Very good* ( $\geq 8$ )	482 (48.6)	362 (56.0)	7 (5.1)	
*Good + very good ( $> 5$ )	802 (80.8)	551 (85.2)	21 (15.4)	-

**Table 3.** Procedure outcomes: key patient characteristics ( $n = 1977$ ).

	Total N (%)	Gender		p	Age		p	Provenience		p
		Male (1079)	Female (898)		<65 (992)	$\geq 65$ (985)		Internal (421)	External (1556)	
		N (%)	N (%)		N (%)	N (%)		N (%)	N (%)	
Completed	1683 (85.1)	876 (81.2)	807 (89.9)	$< 0.001$	859 (86.6)	824 (83.7)	0.184	306 (72.7)	1377 (88.5)	$< 0.001$
Interrupted	260 (13.2)	180 (16.7)	80 (8.9)		118 (11.9)	142 (14.4)		98 (23.3)	162 (10.4)	
Not done	34 (1.7)	23 (2.1)	11 (1.2)		15 (1.5)	19 (1.9)		17 (4.0)	17 (1.1)	

**Table 4.** Procedure outcomes: main types of preparation used (n=1776).

Score	Product used for bowel cleansing			p
	High volume osmotic action (993) N (%)	Low volume osmotic action (647) N (%)	Enema (136) N (%)	
Completed	862 (86.8)	593 (91.7)	79 (58.1)	<0.001
Interrupted	117 (11.8)	54 (8.3)	44 (32.3)	
Not done	14 (1.4)	0 (0.0)	13 (9.6)	

interrupted with low-volume preparations compared to 11.8% with high-volume ones. None of the patients using a low-volume preparation had their procedure canceled, whereas 1.4% of those using high-volume osmotic products did not proceed (p=0.001).

## Discussion

Our study aimed to assess the inadequate bowel preparation rate in both those treated as outpatients and those admitted to the hospital. We found that nearly 25% of patients had inadequate bowel preparation, particularly among those who were hospitalized. This is consistent with other study findings.<sup>15</sup>

Using low-volume osmotic preparations for bowel preparation led to better colon cleansing than other methods. This resulted in fewer interruptions or cancellations of the procedure. Previous research has also shown similar benefits.<sup>16,17</sup> Low-volume preparations are better tolerated by patients, which likely contributes to better compliance in completing the preparation correctly. In contrast, high-volume solutions often cause adverse reactions like nausea, vomiting, abdominal pain, and sleep disturbances,<sup>18</sup> leading patients to discontinue the preparation procedure, consequently reducing compliance.

Women tended to have better preparation than men. This gender difference has been observed in other studies as well. For example, studies by Hwang *et al.* and Panitch *et al.* (2018) found that females generally had better preparation than males. This highlights the need to focus more on educating men about proper bowel preparation.

It was found that colonoscopies performed on hospitalized patients had higher rates of inadequate bowel preparation compared to outpatient procedures, with some studies reporting rates as high as 50%.<sup>19</sup> This is not surprising, as these patients are typically older, frailer, bedridden, often suffer from constipation, and have comorbidities that hinder the adequate intake of bowel preparation, and in comprehending and adhering to preparatory instructions.<sup>20</sup>

## Limitations

One drawback of this study is its retrospective design. Furthermore, due to the single-center nature of this study, caution is warranted when generalizing the findings, although they are consistent with previous reports in the global literature. Factors such as medication use, previous abdominal surgeries, and chronic constipation could contribute to an increased risk of inadequate preparation. However, we did not record these factors, which could affect the accuracy of the results. Furthermore, lacking data on hospital status may negatively influence the effectiveness of bowel preparation agents.

## Conclusions

The study's findings could guide healthcare providers in enhancing patient education for colonoscopy preparation. There should be increased attention to hospitalized patients, who represent a population with a higher rate of inadequate preparation. Strategies should align with guidelines but also prioritize personalized approaches.

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Correspondence: Roberta Di Matteo, SC Research Training Innovation Infrastructure, Integrated Activities, Research, Innovation Department (DAIRI), Azienda Ospedaliero-Universitaria SS. Antonio e Biagio e Cesare Arrigo, via Venezia 16, 15121 Alessandria, Italy.  
 E-mail: rdimatteo@ospedale.al.it

Authors' contributions: RDM, CG, TB, and AM have made substantial contributions to conception and design, acquisition of data, analysis, and interpretation of data; RDM, CG, CB, LM, RP, SA, MG, GC, AC have made contributions to data acquisition, analysis and interpretation of data. All authors have been involved in drafting the manuscript or revising it critically for important intellectual content, given final approval of the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of interest: the authors declare no potential conflict of interest.

Funding: none.

Ethics approval and consent to participate: the research received approval from the Ethical Committees of all participating centers (approval number 507 dated 29/03/2022). Data collection commenced only after obtaining written consent from all participants. Before analysis, all data were anonymized to protect privacy.

Informed consent: the study included the medical/nursing records of adults aged 18 years and older who underwent routine colonoscopy, regardless of the indication, but only after they provided signed informed consent.

Availability of data and materials: data will be available upon request from the authors.

Received: 5 April 2024.

Accepted: 30 April 2024.

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*Working Paper of Public Health* 2024;12:10009

doi:10.4081/wpph.2024.10009

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