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REVIEW

The impact of preoperative stoma education on postoperative outcomes for patients with new stomas after colorectal surgery: a systematic review and meta-analysis

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Abstract

Background In accordance with Enhanced Recovery After Surgery (ERAS) principles, it has recently been suggested that preoperative stoma education protocols be routinely introduced in perioperative care. Potential benefits of such programs include shorter postoperative length of stay (LOS) and decreased readmission following discharge. We designed this systematic review and meta-analysis to further investigate the effect of preoperative stoma education on postoperative outcomes.

Methods A search in MEDLINE, Embase, and CENTRAL from inception to February 2024 was performed. We included randomized controlled trials or observational cohort studies evaluating patients who underwent stoma formation during colorectal surgery and compared those receiving and not receiving preoperative stoma education. Main outcomes included stoma-related morbidity, peristomal complications, overall morbidity, postoperative LOS, readmission, and quality of life (QoL). Meta-analyses were performed using inverse variance random effects models.

Results Nine studies (four randomized studies and five cohort studies) met inclusion criteria. Overall, 507 patients (mean age: 60.95 ± 12.86 years, 40.1% female) received preoperative stoma education prior to stoma formation, and 356 patients (mean age: 61.75 ± 12.31 years, 39.2% female) did not. Meta-analysis showed that peristomal skin complications were significantly reduced with preoperative stoma education (two studies, 9.5% versus 19.4%, risk ratio (RR) 0.45, 95% confidence interval (CI) 0.29–0.72, $p < 0.01$, $I^2 = 0\%$).There were no significant differences in other outcomes, and there was insufficient available data for meta-analysis of stoma-related morbidity or QoL.

Conclusions This study presents very low-certainty evidence suggesting that preoperative stoma education may reduce peristomal skin complications, but otherwise no significant clinical benefits were identified. Future prospective studies are warranted to further investigate the impact of preoperative stoma education.

PROSPERO registration CRD4202451323

Keywords Colorectal surgery · Digestive system surgical procedures · Colostomy · Ileostomy · Wound, ostomy, continence nurse

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Introduction

Preoperative stoma education protocols play an important role in colorectal surgery [1]. Temporary or permanent stoma formation is often required following colorectal surgery; thus, patients must be equipped with knowledge and ability to manage their new stoma [2]. Preoperative stoma education often includes communication of information regarding ostomy management, such as pouching options, caring for peristomal skin, and recognizing stomal complications [1]. Stoma education also includes teaching patients about lifestyle changes that occur as a result of stoma formation, including diet, physical activity, and sexual health counseling [1]. Moreover, psychosocial support can be an important component of stoma education as patients may experience significant stress and anxiety as they transition to living with a stoma [1–3].

Traditionally, stoma education was offered after patients had undergone surgery. Discharge occurred once independent stoma care was demonstrated. Therefore, stoma formation was often recognized as a reason for prolonged hospital stay [4]. In accordance with Enhanced Recovery After Surgery (ERAS) principles, it has been suggested that preoperative stoma education protocols be routinely introduced [5]. Potential benefits include shorter postoperative length of stay (LOS), decreased readmission following discharge, and improved quality of life (QOL) [6–9]. This is significant as there are substantial financial burdens related to readmissions owing to stoma-related complications. Notably, in a study by Taneja et al. [10], patients with parastomal skin complications generated an average of $8000 USD more in healthcare utilization costs within 120 days of surgery compared with those without complications [10]. Similarly, a study by Vogel et al. [11] found that dehydration-related hospital admissions occurred in approximately 6% of patients following ostomy creation, with associated costs ranging from US $2750 to $5924 per admission [11]. Evidence suggests that enhanced and personalized preoperative stoma education can also help to mitigate the physical, mental, and social challenges that come with living with an ostomy. In particular, studies have demonstrated a significant reduction in the anxiety level of patients [12]. In addition, preoperative ostomy education may serve to improve the quality of stoma teaching.

Several systematic reviews have synthesized studies investigating the effect of stoma site marking preoperatively on surgical outcomes, but many of the included studies only evaluated stoma marking alone without concomitant patient-directed stoma teaching [13, 14]. In 2007, Colwell and Gray examined three studies to explore the effect of preoperative teaching and stoma site marking on surgical outcomes, including postoperative stomal complications and patient well-being [15]. They found limited evidence supporting the conclusion that preoperative stoma education improves postoperative outcomes [15]. Since then, there has been an increasing number of studies seeking to gauge the effect of preoperative stoma education on surgical and patient outcomes. As such, we designed this systematic review and meta-analysis to include more recently published studies evaluating postoperative outcomes for patients who received preoperative stoma education protocols as compared with those who did not. We hypothesize that patients who received preoperative stoma education will experience improved postoperative outcomes, including reduced LOS and improved QOL.

Methods

This systematic review and meta-analysis is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Appendices 1–2). Local ethics approval was not required. The study protocol was registered a priori on the International Prospective Register of Systematic Reviews (PROSPERO; CRD4202451323).

Search strategy

Medline, EMBASE, and Cochrane Central Register of Controlled Trials (CENTRAL) databases were searched from database inception through to 2 February 2024. Search terms included “colorectal surgery,” “ostomy,” and “preoperative education,” among others (complete search strategy available in Appendix 3). Gray literature was searched via clinicaltrials.gov and the World Health Organization (WHO) International Clinical Trials Registry Platform manually to ensure that all relevant articles were included.

Eligibility criteria

Eligible articles included randomized controlled trials (RCTs) or observational cohort studies comparing adult patients (i.e., over the age of 18 years) who underwent colorectal surgery with stoma formation and received preoperative stoma teaching with those who did not receive any preoperative education. Conference abstracts were also considered for inclusion. Studies comparing patients receiving care as per ERAS protocols (in which preoperative stoma education is included) with patients receiving care not dictated by ERAS protocols were excluded, as well as single-armed, noncomparative studies. Systematic reviews, meta-analyses, and any type of study not reporting primary data were also excluded.

Study selection

Three reviewers (V.S., S.A., and M.A.) independently evaluated titles and abstracts using a standardized, pilot-tested form on Covidence (Melbourne, Australia). Discrepancies that occurred at the title and abstract screening phases resulted in inclusion of the study. The same reviewers then completed full-text screening. Discrepancies that occurred at the full-text stage were resolved by consulting an additional reviewer (T.M.).

Outcomes assessed

The main outcomes defined a priori included stoma-related morbidity, peristomal complications, overall morbidity, postoperative LOS, readmission, and quality of life (QoL). Stoma-related morbidity was defined as any deviation from the expected postoperative course concerning the stoma itself, described as one or more of the following as per the Wound, Ostomy, Continence Nurse (WOCN) Society: high output ileostomy, parastomal hernia, mucocutaneous separation, stenosis, necrosis, prolapse, fistula, trauma, and stomal retraction [16]. Peristomal complications were defined as any alteration(s) to the skin surrounding the stoma, as well as skin under hydrocolloid or barrier adhesive of the pouching system. The WOCN Society provides examples such as moisture-associated skin damage, allergic contact dermatitis, mechanical injury, fungal/candidiasis infection, varices, folliculitis, pyoderma gangrenosum (PG), hyperplasia, and suture granulomas [16, 17]. Overall postoperative morbidity included any deviation from the expected postoperative course as reported by each included study. If this was not reported as a pooled outcome in the included study (i.e., overall postoperative morbidity), then the outcome was recorded as missing. Postoperative LOS was defined as the number of days from the index procedure to the time the patient left an acute care bed. The 30-day readmission was defined as readmission to hospital reported by each included study within 30 days of the index surgery. QoL concerns various aspects of the patient's life, including functional status, physical health, and psychosocial well-being, most frequently measured using structured questionnaires such as the City of Hope Quality of Life Ostomy Questionnaire (COHQOL-OQ), or the Stoma-QoL [3, 18, 19]. We included any health-related (HRQoL) data obtained using a validated questionnaire, as well as any QoL data pertaining to adjustment to stoma, self-efficacy, stoma acceptance, or stoma function, as these are closely tied to HRQoL.

Risk of bias assessment and certainty of evidence

Risk of bias for randomized controlled trials (RCTs) was assessed using the Cochrane Risk of Bias Tool for RCTs 2.0. Risk of bias for observational studies was assessed using the Risk of Bias in Nonrandomized Studies of Interventions (ROBINS-I) assessment tool.

Certainty of evidence for estimates derived from meta-analyses were assessed by Grading of Recommendations, Assessment, Development and Evaluation (GRADE) [20]. Results were then synthesized in a summary of findings table, recommended by the Cochrane Collaborative [21]. The calculations and organization of results into a summary of findings table were carried out using the GRADEPro software [21].

Statistical analysis

All statistical analyses were conducted using STATA version 18 (StataCorp, College, TX) and DataParty (Hamilton, ON, Canada), with the threshold for statistical significance predetermined at a p-value of < 0.05. A pairwise meta-analysis employed an inverse variance random effects model for all comparative data. A random effects model was chosen for anticipated heterogeneity across nonrandomized studies. Pooled effect estimates were derived by calculating the risk ratio (RR) with corresponding 95% confidence intervals (CI) for dichotomous data, and mean differences (MD) with their respective 95% CIs for continuous data. In cases where different QoL scales were combined, standardized mean differences (SMD) and their 95% CIs were calculated when possible. When only median and interquartile range (IQR) were reported, means and standard deviations (SD) were estimated using the approach outlined by Wan et al. [22]. Missing SD values were computed using the prognostic method [23]. The inconsistency (I^2) statistic was used to assess heterogeneity, and values above 40% were considered to suggest substantial heterogeneity [24]. We performed a post hoc sensitivity analysis on the basis of whether control groups comprised patients undergoing elective surgery or emergency surgery (i.e., we excluded studies in which the control group did not have access to preoperative stoma education owing to emergency surgery/unplanned stoma). Additional sensitivity analyses were conducted on the basis of the inclusion of stoma siting (i.e., studies incorporating preoperative stoma siting education were excluded) and presence of inputted data (i.e., studies that required estimation of mean and SD). Heterogeneity was further investigated through several a priori subgroup analyses: (1) type of stoma (more than 50% ileostomy versus less than 50% ileostomy); (2) operative approach (more than 50% minimally invasive versus less than 50% minimally invasive); (3) oncologic disease (more than 50% of cases for cancer versus less than 50%); (4) stoma permanence (more than 50% reported as permanent versus less than 50%); (5) type of providers (education by WOCN versus other healthcare practitioners); (6) type of study (i.e., randomized controlled

trial versus nonrandomized controlled trial). Potential bias in the meta-analyzed outcomes was evaluated using funnel plots if more than ten studies were included in the meta-analysis [25].

Results

Results of the search

After reviewing 2507 relevant citations, nine studies met inclusion criteria (four RCTs, two prospective cohorts, and three retrospective cohorts) [6–9, 26–30]. The reasons for exclusion of the seven studies excluded at the full-text review stage are recorded in Supplementary Table 1 [12, 31–35]. A PRISMA flow diagram of the study selection process is illustrated in Fig. 1.

Study characteristics

Overall, 507 patients (mean age: 60.95 ± 12.86 years, 40.1% female) received preoperative stoma education prior to stoma formation, and 356 patients (mean age: 61.75 ± 12.31 years, 39.2% female) did not. Included studies were conducted between 2004 and 2023. See Table 1 for detailed study characteristics.

Operative and disease characteristics

Operative and disease characteristics for each of the included studies are reported in Table 2. The most common operations reported in both groups were low anterior resections (preoperative stoma education: 46.9%; control: 54.3%). The most reported type of stoma was ileostomy for both groups (preoperative stoma education: 54.6%, control: 57.6%). The

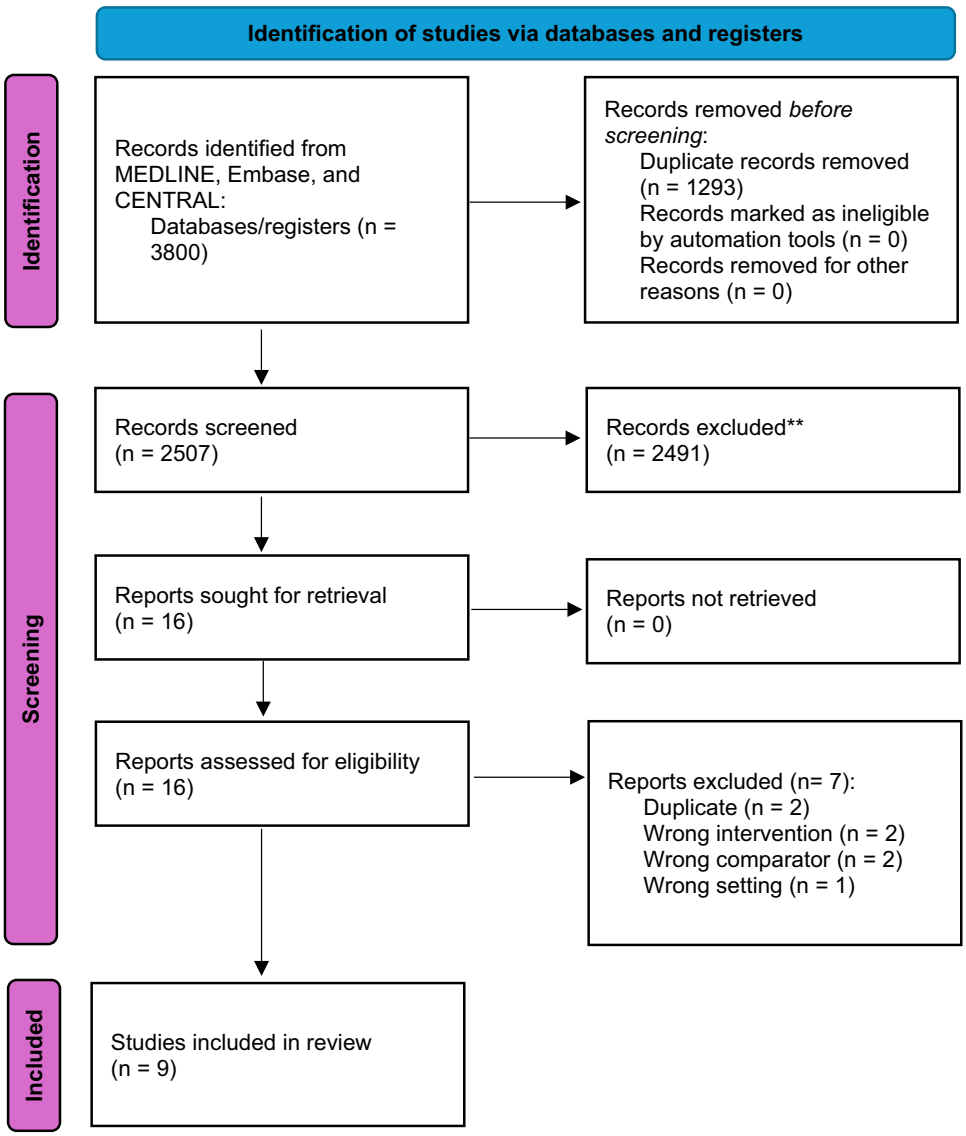


Fig. 1 PRISMA diagram—transparent reporting of systematic reviews and meta-analysis flow diagram outlining the search strategy results from initial search to included studies

Table 1 Study characteristics of included studies

Study	Study type	Inclusion	Description of preoperative education	Person providing education	Arm	*N*	Mean age in years (SD)	*N* female (%)	ASA score (%)
Gulbiniene 2004 [29]	Randomized controlled trial	–	Preoperative stoma siting	–	Preoperative education	–	–	–	–
					Control	–	–	–	–
Chaudhri 2005 [9]	Randomized controlled trial	Patients undergoing elective colorectal resections that would require formation of a temporary or permanent stoma, and who after an initial assessment by a colorectal nurse specialist, were likely to be self-sufficient in managing their stoma pouching system after surgery	Preoperative stoma teaching	WOCN	Preoperative education	21	63.25 (11.38)	10 (47.6)	–
					Control	21	62.25 (10.32)	8 (38.1)	–
Gulbiniene 2009 [30]	Randomized controlled trial	–	Preoperative stoma siting and adequate preoperative and postoperative teaching	WOCN	Preoperative education	–	–	–	–
					Control	–	–	–	–
Devaraj 2010 [8]	Prospective cohort study	Patients who underwent colorectal (involving left colon and or rectum) for primary colorectal malignancy and benign colorectal disorders between November 2008 and October 2009	Preoperative stoma education	WOCN	Preoperative education	19	–	–	–
					Control	12	–	–	–

Table 1 (continued)

Study	Study type	Inclusion	Description of preoperative education	Person providing education	Arm	*N*	Mean age in years (SD)	*N* female (%)	ASA score (%)
Millan 2010 [28]	Prospective cohort study	Patients above 18 years of age with a diagnosis of colorectal cancer with a stoma performed at the participating institutions (included 12 colorectal surgery units from public hospitals in Spain)	Preoperative stomatherapy visit and stoma siting	WOCN	Preoperative education	204	–	–	–
					Control	66	–	–	–

Table 1 (continued)

Study	Study type	Inclusion	Description of preoperative education	Person providing education	Arm	*N*	Mean age in years (SD)	*N* female (%)	ASA score (%)
Stokes 2017 [27]	Retrospective cohort study	Patients from a 1-year period prior to initiation of the educational intervention (September 2011–August 2012) who had undergone an elective procedure requiring ostomy creation at the Hershey Medical Center	A preoperative 2-h stoma education class was led by nursing care coordinators and WOCNs that used the American College of Surgeons Ostomy Home Skills Kit to teach these patients and their significant others in a group setting with approximately three to six patients per class. Patients and their partners or caregivers were given a hands-on tutorial regarding care of a fecal stoma. A PowerPoint (Microsoft, Redmond, Washington, USA) presentation was prepared that included an outline of the pre- and postoperative interventions patients could expect in the perioperative period, as well as necessary changes to their diet, instructions regarding symptoms of dehydration due to ileostomy dysfunction, and examples of various stoma appliances and adjunct supplies	Nursing care coordinators and WOCNs	Preoperative education	124	58.7 (n/a)	56 (45.2)	–
					Control	94	55.4 (n/a)	39 (41.5)	–

Table 1 (continued)

Study	Study type	Inclusion	Description of preoperative education	Person providing education	Arm	*N*	Mean age in years (SD)	*N* female (%)	ASA score (%)
Hughes 2020 [7]	Retrospective cohort study	All stoma types were included (colostomy and ileostomy, permanent and temporary) from patients undergoing elective colorectal surgery between 2012 and 2016 at the Victoria Hospital in Kirkcaldy, UK who underwent stoma formation	Preoperative stoma training was carried out in the community by liaison with stoma nurse specialists. Patients who were anticipated to require a stoma (temporary or permanent) went through a counseling session with the stoma nurse. This is performed in an outpatient facility approximately 7 days before surgery is to be undertaken. Information is given to the patient regarding the requirements of stoma care. The patient also receives a training pack comprising dummy stomas and stoma bags, which can be used to practice stoma bag application	WOCN	Preoperative education	53	60.4 (13.5)	23 (43.4)	I: 3 (5.7); II: 35 (66.0); III: 15 (28.3); IV: 0 (0)
					Control	70	69 (12.5)	30 (42.9)	I: 11 (15.7); II: 35 (50.0); III: 23 (32.9); IV: 1 (1.4)

Table 1 (continued)

Study	Study type	Inclusion	Description of preoperative education	Person providing education	Arm	*N*	Mean age in years (SD)	*N* female (%)	ASA score (%)
Garcia-Cabrera 2023 [26]	Retrospective cohort study	Patients older than 18 years and undergoing elective colorectal resections that require formation of an ostomy (colorectal cancer up to 20 cm from the anal verge, colonic polyposis, and inflammatory bowel disease)	Patients in the intervention group underwent a 45-min education and counseling session delivered several days before surgery with the ostomy nurse specialist; this session was completed in the colorectal clinic. Ostomy education focused on basic skills to optimize ostomy self-care such as pouching system selection and changing, along with peristomal skincare, fluid and dietary advice, and adjustment to life with a new ostomy	WOCN	Preoperative education	65	64.89 (11.85)	17 (26.2)	I–II: 34 (52.3); III–IV: 31 (47.7)
					Control	73	63.26 (13.26)	24 (32.9)	I–II: 46 (63); III–IV: 27 (37)

Table 1 (continued)

Study	Study type	Inclusion	Description of preoperative education	Person providing education	Arm	*N*	Mean age in years (SD)	*N* female (%)	ASA score (%)
Yeo 2023 [6]	Randomized controlled trial	Patients aged 18–80 years; diagnosed with colon cancer or rectal cancer and scheduled for low anterior resection, abdominoperineal resection, Hartmann's surgery, proctocolectomy, or colectomy with temporary (generally ≥ 3 months) or permanent ostomy formation	A WOCN nurse developed the contents of the preoperative ostomy education by combining video clips from existing ostomy education programs, ostomy care leaflets, and tips gleaned from literature review. The video "Ostomy Care for a Healthy Daily Life" lasted 9 min 40 s. Content of the video and associated instruction was reviewed by five experts in relevant fields: two certified WOCN nurses and three colorectal surgeons for accuracy and completeness Intervention group participants viewed the video presentation on a computer tablet, followed by verbal instruction and hands-on training. This educational intervention was delivered during a single 45-min session the day before ostomy surgery	WOCN	Preoperative education	21	61.1 (14.3)	8 (38.1)	–
					Control	20	60.2 (10.5)	8 (40)	–

N, Number of patients; ASA, American Society of Anesthesiologists

most common specified operative indication for both sets of patients was malignancy (preoperative stoma education: 76.7%; control: 84.2%). Of two studies reporting stoma permanence, stomas for patients who received preoperative education were more likely to be permanent, compared with patients without education (preoperative stoma education: 70.3%; control: 37.4%).

Preoperative stoma education protocol

Protocols detailed in the nine included studies varied (Table 1). Most studies that detailed information relating to the preoperative teaching described teaching sessions ranging from 45 min to 2 h, with most including verbal teaching coupled with a hands-on component. Yeo and Park's study combined this with a video component as well [6]. All studies detailing the type of educator involved in the preoperative education session reported WOCNs leading the teaching (Table 3).

Control protocol

Generally, standard protocols involved an absence of preoperative stoma teaching, with postoperative education instead. However, the extent and nature of the education received by the control group varied between studies. In the study by Yeo and Park, the control group received no preoperative education and three sessions of postoperative education [6]. Similarly, in the study by Hughes et al., the control group received conventional education after surgery [7]. The control group of the study by Devaraj et al. was composed of patients who had unplanned stomas and therefore received no education [8]. In the study by Chaudhri et al., the researchers used similar methods and had a postoperative teaching control group [9]. Garcia-Cabrera et al.'s study also compared the intervention group with a postoperative education control group [26]. The study by Stokes et al. did not elaborate on the teaching methods of the control group, mentioning only that data were gathered from a group of patients who underwent ostomy surgeries before the initiation of their proposed classes [27]. In contrast, the control group in Millan et al.'s study consisted exclusively of emergent cases without opportunity for preoperative training [28]. The control groups were significantly different between these two studies. Millan et al. included patients undergoing emergent stoma formation in their control group, while Stokes et al. utilized a quasiexperimental before-and-after design evaluating patients undergoing elective colectomy with stoma formation prior to implementation of a stoma education protocol as their control [27, 28]. Next, in the study by Gulbinienė et al. [29], the control group was not explicitly defined [29]. Finally, the study by Gulbinienė et al. [30] explored three patient groups: the first received proper preoperative stoma siting along with both pre- and postoperative education, the second received only postoperative education, and the third received no educational sessions or stoma site marking [30].

Peristomal complications

Two studies reported peristomal complication data [27, 28]. Meta-analysis of these studies showed that peristomal skin complications were significantly reduced with preoperative stoma education (9.5% versus 19.4%, RR 0.45, 95% CI 0.29–0.72, $p = 0.00$, $I^2 = 0\%$) (Fig. 2). Sensitivity analyses and subgroup analyses could not be performed.

Overall morbidity

Of the two studies, no significant findings emerged after meta-analysis (RR 1.08, 95% CI 0.59–2.0, $p = 0.79$, $I^2 = 80\%$) (Fig. 3) [7, 26]. Sensitivity analyses and subgroup analyses could not be performed. Neither of the included studies that reported postoperative morbidity defined this outcome thoroughly.

Postoperative LOS

Six studies reported postoperative LOS data, showing no significant differences on meta-analysis (MD 0.09, 95% CI −3.1 to 3.28, $p = 0.96$, $I^2 = 95\%$) (Fig. 4) [6–9, 26, 27]. There were no observed subgroup interactions according to operative approach ($p = 0.37$), stoma type ($p = 0.49$), oncologic disease ($p = 0.96$), or study type ($p = 0.56$) for this outcome. Subgroup analyses based on type of educator and stoma permanence could not be performed. Sensitivity analyses were based on presence of inputted data and inclusion of preoperative stoma marking as part of the described intervention.

Readmission

Meta-analysis found no significant difference in readmission data reported by three studies (RR 1.20, 95% CI 0.52–2.77, $p = 0.67$, $I^2 = 58\%$) (Fig. 5) [7, 26, 27]. There were no observed subgroup interactions according to operative approach ($p = 0.67$), stoma type ($p = 0.67$), or oncologic disease ($p = 0.67$). Subgroup analyses based on type of educator and stoma permanence could not be performed. Sensitivity analysis based on the inclusion of preoperative stoma siting left findings unchanged.

Table 2 Study characteristics of included studies; Operative Data

Study	Arm	Operative indication, *N* (%)	Operative approach, *N* (%)	Type of surgery, *N* (%)	Type of stoma, *N* (%)	Permanent stoma, *N* (%)	ERAS-compliant care
Gulbiniene 2004 [29]	Preoperative education	–	–	–	–	–	–
	Control	–	–	–	–	–	–
Chaudhri 2005 [9]	Preoperative education	–	–	LAR: 12 (57.1); abdominoperineal resection: 3 (14.3); restorative proctocolectomy: 2 (9.5); total or subtotal colectomy: 3 (14.3); no resection:1 (4.8)	Ileostomy: 16 (76.2); colostomy: 5 (23.8)	7 (33.3)	–
	Control	–	–	LAR: 9 (42.9); abdominoperineal resection: 5 (23.8); restorative proctocolectomy: 2 (9.5); total or subtotal colectomy: 4 (19.0); no resection: 1 (4.8)	Ileostomy: 15 (71.4); colostomy: 6 (28.6)	Permanent: 10 (47.6)	–
Gulbiniene 2009 [30]	Preoperative education	–	–	–	–	–	–
	Control	–	–	–	–	–	–
Devaraj 2010 [8]	Preoperative education	–	–	–	–	–	–
	Control	–	–	–	–	–	–
Millan 2010 [28]	Preoperative education	Colorectal cancer: 204 (100)	–	–	–	–	–
	Control	Colorectal cancer: 66 (100)	–	–	–	–	–
Stokes 2017 [27]	Preoperative education	Malignancy: 57 (46.0); Crohn's disease: 14 (11.3); ulcerative colitis: 33 (26.6); diverticular disease: 8 (6.5); other: 12 (9.7)	Open: 64 (51.6); laparoscopic/robotic: 7 (5.6); laparoscopic/robotic-assisted: 7 (5.6); single-site laparoscopic: 27 (21.8)	–	Colostomy: 48 (38.7); ileostomy: 76 (61.3)	–	No
	Control	Malignancy: 44 (46.8); Crohn's disease: 12 (12.8); ulcerative colitis: 14 (14.9); diverticular disease: 9 (9.6); other: 15 (16.0)	Open: 54 (57.4); laparoscopic/robotic: 5 (5.3); laparoscopic/robotic-assisted: 8 (8.5); single-site laparoscopic: 27 (28.7)	–	Colostomy: 27 (28.7); ileostomy: 67 (71.3)	–	No

Table 2 (continued)

Study	Arm	Operative indication, *N* (%)	Operative approach, *N* (%)	Type of surgery, *N* (%)	Type of stoma, *N* (%)	Permanent stoma, *N* (%)	ERAS-compliant care
Hughes 2020 [7]	Preoperative education	Colonic cancer: 1 (1.9); rectal cancer: 33 (62.3); diverticular disease: 1 (1.9); polyp: 3 (5.7); inflammatory bowel disease: 12 (22.6); prolapse: 1 (1.9); other: 2 (3.8)	Open: 14 (26.4); laparoscopic: 39 (73.6)	APER: 29 (54.7); LAR: 4 (7.5); stoma formation: 0 (0); Hartmann's procedure: 1 (1.9); LH, RH, SC: 1 (1.9); subtotal/total colectomy: 16 (30.2); prostatectomy: 2 (3.8); resection rectopexy: 0 (0)	Colostomy: 34 (64.2); ileostomy: 19 (35.8)	45 (84.9)	Yes
	Control	Colonic cancer: 18 (25.7); rectal cancer: 43 (61.4); diverticular disease: 0 (0); polyp: 1 (1.4); inflammatory bowel disease: 3 (4.3); prolapse: 1 (1.4); other: 4 (5.7)	Open: 26 (37.1); laparoscopic: 44 (62.9)	APER: 13 (18.6); LAR: 28 (40); stoma formation: 2 (2.9); Hartmann's procedure: 18 (25.7); LH, RH, SC: 4 (5.7); subtotal/total colectomy: 3 (4.3); prostatectomy: 1 (1.4); resection rectopexy: 1 (1.4)	Colostomy: 37 (52.9); ileostomy: 33 (47.1)	24 (34.3)	Yes
Garcia-Cabrera 2023 [26]	Preoperative education	Rectal and anal carcinoma: 48 (79.5); sigmoid and rectosigmoid junction carcinoma: 13 (20); inflammatory bowel disease: 1 (1.5); colonic polyposis: 3 (4)	Open: 21 (32.3); laparoscopic: 40 (61.5); robotic: 4 (6.2)	LAR: 44 (67.7); Hartmann's procedure: 10 (15.4); sigmoidectomy: 4 (6.2); total colectomy: 4 (6.2); left colectomy: 2 (3.1); APR: 1 (1.5); proctocolectomy: 0 (0); ileocecal resection: 0 (0)	Colostomy: 37 (56.9); ileostomy: 28 (43.1)	–	Yes
	Control	Rectal and anal carcinoma: 58 (79.5); sigmoid and rectosigmoid junction carcinoma: 10 (13.7); inflammatory bowel disease: 5 (6.8); colonic polyposis: 0 (0)	Open: 35 (47.9); laparoscopic: 24 (32.9); robotic: 14 (19.2)	LAR: 49 (67.1); Hartmann's procedure: 11 (15.1); sigmoidectomy: 4 (6.2); total colectomy: 1 (1.4); left colectomy: 1 (1.4); APR: 3 (4.1); proctocolectomy: 2 (2.7); ileocecal resection: 2 (2.7)	Colostomy: 41 (56.2); ileostomy: 31 (43.1)	–	Yes

Table 2 (continued)

Study	Arm	Operative indication, *N* (%)	Operative approach, *N* (%)	Type of surgery, *N* (%)	Type of stoma, *N* (%)	Permanent stoma, *N* (%)	ERAS-compliant care
Yeo 2023 [6]	Preoperative education	Colon cancer: 1 (4.8); rectal cancer: 20 (95.2)	–	LAR: 15 (71.4); APR: 4 (19); other: 2 (9.5)	Ileostomy: 16 (76.2); transverse colostomy: 1 (4.8); sigmoid colostomy: 4 (19)	–	No
	Control	Colon cancer: 0 (0); rectal cancer: 20 (100)	–	LAR: 14 (70); APR: 4 (20); other: 2 (10)	Ileostomy: 14 (70); transverse colostomy: 1 (5); sigmoid colostomy: 5 (25)	–	No

N, Number of patients; LAR, Low Anterior Resection; APER, Abdominoperineal Excision of the Rectum; LH, Left Hemicolectomy; RH, Right Hemicolectomy; SC, Sigmoid Colectomy; APR, Abdominoperineal Resection

Sensitivity analysis on the basis of the presence of inputted data could not be completed.

Stoma-related morbidity and QoL

Meta-analysis could not be performed for overall stoma-related morbidity owing to insufficient data. In terms of QoL, despite several studies reporting data, meta-analysis was not possible owing to differences in types of data reported [6, 9, 28–30]. Chaudhri et al. compared preoperative and postoperative anxiety and depression using Hospital Anxiety Depression Scale (HADS) questionnaires, showing that scores tended to be lower in the intervention group than in the control group (9 versus 11) [9]. In addition, patients receiving preoperative intervention achieved proficiency in stoma management sooner than the control group [9]. The median time to attaining proficiency was 5.5 days (range 2–10) for the intervention group and 9 days (range 4–10) for the control group ($p = 0.0005$) [6]. Yeo and Park reported HADS scores, as well as self-care knowledge and self-care proficiency data. Self-care knowledge was measured using a 30-item instrument completed by the patient, while self-care proficiency was measured using a 10-item instrument, observed and rated by a WOCN [6]. Intervention group patients had higher self-care knowledge (MD 4.3, 95% CI 3.9–4.8, $Z = -5.6$, $p < 0.001$) and proficiency (MD 5.2, 95% CI 4.5–6.0, $Z = -5.5$, $p < 0.001$) compared with the control group, though both groups showed a significant increase in self-care knowledge and proficiency [6]. The intervention group saw a significant reduction in anxiety scores after the preoperative session (MD −0.6, 95% CI −1.3–0.1, $Z = -2.2$, $p = 0.025$), as well as depression scores (MD −0.9, 95% CI −1.2–0.2, $Z = -2.5$, $p = 0.014$), compared with the control group with no significant decrease [28]. Millan et al. used a questionnaire with questions related to anxiety over stoma formation, diagnosis, and surgery, finding that patients seen by a WOCN for education and siting indicated significantly less worry over stoma formation (''very worried'': 73.3% versus 84.5%, $p < 0.001$), diagnosis (''very worried'': 77.5% versus 84.5%, $p < 0.001$), and surgery (''very worried'': 73.3% versus 84.5%, $p < 0.001$) [28]. Gulbiniene et al. reported no significant change in general quality of life for intervention patients and noted improved emotional functioning, sexual satisfaction, stoma site comfort, and satisfaction with medical staff, and decreased reports of stoma-related problems, though no numerical data were included [29]. Gulbiniene and Seskevicius assessed patient knowledge using a questionnaire [30]. Group I (patients with preoperative stoma siting, and both preoperative and postoperative education) scored a mean of 9 points, group II (patients with only postoperative education) scored a mean of 8.8, and group III (patients with no teaching) scored a mean of 6.5 ($p < 0.05$) on the day of discharge [30]. At 6 months

Table 3 Study characteristics of included studies; Outcomes

Study	Arm	Mean LOS (SD), days	30-day morbidity, *N* (%)	Readmission, *N* (%)	Peristomal skin complication, *N* (%)
Gulbiniene 2004 [29]	Preoperative education	–	–	–	–
	No education	–	–	–	–
Chaudhri 2005 [9]	Preoperative education	8 (5–15)[a]	–	–	–
	No education	10 (4–16)[a]	–	–	–
Gulbiniene 2009 [30]	Preoperative education	–	–	–	–
	No education	–	–	–	–
Devaraj 2010 [8]	Preoperative education	7 (2–24)[a]	–	–	–
	No education	16 (5–61)[a]	–	–	–
Millan 2010 [28]	Preoperative education	–	–	–	21 (10.3)
	No education	–	–	–	16 (24.2)
Stokes 2017 [27]	Preoperative education	5 (2–27)[a]	–	19 (15.3)	10 (8.1)
	No education	6 (0–20)[a]	–	19 (20.2)	15 (16.0)
Hughes 2020 [7]	Preoperative education	2 (1–2)[b]	17 (32.1)	7 (13.2)	–
	No education	2 (1–3.25)[b]	29 (41.4)	9 (12.9)	–
Garcia-Cabrera 2023 [26]	Preoperative education	12.76 (9.88)	47 (72.3)	8 (12.3)	–
	No education	12.32 (11.52)	37 (51.7)	2 (2.7)	–
Yeo 2023 [6]	Preoperative education	8.7 (2.4)	–	–	–
	No education	11.1 (2.7)	–	–	–

LOS, length of stay (days); *SD*, standard deviation; *IQR*, interquartile range; *N*, number of patients; *ASA* American Society of Anesthesiologists

[a]Median (range)

[b]Median (IQR)



Fig. 2 Forest plot of peristomal skin complications

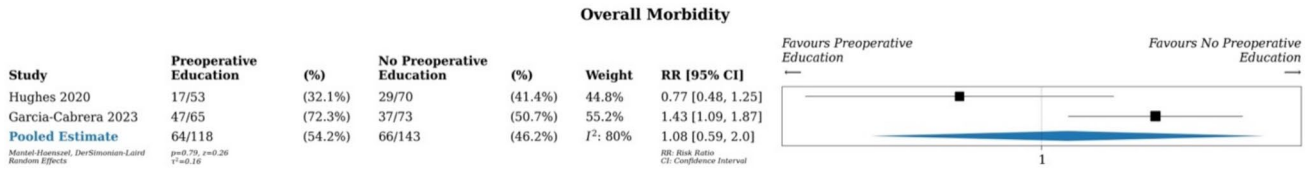


Fig. 3 Forest plot of overall morbidity

postoperatively, the scores of all groups improved, but group III continued to score significantly lower than others [30].

Risk of bias

Figure 6 shows the risk of bias analyses according to the RoB 2.0 tool for the four included RCTs. Figure 7 shows the risk of bias analyses according to the ROBINS-I for the five included observational cohort studies. One study was found to be at high risk of bias owing to bias in outcome measurement [6, 9]. Two studies were found to be at low risk of bias [6, 9]. The remaining studies were found to be at moderate risk of bias [7, 8, 26–28, 30]. All observational studies were

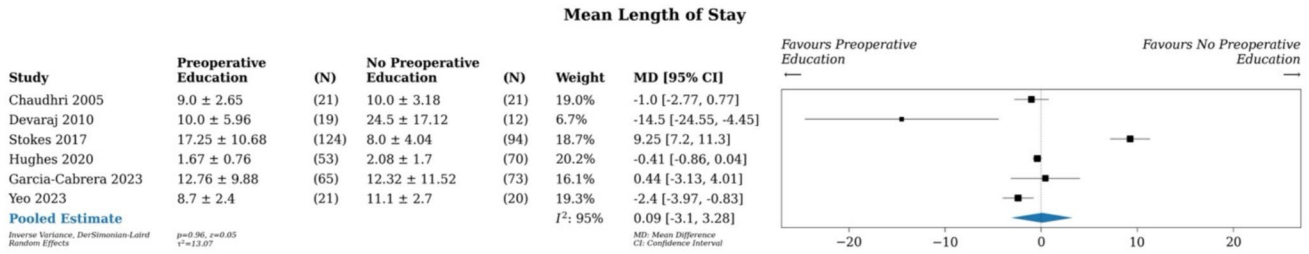


Fig. 4 Forest plot of postoperative length of stay (LOS)

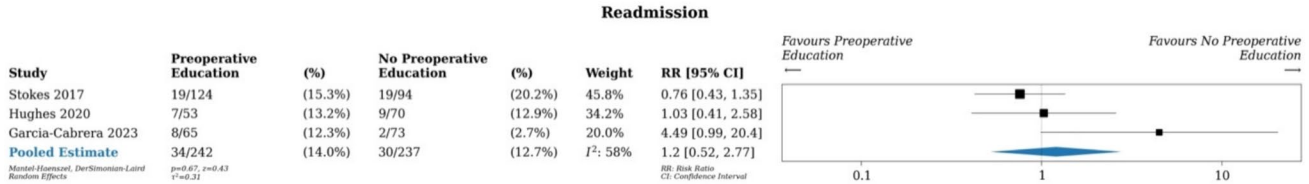


Fig. 5 Forest plot of readmission

at moderate risk of bias owing to outcome measurement and reported result selection.

Certainty of evidence

The GRADE certainty of evidence summary table is presented in Table 4. Overall certainty of evidence for all meta-analyzed outcomes was very low, except peristomal skin complications, which was low. All outcomes were downgraded owing to risk of bias as a result of inclusion of multiple studies at moderate risk of bias, inconsistency owing to heterogeneity ($I^2 > 40\%$), and imprecision owing to the overall pooled sample size being less than the optimal information size. In addition, all outcomes other than peristomal skin complications had wide 95% confidence intervals.

Discussion

After pooling data, the relative risk reduction of peristomal skin complications was 55% in patients receiving preoperative stoma education compared with patients receiving standard care, which often consisted of postoperative stoma education alone. No significant differences were observed in postoperative LOS and readmission. QoL and anxiety were unable to be meta-analyzed, though several studies reported significant improvements with preoperative education. It is important to note that there was significant statistical heterogeneity between studies, particularly in the outcomes of overall morbidity, LOS, and readmission rates. For example, the variable of overall morbidity was only reported in two of the included studies, consequently limiting the results of the pooled estimate.

The American Society of Colon and Rectal Surgeons makes a strong recommendation for both preoperative and postoperative education prior to colorectal surgery with ostomy formation, supported by moderate-quality evidence [36]. Preoperative stoma site marking by a trained provider, and follow-up teaching, are strongly recommended on the basis of moderate-quality and low-quality evidence, respectively [36]. ERAS guidelines for colorectal surgery emphasize the importance of preoperative counseling, outlining important benefits associated with patient education, including reduction of patient anxiety prior to surgery, increased patient satisfaction, and overall surgical experience [5]. A preoperative meeting between patients, relatives/caregivers, and a multidisciplinary team is strongly recommended, supported by moderate-certainty evidence [5].

The role of WOCNs in stoma formation has been studied in several contexts. A randomized study by Huang et al. suggested that follow-up care from a WOCN may further benefit patients with new stomas, as patients with weekly follow-ups via phone or home visits from a WOCN reported less stomal complications, including stomal stenosis, bleeding, and peristomal contact dermatitis after 4.5 months compared with patients without visits ($p < 0.01$) [37]. The intervention group also scored significantly higher on the Exercise of Self-Care Agency scale (ESCA) ($p < 0.01$) and QoL Questionnaire-Core 30 (QLQ-C30) ($p < 0.01$) compared with the control group [37]. Stoma marking alone by a WOCN has been associated with increased HRQoL [38]. Cakir and Ozbayir sited stomas of intervention subjects according to the anatomic and individual characteristics of each patient

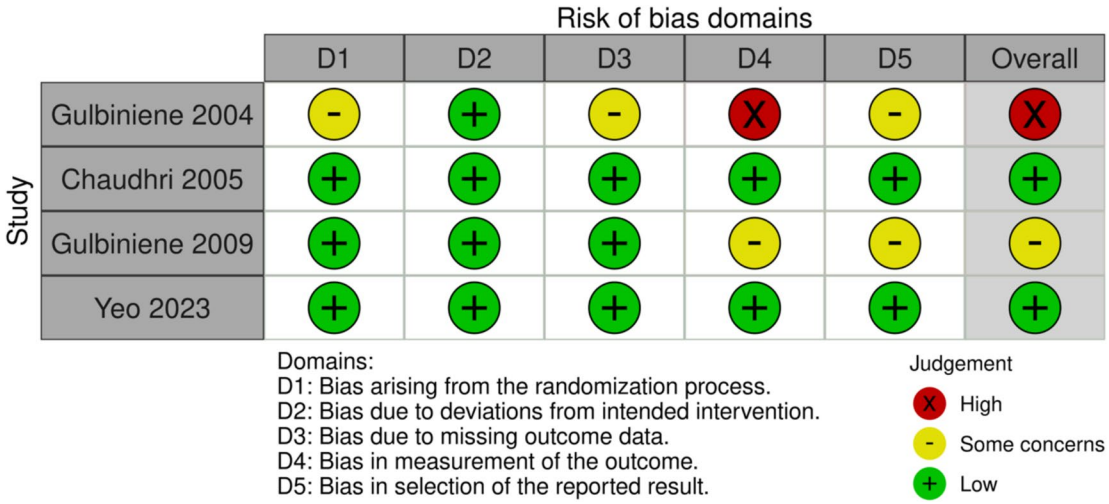


Fig. 6 Revised Cochrane Risk of Bias (RoB 2) tool for randomized trials results per individual randomized controlled trial

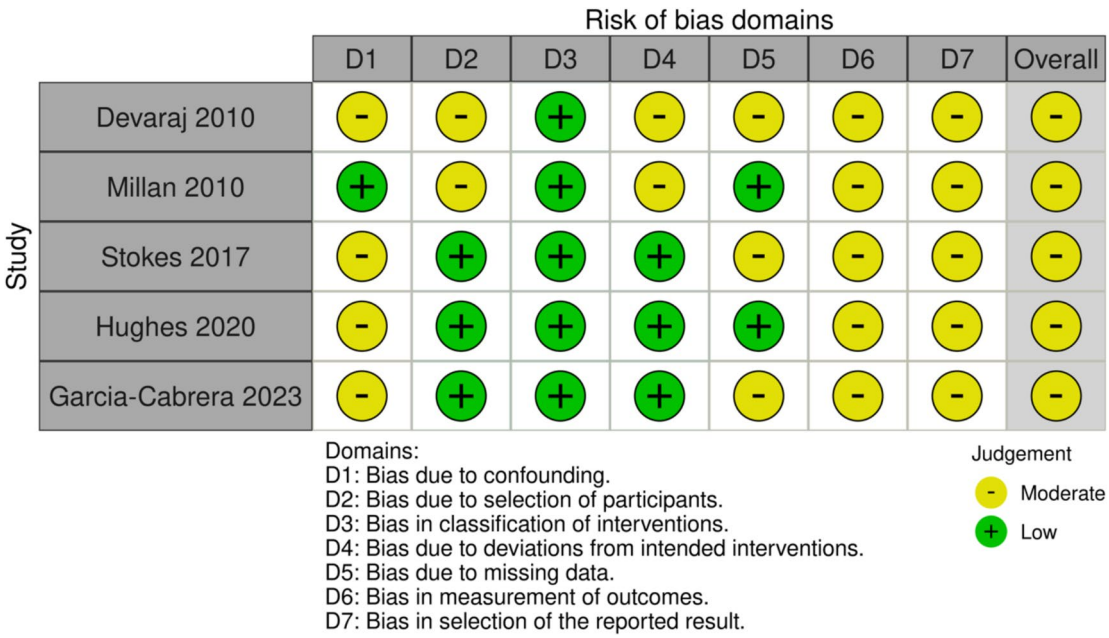


Fig. 7 Risk of Bias in Nonrandomized Studies of Interventions (ROBINS-I) assessment tool results per individual observational cohort study

[38]. Both groups then received the same postoperative care and were evaluated with the COHQOL-OQ [38]. Despite no difference 1 month postsurgery, the preoperative siting group demonstrated a significantly greater HRQoL 6 months after surgery (mean score: 5.43 versus 5.01, $p = 0.031$) [38, 39]. McKenna et al., using the Stoma Quality of Life (Stoma-QOL) instrument, demonstrated significantly higher scores for stoma-marked patients at 2 months of follow-up (mean score: 60.6 versus 56.6; $p = 0.031$) [39].

It is crucial to note that not all results evaluated in this review may have been directly influenced by preoperative stoma education plus postoperative education versus postoperative education alone. There are many stoma-related complications that cannot be influenced by intervention or the patient's role in caring for their abdominal stoma [40, 41]. For example, stomal necrosis and parastomal hernia risk factors are more closely associated with nonmodifiable patient factors (e.g., waist circumference, age) and surgical techniques (e.g., minimally invasive approaches, transperitoneal route of formation) rather than patient behavior [40, 41]. Therefore, the results of this study must be interpreted

Table 4 Preoperative stoma education compared with no preoperative stoma education for patients undergoing colorectal surgery with stoma formation

Certainty assessment							Summary of findings				
Participants (studies) follow-up	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall certainty of evidence	Study event rates (%)		Relative effect (95% CI)	Anticipated absolute effects	
							With no preoperative stoma education	With preoperative stoma education		Risk difference with no preoperative stoma education	Risk difference with preoperative stoma education
Overall morbidity											
261 (2 non-randomized studies)	Serious[a]	Serious[b]	Not serious	Very serious[c]	None	⨁◯◯◯ Very low	66/143 (46.2%)	64/118 (54.2%)	**RR 1.08** (0.59–2.00)	66/143 (46.2%)	**37 more per 1000** (from 189 fewer to 462 more)
Readmission											
479 (3 non-randomized studies)	Serious[a]	Serious[b]	Not serious	Very serious[c]	None	⨁◯◯◯ Very low	30/237 (12.7%)	34/242 (14.0%)	**RR 1.20** (0.52–2.77)	30/237 (12.7%)	**25 more per 1000** (from 61 fewer to 224 more)
Length of stay											
593 (7 non-randomized studies)	Serious[a]	Serious[b]	Not serious	Very serious[c]	None	⨁◯◯◯ Very low	290	303	–	290	MD **0.46 days higher** (2.73 lower to 3.66 higher)
Peristomal skin complications											
488 (2 non-randomized studies)	Serious[a]	Not serious	Serious[d]	Serious[e]	None	⨁◯◯◯ Very low	31/160 (19.4%)	31/328 (9.5%)	**RR 0.45** (0.29–0.72)	31/160 (19.4%)	**107 fewer per 1000** (from 138 to 54 fewer)

CI confidence interval, *MD* mean difference, *RR* risk ratio

[a]Downgraded for inclusion of more than one study at moderate risk of bias

[b]Downgraded one level for $I^2 > 40\%$

[c]Downgraded two levels for wide 95% confidence intervals crossing the clinical decision-making threshold, and for the overall pooled sample size being less than the optimal information size (OIS)

[d]Downgraded one level for differences in comparator groups across studies and between the individual studies and the review question

[e]Downgraded one level for 95% confidence intervals crossing the clinical decision-making threshold, and for the overall pooled sample size being less than the optimal information size (OIS)

with caution as they may not completely reflect the effect of the educational intervention.

Strengths of this study include the high-quality methodology, comprehensive search strategy, thorough risk of bias analysis, and evaluation of the certainty of evidence with GRADE. Its limitations include the limited number of studies, reliance on observational data, between-study heterogeneity, and inclusion of a studies with inconsistent control groups. Despite an extensive search, we were only able to find nine studies meeting inclusion criteria, yielding low statistical power. Furthermore, most included studies were observational in nature, as only four randomized studies were identified, increasing the risk of biases such as residual confounding and selection bias. Certain clinically relevant factors were also not explored via subgroup analyses, such as stoma configuration (i.e., loop versus end) or receipt of postoperative home care, owing to lack of data in the included studies. Some of the outcomes reported among the included studies were not completely defined and, thus, there is potential for indirectness. This is reflected in our GRADE assessment of the certainty of evidence.

Heterogeneity in outcome reporting further limited statistical power as not all studies were included in meta-analyses. Differences in details of stoma teaching and standard care, such as time period of preoperative teaching and teaching setting (group versus individual), included hands-on components, and media, increased heterogeneity. Particularly, QOL was not able to be qualitatively integrated owing to the wide variety of measurement tools used across the different studies included in this paper. This greatly limits our ability to compare outcomes and draw conclusions about the impact of preoperative stoma education on QOL. Lastly, it is difficult to say with confidence whether the preoperative stoma education was the primary factor driving the observed outcomes, as some of the included studies (Millan et al. and Hughes et al.) contained a control group made up exclusively of emergent or unplanned cases [7, 28]. In addition, we were unable to perform our planned sensitivity analysis controlling for this owing to a lack of data. Consequently, the different baseline risks found in the studies may have impacted our pooled estimates and introduced confounding to our results. Sensitivity analyses were planned but often could not be performed owing to a limited number of studies in the meta-analyses for dichotomous outcomes. Thus, the influence of decisions we made throughout the conduct of this study on the findings is largely unexplored.

Conclusions

Preoperative stoma education may offer a benefit in postoperative outcomes for patients undergoing colorectal surgery with stoma formation, specifically in terms of peristomal skin complications and QoL. The influence of preoperative stoma education on other clinical outcomes is unclear. Furthermore, it remains challenging to determine what part of the observed outcomes can be attributed to preoperative stoma education versus stoma marking, as the two are often implemented in unison. Future large, high-quality prospective evaluation of preoperative stoma education for colorectal surgery patients is required to further understand the benefits associated with this intervention and the type of patient that may stand to benefit the most from its implementation.

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Data availability Data sharing is not applicable to this article as no new data were created or analyzed in this study. No datasets were generated or analyzed during the current study.

Declarations

Conflicts of interest The authors declare that there are no conflicts of interest.

Ethics statement Local ethics review board approval was not required.

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