Review

Application of Intelligent Digital Monitoring for Colorectal Cancer Nutrition: Systematic Review and Meta-Analysis

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Abstract

Background: Nutritional problems are common during colorectal cancer (CRC) treatment and recovery; digital technologies may extend nutrition care beyond clinical visits. Intermittent care may miss intake, symptoms, and nutritional status; prior reviews addressed broader digital health or mobile app interventions rather than monitoring-informed CRC nutrition management.

Objective: This review evaluated intelligent digital monitoring–supported nutrition management with respect to anthropometric outcomes, nutritional status, dietary intake, quality of life, and nutrition-related biochemical markers in adults with CRC.

Methods: We searched PubMed, Embase, Web of Science, Scopus, CENTRAL, ProQuest Dissertations and Theses Global, China National Knowledge Infrastructure, Wanfang Data, VIP Database, and SinoMed from inception through June 30, 2026. Eligible interventions required repeated nutrition-related data collection, digitally traceable recording or transmission, and data-informed feedback or action. We included randomized controlled trials (RCTs), nonrandomized comparative studies, prospective cohorts, and prospective single-arm studies. Risk of bias was assessed using Cochrane Risk of Bias 2 (RoB 2) and ROBINS-I (Risk of Bias in Non-Randomized Studies of Interventions) tools. Comparable RCTs were pooled using random-effects models; all other studies were synthesized narratively. Evidence certainty was assessed using the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) approach.

Results: Ultimately, 14 unique studies from 15 reports (2617 participants), including 7 RCTs, were included; 9 were conducted in China. All RCTs had some concerns; 5 of 7 nonrandomized studies had serious risk of bias. Body weight was synthesized narratively. Patient-Generated Subjective Global Assessment (PG-SGA) scores were lower than in controls (3 RCTs; n=244; mean difference [MD] −1.50, 95% CI −1.85 to −1.15; moderate certainty). Primary analysis showed higher energy intake (2 RCTs; n=138; MD 204.30 kcal/d, 95% CI 191.57 to 217.04; very low certainty), but this finding was not robust in a post hoc small-sample sensitivity analysis (95% CI −379.28 to 787.88; P=.14). Effects were unclear for BMI (3 RCTs; n=305; MD 0.82 kg/m^2, 95% CI −0.27 to 1.90; low certainty), protein intake (2 RCTs; n=138; MD 20.16 g/d, 95% CI −37.39 to 77.72; I^2=74%; very low certainty), quality of life (3 RCTs; n=188; MD 16.82, 95% CI −14.62 to 48.26; I^2=95%; very low certainty), albumin (2 RCTs; n=188; MD 4.75 g/L, 95% CI −36.48 to 45.98; I^2=98%; very low certainty), and hemoglobin (2 RCTs; n=188; MD 9.36 g/L, 95% CI −104.87 to 123.59; I^2=95%; very low certainty).

Conclusions: Intelligent digital monitoring–supported nutrition management may improve nutritional status, but effects on energy intake and other outcomes remain uncertain. Monitoring should complement, not replace, professional nutritional assessment and individualized care. Few trials, risk-of-bias concerns, heterogeneity, and geographic concentration limit conclusions; larger multicenter RCTs with standardized outcomes and defined monitoring-feedback components are needed.

Trial Registration: PROSPERO CRD420251218785; https://www.crd.york.ac.uk/PROSPERO/view/CRD420251218785

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Keywords: colorectal cancer; nutritional management; remote patient monitoring; digital health; systematic review; meta-analysis

Introduction

Colorectal cancer (CRC) remains a major global health burden, accounting for approximately 1.93 million new cases and 0.90 million deaths worldwide in 2022 [1,2]. Beyond its substantial disease burden, CRC and its treatment can compromise dietary intake and nutritional status through gastrointestinal symptoms, appetite changes, altered taste, and other treatment-related adverse effects [3]. Recent Patient-Generated Subjective Global Assessment (PG-SGA)–based evidence has highlighted substantial nutritional risk and nutrition-impact symptoms among patients with CRC receiving chemotherapy [3]. Because dietary intake, weight, and nutrition-impact symptoms may change during cancer treatment, clinical guidelines recommend regular nutritional screening and assessment, including evaluation of dietary intake, weight change, and BMI, with reassessment according to the patient's clinical condition [4]. Clinical nutrition guidelines recommend regular nutritional screening and assessment, including evaluation of dietary intake, weight change, and BMI, with reassessment according to the patient's clinical condition [4,5]. Postdiagnosis diet quality has also been associated with survival outcomes in patients with CRC, supporting sustained nutritional management across the cancer care trajectory [6,7]. Although these observational associations do not establish the causal effects of nutritional interventions, they reinforce the clinical importance of addressing nutrition throughout CRC treatment and survivorship.

Conventional nutritional care largely relies on in-person screening, dietitian-led counseling, and nutritional support when indicated [4]. Although these approaches remain essential, episodic encounters may not capture changes in dietary intake, symptoms, and nutritional status between clinical visits [8]. Because nutritional needs and symptoms may change over time, ongoing assessment and individualized guidance remain important [4,5]. A review of nutritional self-management in patients with CRC and survivors identified variation in the personalization and delivery of available interventions and resources, highlighting the need for reliable, detailed, and individualized nutritional information [8]. Digital health technologies can extend nutritional care through the repeated collection of patient-generated data, traceable data transmission, and timely feedback [9,10]. In oncology, remote monitoring approaches have been investigated to support follow-up and care coordination beyond conventional clinical encounters [11]. CRC-specific remote monitoring systems have incorporated periodic health monitoring, clinician review, reminders, and patient education [12]. In addition, electronic patient-reported outcome–based nutritional management has linked repeated dietary and symptom reporting with clinician alerts and individualized nutritional care. In a multicenter prospective cohort study, adherence to digitally supported nutritional journaling was associated with the likelihood of meeting energy and protein intake targets; however, the observational design does not establish a causal treatment effect [13]. These findings illustrate the potential clinical relevance of digital nutritional monitoring while underscoring the need to evaluate the effectiveness of interventions that link monitoring with subsequent feedback or action.

Drawing on established digital health classifications and oncology remote monitoring models [9-11], we operationally defined intelligent digital monitoring–supported nutrition management as digitally enabled nutritional care that combines repeated collection and traceable recording or transmission of nutrition-related data with feedback or action informed by those data. Importantly, the use of a digital platform alone does not necessarily constitute intelligent digital monitoring. Digital tools may provide educational information or generic reminders without using collected data to guide subsequent care. In this review, eligibility was based on 3 prespecified operational criteria: (1) structured and repeated collection of nutrition-related data during the intervention period; (2) digitally traceable recording or transmission of individual-level data; and (3) feedback or action informed by the monitored data. Monitoring-informed actions could include individualized guidance, professional follow-up, data-responsive reminders, threshold-triggered alerts, clinical decision support, or adjustment of the nutrition care plan. In this review, "intelligent" refers to monitoring-informed responsiveness and does not necessarily imply the use of AI.

Existing reviews have examined digital nutrition interventions from different perspectives. A systematic review and meta-analysis evaluated mobile app–based dietary interventions among cancer survivors [14], while another systematic review examined nutritional mobile apps in populations with cancer [15]. More recently, a systematic review and meta-analysis of randomized controlled trials (RCTs) evaluated digital health interventions in patients with CRC, focusing on nutritional status and quality of life (QoL) [16]. These reviews provide important evidence, but their scopes differ from the present review's focus on interventions meeting explicit monitoring-informed eligibility criteria and its assessment of a broader range of nutrition-related outcomes. Specifically, the present review examines dietary intake, anthropometric outcomes, nutritional status or risk, QoL, and nutrition-related biochemical markers in adults with CRC. It also distinguishes quantitative synthesis of sufficiently comparable RCTs from narrative synthesis of prospective cohort and single-arm evidence. This approach evaluates whether repeated nutritional monitoring is linked to subsequent nutritional management across a range of clinically relevant outcomes.

Therefore, this systematic review and meta-analysis aimed to evaluate the effects of intelligent digital monitoring–supported nutrition management on dietary intake, anthropometric outcomes, nutritional status, QoL, and nutrition-related biochemical markers in adults with CRC.

Methods

Overview

This systematic review and meta-analysis was registered with PROSPERO (International Prospective Register of Systematic Reviews; CRD420251218785) and reported in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 statement [17]. The completed PRISMA 2020 expanded checklist is provided in Checklist 1, and the PRISMA 2020 for abstracts checklist is provided in Checklist 2. No separate protocol document was prepared beyond the PROSPERO registration record.

The PROSPERO registration included prospective cohort and prospective single-arm studies as eligible study designs. In December 2025, before formal study screening and data extraction, we further clarified the synthesis plan. Prospective cohort and prospective single-arm studies were retained as complementary evidence and synthesized narratively, whereas quantitative meta-analysis was restricted to RCTs with sufficiently comparable interventions and outcome data. This approach was intended to retain relevant complementary evidence while avoiding the quantitative pooling of randomized and nonrandomized evidence and ensuring that pooled estimates were based on sufficiently comparable studies. These methodological decisions were finalized before study selection and data extraction and were not influenced by the direction or statistical significance of the study findings.

Eligibility Criteria

Studies were eligible if they met the following criteria: (1) population: adults aged 18 years or older with CRC, including colon or rectal cancer, regardless of disease stage or treatment phase; (2) intervention: nutritional management supported by digital technologies, including mobile apps or miniprograms, web-based platforms, remote monitoring systems, wearable devices, SMS text messaging, or telehealth, with eligibility determined by monitoring functions rather than platform type; (3) comparator: for comparative studies, usual care, routine follow-up, or conventional nutritional care; (4) outcomes: at least 1 nutrition-related or patient-centered outcome, including dietary intake, anthropometric outcomes, nutritional status or risk, QoL, or nutrition-related biochemical markers; (5) study design: RCTs, nonrandomized comparative studies, prospective cohort studies, or prospective single-arm studies; and (6) reporting characteristics: studies published in English or Chinese, with no restriction on publication date or minimum follow-up duration. Studies involving mixed populations with cancer were eligible only when CRC-specific data were separately extractable.

Drawing on established digital health classifications and oncology remote monitoring models [9-11], intelligent digital monitoring–supported nutrition management was operationally defined as an intervention meeting all three criteria: (1) structured and repeated collection of nutrition-related data during the intervention period, (2) digitally traceable recording or transmission of individual-level data, and (3) feedback or action informed by the monitored data. Monitoring-informed actions could include individualized guidance, professional follow-up, data-responsive reminders, threshold-triggered alerts, clinical decision support, or adjustment of the nutrition care plan. For multiarm trials, each intervention arm was separately assessed against the same 3 operational eligibility criteria. Eligibility decisions were based on the reported intervention mechanisms, rather than the direction, magnitude, or statistical significance of the observed treatment effects.

Studies were excluded if they (1) involved interventions limited to one-way education, generic counseling, or reminders unrelated to monitored data, or a single digital assessment without repeated monitoring and monitoring-informed feedback or action; (2) did not assess or report sufficient data for any eligible outcome; or (3) were reviews, protocols, case reports, qualitative studies, methodological studies, or other publications without original eligible data.

Information Sources

The literature search was reported in accordance with the PRISMA-S (Preferred Reporting Items for Systematic Reviews and Meta-Analyses literature search extension) extension [18]. The completed PRISMA-S checklist is provided in Checklist 3. We searched PubMed, Embase, Web of Science, Scopus, the Cochrane Central Register of Controlled Trials (CENTRAL), ProQuest Dissertations and Theses Global, China National Knowledge Infrastructure, Wanfang Data, VIP Database, and SinoMed from database inception. Reference lists of included studies and relevant reviews were screened for additional eligible studies, and forward citation searching was performed using Web of Science. All searches, including citation searching, were completed on June 30, 2026.

Search Strategy

The search strategy combined database-specific controlled vocabulary, where available, with free-text terms across 3 concept blocks: CRC, nutrition, and digital monitoring. Digital-health terms encompassed remote patient monitoring, telemonitoring, mobile and smartphone apps, wearable devices, eHealth, mobile health (mHealth), and clinical decision support. Terms within each concept were combined using "OR," and the 3 concept blocks were combined using "AND." No publication-date or study-design filters were applied. The search strategy did not undergo formal peer review. Complete database-specific search strategies are provided in Multimedia Appendix 1.

Selection Process and Data Collection Process

XC and YZ independently screened the titles and abstracts of all retrieved records and subsequently assessed potentially

eligible full-text reports. Disagreements were resolved through discussion, and any unresolved disagreements were adjudicated by LN. Reasons for full-text exclusion were recorded in the PRISMA flow diagram. When multiple reports originated from the same underlying study, they were linked and treated as a single study, and no participant sample was counted more than once in any meta-analysis. XC and YZ independently extracted data from each included report using a standardized data extraction form, with any unresolved discrepancies adjudicated by LN.

Data Items

Data items included study characteristics (first author, publication year, country, and study design), participant characteristics (sample size, age, cancer type, stage, and treatment status), and intervention and comparator characteristics. Digital monitoring features included the digital modality, monitored variables, data traceability, feedback or trigger mechanisms, monitoring frequency, and intervention duration. Outcomes included body weight, BMI, nutritional status, energy and protein intake, QoL, and nutrition-related biochemical markers, including total protein (TP), albumin, hemoglobin, and prealbumin. For continuous outcomes, means, SDs, and sample sizes were extracted when available.

Study Risk-of-Bias Assessment

XC and YZ independently assessed risk of bias, with disagreements resolved through discussion and unresolved disagreements adjudicated by LN. RCTs were assessed using the Cochrane Risk of Bias 2 (RoB 2) tool [19], whereas nonrandomized intervention studies were assessed using the ROBINS-I (Risk Of Bias In Non-randomized Studies of Interventions) tool [20]. The nonrandomized evidence included comparative studies and uncontrolled prospective before-and-after studies. For the uncontrolled before-and-after studies, we considered the design-specific guidance in the Cochrane Handbook on ROBINS-I assessments for this study design [21]. Accordingly, we retained ROBINS-I for these studies and considered the design-specific sources of bias described in this guidance. Particular attention was paid to whether observed pre-post changes could reflect concurrent events or temporal trends rather than the intervention, whether the available preintervention measurements were sufficient to characterize temporal patterns, and whether changes in outcome measurement, missing data, or selective reporting could have introduced bias [21]. Overall risk-of-bias judgments were determined according to the guidance for each tool.

Effect Measures

For continuous outcomes measured using the same scale or unit, intervention effects were expressed as mean differences (MDs) with 95% CIs. MDs were used for PG-SGA, BMI, energy intake, protein intake, QoL, albumin, and hemoglobin. Effect direction was interpreted according to the clinical meaning of each outcome; no uniform favorable direction was prespecified for BMI because its clinical interpretation depends on baseline nutritional status and treatment context.

Synthesis Methods

Meta-analysis was performed when at least 2 RCTs reported sufficiently comparable outcomes. RCTs were not quantitatively pooled with nonrandomized studies; nonrandomized comparative, cohort, and single-arm studies were synthesized narratively. When change-from-baseline data were not consistently available across contributing RCTs, postintervention values were used to permit consistent synthesis. PG-SGA results reported only as medians and IQRs were not converted to means and SDs and were narratively synthesized to avoid additional distributional assumptions.

In the 4-arm RCT by Kim et al [22], Group A (Noom; n=81) was included in the BMI meta-analysis because the reported intervention explicitly linked repeated dietary and weight monitoring to ongoing feedback provided by human advisors and AI. Group B (WalkOn; n=80) was excluded because its digital monitoring primarily focused on physical activity rather than nutrition-related data. Although Group C (Second Doctor; n=79) incorporated calorie recording and consultations with health professionals, including nutritionists, the published intervention descriptions did not explicitly establish that the monitored nutrition-related data were used to inform individualized nutritional feedback or subsequent nutrition-related actions. Accordingly, Group C was judged ineligible under the third operational eligibility criterion based on available reporting. Only the comparison between Group A (Noom; n=81) and Group D (usual care; n=80) was extracted for the BMI meta-analysis. Group D was included only once, as the comparator for Group A; no comparisons involving Groups B or C were included.

Random-effects models were used because true intervention effects were expected to vary across treatment settings, monitoring approaches, and intervention durations, irrespective of the observed I^2 value [23,24]. Pooled estimates were calculated using inverse-variance weighting, with between-study variance estimated using restricted maximum likelihood and 95% CIs calculated using the Hartung-Knapp-Sidik-Jonkman adjustment [24,25]. For each meta-analysis, Cochran Q statistic, its degrees of freedom and P value, I^2, τ^2, and τ were reported. The τ^2 statistic represents the estimated between-study variance, whereas τ represents the corresponding between-study SD, calculated as the square root of τ^2 and expressed on the outcome scale. I^2 was interpreted as a relative measure of inconsistency in study results rather than as an absolute measure of the magnitude of between-study variation [23,26,27]. I^2 was not used alone to determine the clinical importance of between-study differences. Interpretation also considered the estimated between-study variance and SD, together with the pooled-effect estimates and the clinical and methodological characteristics of the included studies [23,27,28]. Prediction intervals were not reported because each meta-analysis included only 2 or 3 RCTs, limiting the reliability of standard prediction-interval estimates [24,29].

Given the small number of contributing trials (2 RCTs), the energy-intake outcome was also evaluated in a post hoc sensitivity analysis using the modified Hartung-Knapp

approach with an ad hoc variance correction [28]. Specifically, the correction was applied when the Hartung-Knapp SE was smaller than that of the conventional random-effects model. This analysis was conducted to assess the robustness of the pooled inference under a small-sample approach [26].

Because very few RCTs contributed to individual outcomes for reliable subgroup analysis or meta-regression, potential sources of heterogeneity, including treatment phase, monitoring intensity, intervention duration, and outcome timing, were considered qualitatively. No risk of bias–based sensitivity analyses were performed because only 2 or 3 RCTs contributed to each meta-analysis, and none of the contributing RCTs was rated as having a high overall risk of bias, precluding a meaningful risk-of-bias exclusion analysis. The primary meta-analyses were conducted using Review Manager Web (Cochrane), and the modified Hartung-Knapp sensitivity analysis was conducted in R (R Foundation for Statistical Computing) using the meta package. All statistical tests were 2-sided, with $P<.05$ considered statistically significant.

Reporting Bias Assessment

Formal assessment of small-study effects, using funnel plots or Egger regression tests, was not performed because fewer than 10 studies contributed to each meta-analysis, limiting the power and interpretability of these methods [30].

Certainty Assessment

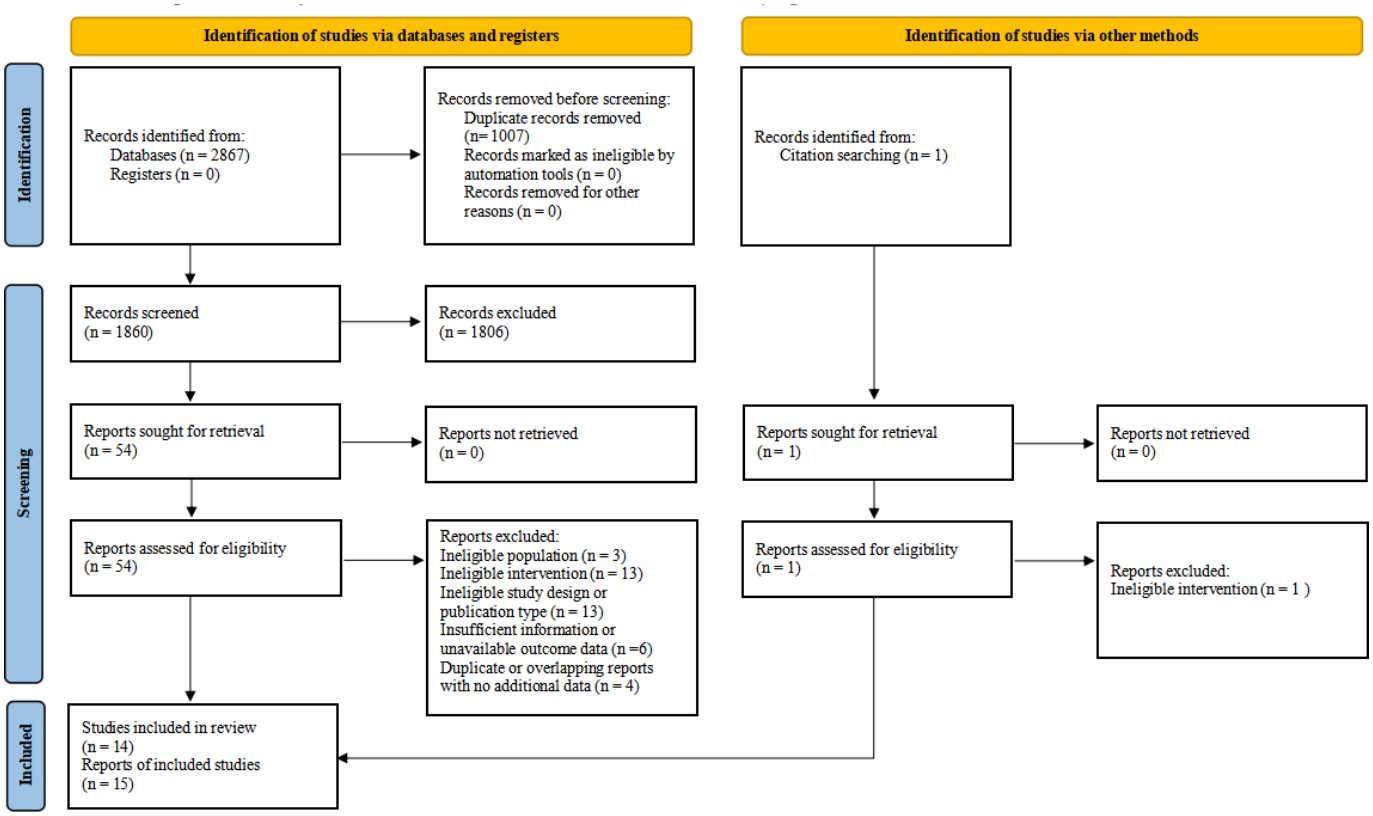
XC and YZ independently assessed the certainty of the evidence for each pooled outcome using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach. Certainty was evaluated across risk of bias, inconsistency, indirectness, imprecision, and publication bias and rated as high, moderate, low, or very low. Disagreements were resolved through discussion, and unresolved disagreements were adjudicated by LN.

Results

Study Selection

The PRISMA 2020 flow diagram of the study selection process is provided in Figure 1. The database searches identified 2867 records, and 1 additional record was identified through backward and forward citation searching. After removing 1007 duplicate records, 1860 records were screened by title and abstract, of which 1806 were excluded. Full texts were retrieved for 54 potentially eligible reports identified through database searching and 1 additional report identified through citation searching. Thus, 55 reports were assessed for eligibility. Of these, 40 reports were excluded because of an ineligible population (n=3), ineligible intervention (n=14), ineligible study design or publication type (n=13), insufficient information or unavailable outcome data (n=6), or duplicate or overlapping reports without additional eligible data (n=4). Ultimately, 15 reports representing 14 unique studies met the predetermined eligibility criteria and were included in the systematic review [13,22,31-43]. Two reports, by Van Blarigan et al [43] and Wang et al [35], originated from the same underlying study and were therefore treated as a single study to avoid double counting.

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 flow diagram.



Study Characteristics

The 14 unique studies, reported across 15 publications [13,22,31-43], were published between 2020 and 2025, and their main characteristics are summarized in Multimedia Appendix 2. Of the 14 studies, 7 (50%) were RCTs [22,31,33,35,38,41-43], including 1 pilot RCT reported in 2 publications [35,43], and 4 (29%) were nonrandomized controlled studies [36,37,39,40]. The remaining 3 studies comprised 1 secondary mixed methods analysis of a single-arm pre-post pilot study [34] and 2 prospective cohort studies [13,32]. Nine studies were conducted in China [13,31,33,36,38-42], 2 in the Netherlands [32,34], and 1 each in the United States [35,43], Brazil [37], and the Republic of Korea [22]. Based on the eligible CRC samples, individual study sample sizes ranged from 11 to 1387 participants, with a total of 2617 participants across the 14 studies. Among studies reporting age data, the mean or median participant age ranged from approximately 46 to 73 years.

Regarding the study populations, 11 studies included broadly defined CRC populations without restriction to colon or rectal cancer [13,22,31-38,42,43], whereas 2 studies focused specifically on patients with rectal cancer [40,41] and 1 included patients with colon cancer [39]. The clinical contexts varied considerably and included postoperative chemotherapy, neoadjuvant chemoradiotherapy, active chemotherapy or other anticancer treatment, posttreatment survivorship, elective surgery, and perioperative or prehabilitation settings.

Risk of Bias in Studies

The risk-of-bias assessments are summarized in Multimedia Appendix 3. All 7 RCTs [22,31,33,35,38,41-43] assessed using the Cochrane RoB 2 tool were rated as having some concerns overall. The main concerns were related to outcome measurement, particularly for self-reported outcomes, as well as to incomplete reporting of the randomization process and prespecified analyses in some trials. In contrast, the risk of bias due to deviations from the intended interventions was low across all RCTs, and missing outcome data were generally adequately addressed.

Among the 7 nonrandomized intervention studies [13,32,34,36,37,39,40] assessed using ROBINS-I, 5 studies were judged to have a serious overall risk of bias [13,32,34,37,40] and 2 had a moderate overall risk [36,39]. Serious risk was primarily attributable to potential confounding, with additional concerns related to outcome measurement, participant selection, deviations from the intended interventions, or missing data in individual studies. Detailed domain-level judgments and supporting rationales are provided in Multimedia Appendix 3.

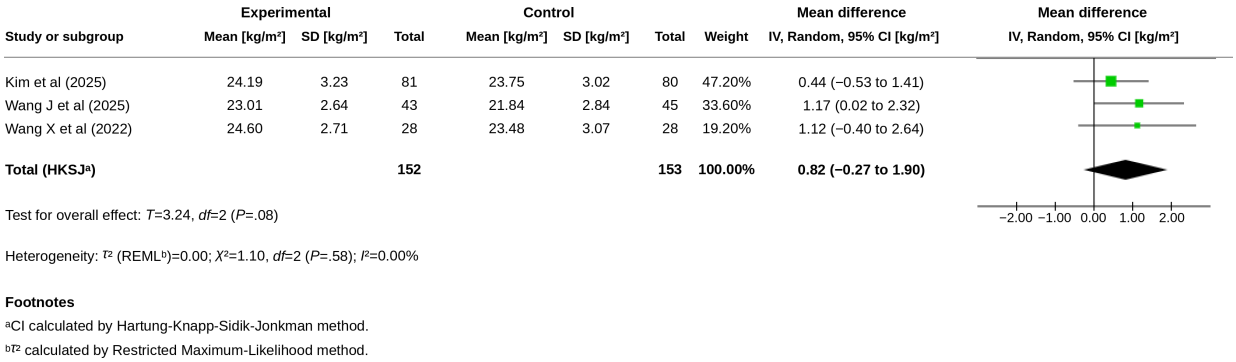
Effect on Anthropometric Measurements

A total of 4 studies, including 2 RCTs [31,43] and 2 nonrandomized controlled trials (NRCTs) [36,39], reported on body weight. Because sufficiently comparable data were unavailable across the RCTs, body weight was narratively synthesized. Among the RCTs, Wang et al [31] reported a more favorable change in body weight in the intervention group over follow-up, whereas Van Blarigan et al [43] found

no clear between-group difference in body weight change at 12 weeks. For the nonrandomized studies, Cheng et al [36] and Chen et al [39] reported more favorable body weight outcomes in the intervention groups than in the control groups.

BMI was reported in 6 studies, including 4 RCTs [22,31,38,43] and 2 NRCTs [36,40]. Of the 4 RCTs, 3 [22,31,38], comprising 305 participants, provided sufficiently comparable data and were included in the meta-analysis (Figure 2). For Kim et al [24], the BMI meta-analysis included Group A (Noom; n=81) as the intervention group and Group D (usual care; n=80) as the comparator. Groups B (WalkOn; n=80) and C (Second Doctor; n=79) were excluded based on the arm-level eligibility assessment described in the *Methods* section, and Group D was counted only once, in comparison with Group A. The pooled analysis showed no statistically significant difference in BMI between the intelligent digital nutrition monitoring and control groups (MD 0.82 kg/m², 95% CI –0.27 to 1.90; *P*=.08). Heterogeneity statistics were Cochran *Q*=1.10 (*df*=2, *P*=.58), I^2=0.00%, τ^2=0.00, and τ=0.00 kg/m². The remaining RCT by Van Blarigan et al [43], which was narratively synthesized, showed no clear between-group difference in BMI change at 12 weeks. For the nonrandomized studies, Zhu et al [40] and Cheng et al [36] reported more favorable BMI outcomes in the intervention groups than in the control groups. The certainty of evidence for BMI using the GRADE approach was low (Multimedia Appendix 4).

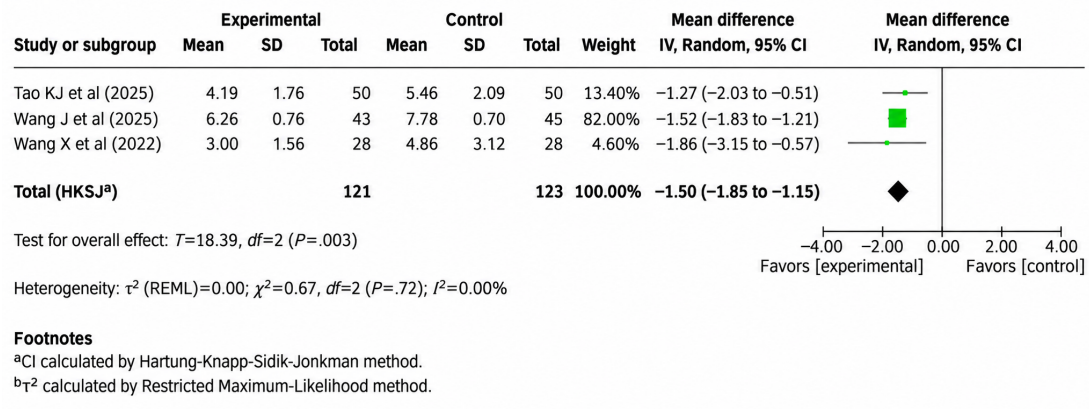
Figure 2. Random-effects meta-analysis of BMI in adults with colorectal cancer receiving intelligent digital monitoring–supported nutrition management vs control. The analysis included 3 randomized controlled trials from China and the Republic of Korea (n=305; published in 2022-2025) [22,31,38].



Nutritional Status

A total of 6 studies, including 3 RCTs [31,33,38] and 3 NRCTs [36,40,42], assessed nutritional status using the PG-SGA. All 3 RCTs [31,33,38], comprising 244 participants, provided sufficiently comparable data and were included in the meta-analysis (Figure 3). The pooled analysis showed significantly lower PG-SGA scores with intelligent digital monitoring–supported nutrition management than in the control group (MD –1.50, 95% CI –1.85 to –1.15; *P*=.003). Heterogeneity statistics were Cochran *Q*=0.67 (*df*=2, *P*=.72), I^2=0.00%, τ^2=0.00, and τ=0.00 points. For the nonrandomized studies, Zhu et al [40] and Cheng et al [36] reported more favorable PG-SGA outcomes in the intervention groups than in the control groups. Wang et al [42] assessed nutritional status categorically and reported a lower proportion of severe malnutrition in the intervention group than in the control group. The certainty of evidence using the GRADE approach was moderate (Multimedia Appendix 4).

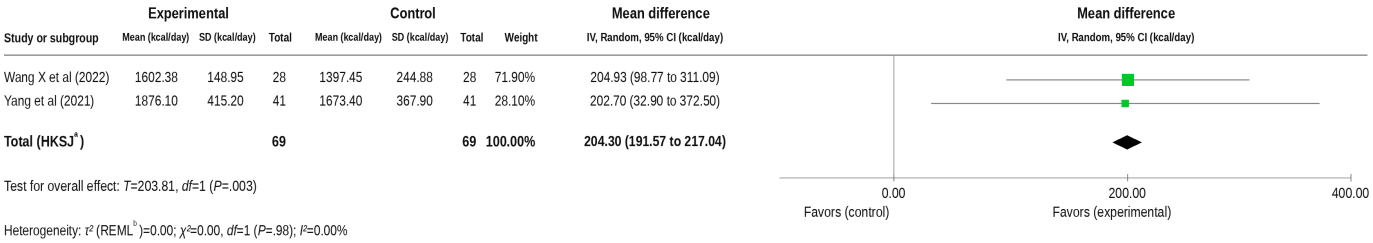
Figure 3. Random-effects meta-analysis of Patient-Generated Subjective Global Assessment scores in adults with colorectal cancer receiving intelligent digital monitoring–supported nutrition management compared with control. The analysis included 3 randomized controlled trials from China (n=244; published in 2022-2025) [31,33,38].



Effect on Dietary Intake

Two RCTs [38,41], 1 prospective cohort study [13], and 1 single-arm pre-post pilot study [34] assessed energy intake among patients with CRC receiving intelligent digital nutrition monitoring–supported nutrition interventions, with the pooled effect of the RCTs shown in Figure 4. Meta-analysis showed significantly higher energy intake in the intervention group than in the control group (MD 204.30 kcal/d, 95% CI 191.57-217.04; P=.003; Figure 4). The between-study statistics were Cochran Q=0.00 (df =1, P=.98), I^2=0.00%, τ^2=0.00, and τ=0.00 kcal/d. These estimates should be interpreted with caution because only 2 RCTs with very low certainty of evidence contributed to the analysis. However, in a post hoc sensitivity analysis using the modified Hartung-Knapp approach with an ad hoc variance correction, the pooled MD remained unchanged at 204.30 kcal/d, whereas the 95% CI widened substantially from –379.28 to 787.88 kcal/d (P=.14), indicating that the statistical significance of the primary analysis was not robust to the modified small-sample inference. For the nonrandomized studies, Beukers et al [34] reported that 89% of participants met their estimated energy requirements at follow-up, whereas Huang et al [13] also reported energy-target attainment among patients with CRC. The certainty of evidence using the GRADE approach was very low (Multimedia Appendix 4).

Figure 4. Random-effects meta-analysis of energy intake in adults with colorectal cancer receiving intelligent digital monitoring–supported nutrition management compared with control. The analysis included 2 randomized controlled trials from China (n=138; published in 2021-2022) [38,41].



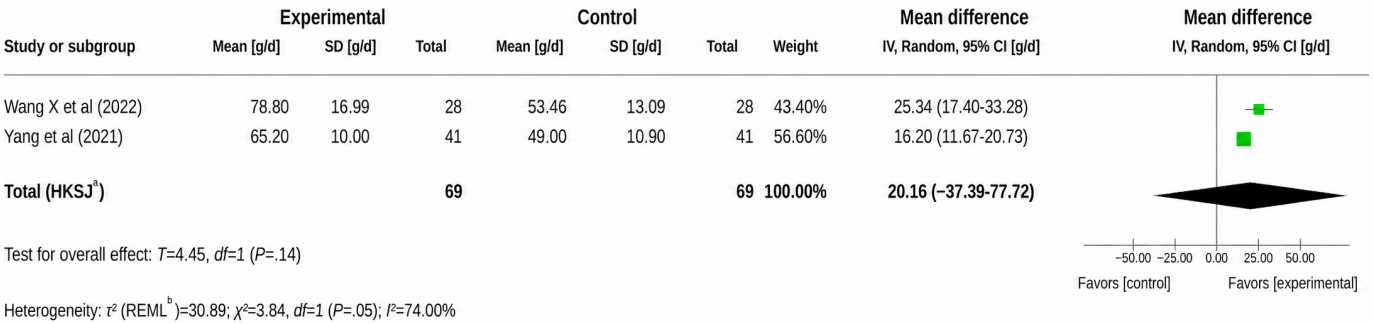
Footnotes

[a] CI calculated by Hartung-Knapp-Sidik-Jonkman method.

[b] τ^2 calculated by Restricted Maximum-Likelihood method.

A total of 2 RCTs [38,41], 1 prospective cohort study [32], and 1 single-arm pre-post pilot study [34] assessed protein intake among patients with CRC receiving intelligent digital nutrition monitoring–supported nutrition interventions, with the pooled effect of the RCTs shown in Figure 5. Meta-analysis showed no statistically significant difference in protein intake between the intervention and control groups (MD 20.16 g/d, 95% CI –37.39 to 77.72; P=.14; Figure 5). Heterogeneity statistics were Cochran Q=3.84 (df=1, P=.050), I^2=74.00%, τ^2=30.89, and τ=5.56 g/d. For the nonrandomized studies, Beukers et al [34] reported that 55% of participants met their estimated protein requirements at follow-up, whereas Timmers et al [32] reported consistently high adherence to recommended protein shake intake (98.6%-100%) during the intervention. The certainty of evidence using the GRADE approach was very low (Multimedia Appendix 4). Albino et al [37] reported transient reductions in food intake during active treatment, with intake subsequently returning toward usual levels.

Figure 5. Random-effects meta-analysis of protein intake in adults with colorectal cancer receiving intelligent digital monitoring–supported nutrition management compared with control. The analysis included 2 randomized controlled trials from China (n=138; published in 2021-2022) [38,41].



Footnotes

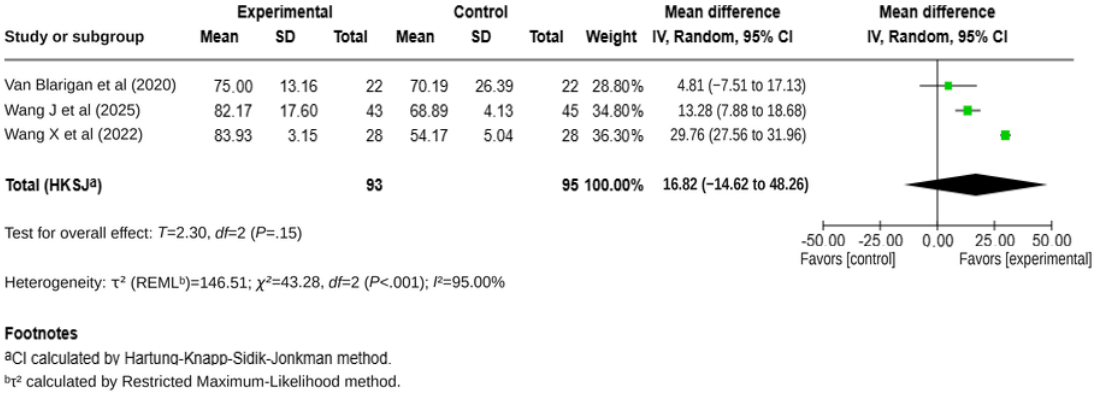
[a] CI calculated by Hartung-Knapp-Sidik-Jonkman method.

[b] τ^2 calculated by Restricted Maximum-Likeiihood method.

Effect on QoL

A total of 3 RCTs [31,38,43] and 1 NRCT [36] reported QoL outcomes. The 3 RCTs [31,38,43] reported QoL using the global health status domain of the European Organisation for Research and Treatment of Cancer (EORTC) Core Quality of Life (QLQ-C30), with the pooled effect shown in Figure 6. Meta-analysis showed no statistically significant between-group difference in QoL (MD 16.82, 95% CI −14.62 to 48.26; *P*=.15; Figure 6). Heterogeneity statistics were Cochran *Q*=43.28 (*df*=2, *P*<.001), I^2=95.00%, τ^2=146.51, and τ=12.10 points. Subgroup analysis or meta-regression was not possible because of the limited number of trials. Cheng et al [36] reported significantly more favorable QoL outcomes in the intervention group. The certainty of evidence using the GRADE approach was very low (Multimedia Appendix 4).

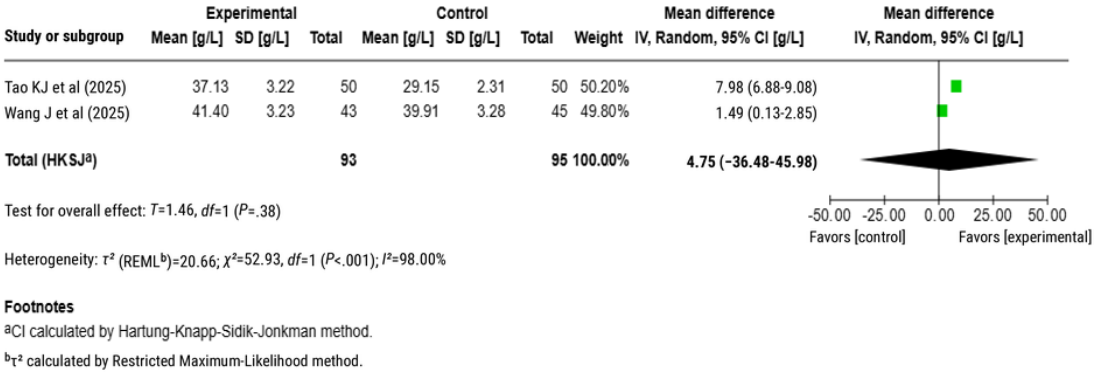
Figure 6. Random-effects meta-analysis of quality of life in adults with colorectal cancer receiving intelligent digital monitoring–supported nutrition management compared with control. The analysis included 3 randomized controlled trials from China and the United States (n=188; published in 2020-2025), using the global health status domain of the European Organisation for Research and Treatment of Cancer (EORTC) Core Quality of Life (QLQ-C30) [31,38,43].



Nutrition-Related Biochemical Markers

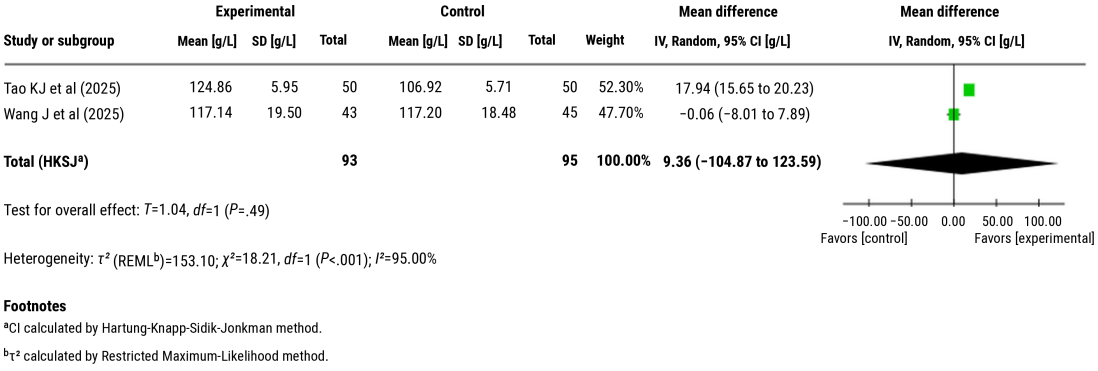
A total of 2 RCTs [31,33] and 3 NRCTs [36,39,40] assessed serum albumin levels among patients with CRC receiving intelligent digital nutrition monitoring–supported nutrition interventions. Meta-analysis showed no statistically significant difference in albumin levels between the intervention and control groups (MD 4.75 g/L, 95% CI −36.48 to 45.98; *P*=.38; Figure 7). Heterogeneity statistics were Cochran *Q*=52.93 (*df*=1, *P*<.001), I^2=98.00%, τ^2=20.66, and τ=4.55 g/L. Subgroup analysis or meta-regression was not possible because of the limited number of trials. Among the 3 NRCTs, Zhu et al [40], Cheng et al [36], and Chen et al [39] reported higher postintervention albumin levels in the intervention groups than in the control groups. The certainty of evidence using the GRADE approach was very low (Multimedia Appendix 4).

Figure 7. Random-effects meta-analysis of serum albumin levels in adults with colorectal cancer receiving intelligent digital monitoring–supported nutrition management compared with control. The analysis included 2 randomized controlled trials from China (n=188; published in 2025) [31,33].



A total of 2 RCTs [31,33] and 3 NRCTs [36,39,40] assessed hemoglobin levels among patients with CRC receiving intelligent digital nutrition monitoring–supported nutrition interventions. Meta-analysis showed no statistically significant difference in hemoglobin levels between the intervention and control groups (MD 9.36 g/L, 95% CI −104.87 to 123.59; *P*=.49; Figure 8). Heterogeneity statistics were Cochran *Q*=18.21 (*df*=1, *P*<.001), I^2=95.00%, τ^2=153.10, and τ=12.37 g/L. Subgroup analysis or meta-regression was not possible because of the limited number of trials. Among the 3 NRCTs, Zhu et al [40], Cheng et al [36], and Chen et al [39] reported higher postintervention hemoglobin levels in the intervention groups than in the control groups. The certainty of evidence using the GRADE approach was very low (Multimedia Appendix 4).

Figure 8. Random-effects meta-analysis of hemoglobin levels in adults with colorectal cancer receiving intelligent digital monitoring–supported nutrition management compared with control. The analysis included 2 randomized controlled trials from China (n=188; published in 2025) [31,33].



TP and prealbumin were each reported in 1 RCT and 2 NRCTs and were summarized narratively. For TP, Tao et al [33] and Chen et al [39] reported higher postintervention levels in the intervention groups than in the control groups, while Zhu et al [40] found a significant Group × Time interaction during treatment (P<.05). For prealbumin, Wang et al [31] and Cheng et al [36] reported more favorable postintervention levels in the intervention groups, while Zhu et al [40] also reported prealbumin during treatment.

Discussion

Principal Findings

This systematic review and meta-analysis extends previous reviews of mobile app–based dietary interventions across broader populations with cancer [14,15] by focusing specifically on the application of intelligent digital monitoring in nutritional management for patients with CRC. The most consistent finding was improved nutritional status, reflected by lower PG-SGA scores and supported by moderate-certainty evidence. Although the primary meta-analysis suggested higher energy intake, this finding was not robust in the post hoc small-sample sensitivity analysis, and the certainty of evidence was very low. In contrast, pooled RCT evidence showed no statistically significant effects on BMI, protein intake, QoL, albumin, or hemoglobin, with certainty ranging from low to very low. Narrative findings for body weight, TP, and prealbumin suggested favorable effects in some studies. Overall, the available evidence suggests that intelligent digital monitoring may support nutritional management in patients with CRC, particularly with respect to nutritional status, whereas its effects on energy intake and other outcomes remain uncertain. Further well-designed RCTs are needed to clarify its effects across outcomes.

Anthropometric responses to intelligent digital monitoring varied across clinical contexts. Although some studies reported favorable weight-related changes, pooled RCT evidence showed no statistically significant effect on BMI, and the certainty of evidence was low. This finding differs from that of Chung et al [14], who reported weight reduction among people living with gastrointestinal cancer receiving mobile app–based dietary interventions. However, weight loss should not be interpreted as inherently beneficial in patients with CRC because its clinical relevance depends on baseline adiposity, treatment phase, and whether the weight change is intentional [44]. Recent evidence suggests that both low and high postdiagnosis BMI may be associated with poorer CRC outcomes [45], while sarcopenia is associated with adverse postoperative outcomes [46], indicating that body weight and BMI alone may not adequately capture clinically meaningful changes in nutritional status and body composition. Future trials should, therefore, prespecify weight-management goals and include body-composition measures alongside BMI to distinguish beneficial weight changes from unintended loss of lean mass.

Pooled RCT evidence suggests that intelligent digital monitoring may improve nutritional status, as reflected by lower PG-SGA scores. Recent PG-SGA–based evidence has highlighted the high nutritional risk and nutrition-impact symptoms experienced by patients with CRC during chemotherapy, reinforcing the importance of timely individualized nutritional management [3,47]. Our finding differs from that of Chung et al [14], whose meta-analysis found no significant effect on nutritional status among people living with gastrointestinal cancer and reported substantial heterogeneity and very low-certainty evidence. This difference may partly reflect the broader populations with cancer, clinical contexts, and nutritional-status measures included in that review, whereas our pooled analysis specifically focused on patients with CRC assessed using PG-SGA. Because PG-SGA incorporates changes in weight, food intake, nutrition-impact symptoms, and functional status [15], repeated monitoring combined with timely feedback and individualized adjustment may facilitate earlier identification and management of nutritional deterioration. Evidence from digital symptom-monitoring trials also supports combining patient-reported monitoring with clinician follow-up and decision support, rather than relying on monitoring alone [48]. Future trials should standardize PG-SGA assessment timing and clarify which monitoring and feedback components contribute most to improvements in nutritional status.

The apparent increase in energy intake should be interpreted with caution because the pooled inference was sensitive to the small-sample approach. Although the primary estimate favored the intervention, the sensitivity analysis did not support a statistically robust effect. This uncertainty is reflected in the very low certainty of evidence for this

outcome. The direction of the primary estimate is consistent with Chung et al [14], whose meta-analysis of mobile app–based dietary interventions found increased energy intake but no significant effect on protein intake among people living with gastrointestinal cancer. In contrast, Gong et al [49] found no significant effect of mHealth dietary interventions on energy intake among cancer survivors. This discrepancy may partly reflect differences in study populations and intervention design, as the RCTs in our energy analysis focused on CRC and incorporated repeated dietary monitoring with individualized feedback or adjustment, whereas the earlier review included broader populations with cancer and mHealth approaches. These findings suggest that dietary effects may depend not only on the digital modality but also on how monitoring is integrated with individualized nutritional management. The effect on protein intake remains uncertain. The 2 contributing RCTs yielded I^2=74.00%, τ^2=30.89, and τ=5.56 g/d. I^2 describes relative inconsistency in the study results, whereas τ quantifies the estimated between-study SD on the outcome scale. Because only 2 RCTs contributed to this analysis, the magnitude and sources of variation in the true effects cannot be determined reliably. Differences in treatment status, monitoring frequency, and intervention duration may have contributed to the observed variation. Yang et al [41] included patients with stage I-IV rectal cancer undergoing surgery with or without radiotherapy or chemotherapy and conducted weekly dietary monitoring over 2 years, whereas Wang et al [38] enrolled posttreatment CRC survivors with disease-free or stable disease and provided follow-up every 4 weeks for 6 months. Differences in treatment status, monitoring frequency, and intervention duration may, therefore, have contributed to the heterogeneity in protein-intake effects. In a recent multicenter cohort of patients with cancer, longer adherence to electronic patient-reported outcome–based nutrition journaling was associated with higher odds of achieving adequate energy and protein intake [13]. Future trials should prespecify energy and protein targets, standardize dietary-intake assessment, and examine whether treatment phase, monitoring frequency, and feedback intensity modify these outcomes.

Pooled RCT evidence did not show a clear effect of intelligent digital monitoring on QoL. The analysis yielded I^2=95.00%, τ^2=146.51, and τ=12.10 points. These statistics describe relative inconsistency and the estimated absolute spread of true effects, respectively. Given that only 3 RCTs contributed to the analysis, the sources and clinical implications of this variation remain uncertain. This finding is consistent with Chung et al [14], whose meta-analysis also found no significant effect on QoL with substantial heterogeneity. In contrast, Gong et al [49] reported a small improvement in QoL across broader populations with cancer. The 3 contributing RCTs differed in treatment context and intervention delivery: Wang J et al [31] evaluated weekly symptom-guided nutrition adjustment during postoperative chemotherapy, Wang X et al [38] studied posttreatment CRC survivors with follow-up every 4 weeks for 6 months, and Van Blarigan et al [43] tested a 12-week web-based and text-based dietary program in survivors not receiving chemotherapy. These differences in treatment status, monitoring frequency, and intervention duration may partly explain the heterogeneity. Recent CRC-specific evidence from Markozannes et al [50] also suggested only small improvements in QoL from diet-quality interventions, with low-certainty evidence. Because QoL is influenced by treatment-related symptoms and physical, psychological, and social functioning, improvements in nutritional outcomes may not translate directly into overall QoL gains. Future RCTs should use consistent EORTC QLQ-C30 assessment time points, report global and domain-specific outcomes consistently, and examine whether treatment phase and intervention intensity modify QoL effects.

The meta-analyses showed no clear effects of intelligent digital monitoring on albumin or hemoglobin. For albumin, I^2 was 98.00%, τ^2 was 20.66, and τ was 4.55 g/L. For hemoglobin, I^2 was 95.00%, τ^2 was 153.10, and τ was 12.37 g/L. I^2 describes relative inconsistency rather than the absolute magnitude of differences in true effects, whereas τ provides an estimate of between-study SD on the respective outcome scales. With only 2 RCTs contributing to each analysis, the sources and clinical implications of the observed variation remain uncertain. This finding is consistent with the recent meta-analysis by Feng et al [16], which also found no significant effect of digital health interventions on nutritional status assessed using albumin. The 2 contributing RCTs differed in monitoring and follow-up: Wang J et al [31] used weekly symptom-guided monitoring during postoperative chemotherapy, whereas Tao et al [33] used daily self-monitoring with follow-up to 6 months. Although narrative findings for TP and prealbumin generally favored the intervention, the evidence was limited by the small number of studies and the predominance of nonrandomized designs. The absence of a clear albumin effect does not necessarily indicate a lack of nutritional benefit because albumin is influenced by inflammation, disease severity, and fluid status and is not a specific indicator of nutritional response [51]. Prealbumin is similarly affected by inflammation and other nonnutritional factors, limiting its value as a stand-alone marker [52]. Hemoglobin is also multifactorial and may be influenced by chemotherapy, blood loss, iron status, inflammation, and the underlying disease [53]. Biochemical markers should, therefore, complement, rather than replace, multidimensional nutritional assessment. Future trials should standardize blood-sampling time points and interpret these markers alongside inflammatory indices, iron status, dietary intake, and PG-SGA.

The findings support intelligent digital monitoring as an adjunct to nutritional care rather than a replacement for professional assessment. Its clinical value may depend on linking repeated nutritional and symptom monitoring with timely professional feedback and individualized adjustment. This interpretation is consistent with recent oncology trials, integrating patient-reported monitoring with clinician follow-up, threshold-based alerts, or decision support [11,48]. Future studies should distinguish simple digital recording or education from monitoring systems in which collected data trigger professional feedback or individualized management. Larger multicenter RCTs should prespecify core intervention

components, monitoring frequency, feedback and escalation criteria, and intervention duration. They should also standardize outcome measures and assessment time points, include nutritional status, dietary intake, body composition, and patient-reported outcomes, and use longer follow-up to assess whether benefits are sustained.

Strengths and Limitations

This review provides a CRC-specific synthesis of intelligent digital monitoring–supported nutritional management and was prospectively registered in PROSPERO, conducted in accordance with PRISMA guidance, and assessed using RoB 2, ROBINS-I, and GRADE. Quantitative synthesis was limited to sufficiently comparable RCTs, and nonrandomized evidence was summarized separately. Several limitations should be noted. Most outcomes were informed by few trials, and some had small samples, limiting subgroup or meta-regression analyses and reliable assessment of small-study effects. All RCTs were rated as having some concerns, whereas most nonrandomized studies had serious risk of bias, mainly due to confounding. Clinical and intervention heterogeneity, including differences in treatment phase, monitoring frequency, follow-up duration, and outcome timing, may have contributed to variation in effects and may have limited the identification of the most effective digital components. Some analyses relied on postintervention values because change-score data were unavailable, and sparse, noncomparable data limited TP and prealbumin to narrative synthesis. In addition, 9 of 14 studies were conducted in China, which may limit generalizability to other health care settings. Finally, several outcomes were supported by low- or very low-certainty evidence, limiting firm clinical inferences.

Conclusions

This systematic review and meta-analysis provides evidence supporting the use of intelligent digital monitoring in nutritional management for patients with CRC, with the most consistent evidence indicating improvements in nutritional status. Although the primary meta-analysis suggested an increase in energy intake, this finding was not robust to the post hoc small-sample sensitivity analysis, and the certainty of evidence was very low. Evidence for BMI, protein intake, QoL, albumin, and hemoglobin remains uncertain, whereas findings for body weight, TP, and prealbumin were based primarily on narrative synthesis. By focusing on repeated nutritional monitoring linked to professional feedback or individualized management, this review extends previous reviews of mobile app–based dietary interventions in broader populations with cancer and highlights the importance of integrating digital monitoring with professional nutritional care. Larger, well-designed multicenter RCTs are needed before firm clinical recommendations can be made.

Generative AI Use

No generative AI tools were used at any stage during the preparation of this manuscript.

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Data Availability

The datasets used and analyzed during this study are available from the corresponding author upon reasonable request.

Authors' Contributions

Conceptualization: LW, ZY, JW
Data curation: XC, YZ, LN
Formal analysis: LW, XC
Investigation: XC, YZ, LN
Methodology: LW, XC
Supervision: LW, ZY, JW
Validation: XC, YZ, LN
Writing – original draft: XC
Writing – review & editing: XC, ZY, YZ, LN, JW, LW

Conflicts of Interest

None declared.

Multimedia Appendix 1

Search strategy.
[DOCX File (Microsoft Word File), 29 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Study characteristics.
[DOCX File (Microsoft Word File), 87 KB-Multimedia Appendix 2]

Multimedia Appendix 3

Risk of bias assessments.
[DOCX File (Microsoft Word File), 641 KB-Multimedia Appendix 3]

Multimedia Appendix 4

GRADE assessment of the certainty of evidence.
[DOCX File (Microsoft Word File), 20 KB-Multimedia Appendix 4]

Checklist 1

PRISMA 2020 expanded checklist.
[DOCX File (Microsoft Word File), 68 KB-Checklist 1]

Checklist 2

PRISMA 2020 for abstracts checklist.
[DOCX File (Microsoft Word File), 271 KB-Checklist 2]

Checklist 3

PRISMA-S checklist.
[DOCX File (Microsoft Word File), 85 KB-Checklist 3]

References

1. Bray F, Laversanne M, Sung H, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2024;74(3):229-263. [doi: 10.3322/caac.21834] [Medline: 38572751]
2. Wu S, Zhang Y, Lin Z, Wei M. Global burden of colorectal cancer in 2022 and projections to 2050: incidence and mortality estimates from GLOBOCAN. BMC Cancer. Nov 14, 2025;25(1):1770. [doi: 10.1186/s12885-025-15138-0] [Medline: 41239247]
3. Sánchez-Diestro LE, Macias-Montero R, Ramalho-Galhanas AI, Aguiar-Frias AM, Paniagua-Vivas MS, Guerrero-Martín J. Nutritional status assessment using the patient-generated subjective global assessment (PG-SGA) in individuals with colorectal cancer undergoing chemotherapy regimens. J Clin Med. Sep 22, 2025;14(18):6664. [doi: 10.3390/jcm14186664] [Medline: 41010868]
4. Muscaritoli M, Arends J, Bachmann P, et al. ESPEN practical guideline: clinical nutrition in cancer. Clin Nutr. May 2021;40(5):2898-2913. [doi: 10.1016/j.clnu.2021.02.005] [Medline: 33946039]
5. Trujillo EB, Kadakia KC, Thomson C, et al. Malnutrition risk screening in adult oncology outpatients: an ASPEN systematic review and clinical recommendations. JPEN J Parenter Enteral Nutr. Nov 2024;48(8):874-894. [doi: 10.1002/jpen.2688] [Medline: 39412097]
6. Trauchburg A, Schwingshackl L, Hoffmann G. Association between dietary indices and dietary patterns and mortality and cancer recurrence among cancer survivors: an updated systematic review and meta-analysis of cohort studies. Nutrients. Jul 14, 2023;15(14):3151. [doi: 10.3390/nu15143151] [Medline: 37513568]
7. Wesselink E, Boshuizen HC, van Lanen AS, et al. Dietary and lifestyle inflammation scores in relation to colorectal cancer recurrence and all-cause mortality: a longitudinal analysis. Clin Nutr. Sep 2024;43(9):2092-2101. [doi: 10.1016/j.clnu.2024.07.028] [Medline: 39094474]
8. Abedin K, Lean QY, Wheelwright S. Nutritional self-management in colorectal cancer patients and survivors: a scoping review. Colorectal Dis. Sep 2024;26(9):1662-1679. [doi: 10.1111/codi.17108] [Medline: 39080848]
9. Aapro M, Bossi P, Dasari A, et al. Digital health for optimal supportive care in oncology: benefits, limits, and future perspectives. Support Care Cancer. Oct 2020;28(10):4589-4612. [doi: 10.1007/s00520-020-05539-1] [Medline: 32533435]
10. Classification of digital interventions, services and applications in health: a shared language to describe the uses of digital technology for health, 2nd ed. World Health Organization; 2023. URL: https://www.who.int/publications/i/item/9789240081949 [Accessed 2026-11-12]
11. Sun V, Xiao Y, Li S, et al. Comparative effectiveness of remote perioperative telemonitoring in cancer surgery: a randomized trial. NPJ Digit Med. Aug 28, 2025;8(1):555. [doi: 10.1038/s41746-025-01961-z] [Medline: 40877442]
12. Ayyoubzadeh SM, Baniasadi T, Shirkhoda M, et al. Remote monitoring of colorectal cancer survivors using a smartphone app and internet of things-based device: development and usability study. JMIR Cancer. Feb 15, 2023;9:e42250. [doi: 10.2196/42250] [Medline: 36790851]

13. Huang J, Xie SW, Tian L, et al. Effectiveness and adherence of nutritional management via electronic patient-reported outcomes platform in patients with cancer: multicenter prospective longitudinal cohort study. JMIR Cancer. Nov 28, 2025;11:e75633. [doi: 10.2196/75633] [Medline: 41328042]
14. Chung KCW, Takemura N, Lam WWT, et al. Efficacy of mobile app-based dietary interventions among cancer survivors: systematic review and meta-analysis. JMIR Mhealth Uhealth. Jul 31, 2025;13:e65505. [doi: 10.2196/65505] [Medline: 40748241]
15. Ng KLS, Munisamy M, Lim JBY, Alshagga M. The effect of nutritional mobile apps on populations with cancer: systematic review. JMIR Cancer. Feb 5, 2025;11:e50662. [doi: 10.2196/50662] [Medline: 39908548]
16. Feng X, Wang J, Shi H, et al. Effect of digital health interventions on the nutritional status and quality of life of patients with colorectal cancer: systematic review and meta-analysis of randomized controlled trials. J Med Internet Res. Aug 18, 2026;28:e87866. [doi: 10.2196/87866] [Medline: 42613928]
17. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. Mar 29, 2021;372:n71. [doi: 10.1136/bmj.n71] [Medline: 33782057]
18. Rethlefsen ML, Kirtley S, Waffenschmidt S, et al. PRISMA-S: an extension to the PRISMA Statement for Reporting Literature Searches in Systematic Reviews. Syst Rev. Jan 26, 2021;10(1):39. [doi: 10.1186/s13643-020-01542-z] [Medline: 33499930]
19. Flemyng E, Moore TH, Boutron I, et al. Using Risk of Bias 2 to assess results from randomised controlled trials: guidance from Cochrane. BMJ Evid Based Med. Aug 2023;28(4):260-266. [doi: 10.1136/bmjebm-2022-112102] [Medline: 36693715]
20. Sterne JA, Hernán MA, Reeves BC, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. Oct 12, 2016;355:i4919. [doi: 10.1136/bmj.i4919] [Medline: 27733354]
21. Sterne JAC, Hernán MA, McAleenan A, Reeves BC, Higgins JPT. Chapter 25: Assessing risk of bias in a non-randomized study. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA, editors. Cochrane Handbook for Systematic Reviews of Interventions. 6.5. Cochrane; 2024. URL: https://www.cochrane.org/authors/handbooks-and-manuals/handbook/current/chapter-25 [Accessed 2026-11-12]
22. Kim YI, Park IJ, Ro JS, et al. A randomized controlled trial of a digital lifestyle intervention involving postoperative patients with colorectal cancer. NPJ Digit Med. May 20, 2025;8(1):296. [doi: 10.1038/s41746-025-01716-w] [Medline: 40394118]
23. Borenstein M, Hedges LV, Higgins JPT, Rothstein HR. A basic introduction to fixed-effect and random-effects models for meta-analysis. Res Synth Methods. Apr 2010;1(2):97-111. [doi: 10.1002/jrsm.12] [Medline: 26061376]
24. Deeks JJ, Higgins JPT, Altman DG, McKenzie JE, Veroniki AA, Simmonds M. Chapter 10: Analysing data and undertaking meta-analyses. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA, editors. Cochrane Handbook for Systematic Reviews of Interventions. Cochrane; 2026. URL: https://www.cochrane.org/authors/handbooks-and-manuals/handbook/current/chapter-10 [Accessed 2026-11-12]
25. IntHout J, Ioannidis JPA, Borm GF. The Hartung-Knapp-Sidik-Jonkman method for random effects meta-analysis is straightforward and considerably outperforms the standard DerSimonian-Laird method. BMC Med Res Methodol. Feb 18, 2014;14:25. [doi: 10.1186/1471-2288-14-25] [Medline: 24548571]
26. Brini S, Leung TI. Value and credibility of meta-analysis: tutorial on enhancing methodological rigor and AI-powered efficiency. J Med Internet Res. Jul 2, 2026;28:e92132. [doi: 10.2196/92132] [Medline: 42390911]
27. Higgins JPT, López-López JA. Reflections on the I-squared index for measuring inconsistency in meta-analysis. Res Synth Methods. May 2026;17(3):389-402. [doi: 10.1017/rsm.2025.10062] [Medline: 41992898]
28. Röver C, Knapp G, Friede T. Hartung-Knapp-Sidik-Jonkman approach and its modification for random-effects meta-analysis with few studies. BMC Med Res Methodol. Nov 14, 2015;15(99):99. [doi: 10.1186/s12874-015-0091-1] [Medline: 26573817]
29. Borenstein M. How to understand and report heterogeneity in a meta-analysis: the difference between I-squared and prediction intervals. Integr Med Res. Dec 2023;12(4):101014. [doi: 10.1016/j.imr.2023.101014] [Medline: 38938910]
30. Sterne JAC, Sutton AJ, Ioannidis JPA, et al. Recommendations for examining and interpreting funnel plot asymmetry in meta-analyses of randomised controlled trials. BMJ. Jul 22, 2011;343:d4002. [doi: 10.1136/bmj.d4002] [Medline: 21784880]
31. Wang J, Huang Y, Zheng X, et al. Effect of nutritional intervention on chemotherapy tolerance and quality of life in patients with colorectal cancer undergoing postoperative chemotherapy: a randomized controlled study. Nutr Cancer. 2025;77(3):414-423. [doi: 10.1080/01635581.2025.2449719] [Medline: 39789810]
32. Timmers TGC, Groen LCB, Schreurs H, Bruns ERJ. Development and implementation of a home-based prehabilitation app for older patients undergoing elective colorectal cancer surgery. A prospective cohort study. Digit Health. 2025;11:20552076251317760. [doi: 10.1177/20552076251317760] [Medline: 39949843]

33. Tao K, Gao S, Xia Y, Wang C. Clinical research on the establishment of “Internet +” whole-process nutrition management in postoperative colorectal cancer patients [Article in Chinese]. Hebei Med J. 2025;47(5):794-797. [doi: 10.3969/j.issn.1002-7386.2025.05.018]
34. Beukers K, Franssen RFW, Beijaard K, van de Wouw AJ, Havermans RC, Janssen-Heijnen MLG. Nutritional intervention during a teleprehabilitation pilot study in high-risk patients with colorectal cancer: adherence, motivators, and barriers. Support Care Cancer. Oct 8, 2024;32(10):710. [doi: 10.1007/s00520-024-08915-3] [Medline: 39375223]
35. Wang L, Langlais C, Kenfield SA, et al. Quality of life among colorectal cancer survivors participating in a pilot randomized controlled trial of a web-based dietary intervention with text messages. Support Care Cancer. Feb 10, 2023;31(3):155. [doi: 10.1007/s00520-023-07620-x] [Medline: 36763183]
36. Cheng Y, Zhang P, Hou X, Wang R, Yan T, Gao C. Application of hospital-to-home nutrition management using Internet platform in colorectal cancer patients treated with chemotherapy [Article in Chinese]. J Nurs Sci. 2023;38(9):10-13. [doi: 10.3870/j.issn.1001-4152.2023.09.010]
37. de Queiroz DA, Passarello RS, de Moura Fé VV, et al. A wearable chatbot-based model for monitoring colorectal cancer patients in the active phase of treatment. Healthc Anal. Dec 2023;4:100257. [doi: 10.1016/j.health.2023.100257]
38. Wang X, Zeng H, Li L, et al. Personalized nutrition intervention improves nutritional status and quality of life of colorectal cancer survivors in the community: a randomized controlled trial. Nutrition. 2022;103-104:111835. [doi: 10.1016/j.nut.2022.111835] [Medline: 36183482]
39. Chen J, Wang B, Yin X, et al. Application value of nutrition support team in chemotherapy period of colon cancer based on internet multidisciplinary treatment mode. Comput Math Methods Med. Jul 23, 2022;2022:1-8. [doi: 10.1155/2022/8234769] [Medline: 35915770]
40. Zhu X, Xie M, Liu H. Participatory whole-course nutrition management for improving the nutritional status of patients with rectal cancer neoadjuvant therapy [Article in Chinese]. Parenter Enter Nutr. 2021;28(6):352-356. [doi: 10.16151/j.1007-810x.2021.06.007]
41. Yang H, Tao Q. Influence of family nursing diet guidance based on WeChat platform on the survival of patients with rectal cancer [Article in Chinese]. Chinese Nursing Research. 2021;35(11):2050-2053. [doi: 10.12102/j.issn.1009-6493.2021.11.039]
42. Wang F, Li Q. Application of a home health care information management platform in patients with colorectal cancer undergoing chemotherapy [Article in Chinese]. Chinese J Rural Med Pharm. 2021;28(24):77-78. [doi: 10.3969/j.issn.1006-5180.2021.24.041]
43. Van Blarigan EL, Kenfield SA, Chan JM, et al. Feasibility and acceptability of a web-based dietary intervention with text messages for colorectal cancer: a randomized pilot trial. Cancer Epidemiol Biomarkers Prev. Apr 1, 2020;29(4):752-760. [doi: 10.1158/1055-9965.EPI-19-0840] [Medline: 31941707]
44. Qin X, Sun J, Liu M, Zhang L, Yin Q, Chen S. The effects of oral nutritional supplements interventions on nutritional status in patients undergoing colorectal cancer surgery: a systematic review. Int J Nurs Pract. Jun 2024;30(3):e13226. [doi: 10.1111/ijn.13226] [Medline: 38128910]
45. Becerra-Tomás N, Markozannes G, Cariolou M, et al. Post-diagnosis adiposity and colorectal cancer prognosis: a Global Cancer Update Programme (CUP Global) systematic literature review and meta-analysis. Int J Cancer. Aug 1, 2024;155(3):400-425. [doi: 10.1002/ijc.34905] [Medline: 38692659]
46. Keshavjee S, Mckechnie T, Shi V, et al. The impact of sarcopenia on postoperative outcomes in colorectal cancer surgery: an updated systematic review and meta-analysis. Am Surg. May 2025;91(5):887-900. [doi: 10.1177/00031348251329748] [Medline: 40127466]
47. Seid A, Debebe Z, Ayelign A, et al. Malnutrition diagnosed by patient-generated subjective global assessment and the risk of all-cause mortality in adults with gastrointestinal cancer: a systematic review and meta-analysis. J Hum Nutr Diet. Feb 2025;38(1):e70012. [doi: 10.1111/jhn.70012] [Medline: 39817621]
48. Mooney K, Gullatte M, Iacob E, et al. Essential components of an electronic patient-reported symptom monitoring and management system: a randomized clinical trial. JAMA Netw Open. Sep 3, 2024;7(9):e2433153. [doi: 10.1001/jamanetworkopen.2024.33153] [Medline: 39269704]
49. Gong Y, Jiang X, Chen X, et al. Effectiveness of mHealth diet interventions in cancer survivors: a systematic review and meta-analysis of randomized controlled trials. Asia Pac J Oncol Nurs. Mar 2023;10(3):100196. [doi: 10.1016/j.apjon.2023.100196] [Medline: 37124242]
50. Markozannes G, Cividini S, Aune D, et al. The role of physical activity, sedentary behaviour, diet, adiposity and body composition on health-related quality of life and cancer-related fatigue after diagnosis of colorectal cancer: a Global Cancer Update Programme (CUP Global) systematic literature review and meta-analysis. ESMO Open. Apr 2025;10(4):104301. [doi: 10.1016/j.esmoop.2025.104301] [Medline: 40086399]

51. Li Y, Chen L, Yang X, et al. Dynamic association of serum albumin changes with inflammation, nutritional status and clinical outcomes: a secondary analysis of a large prospective observational cohort study. Eur J Med Res. Jul 28, 2025;30(1):679. [doi: 10.1186/s40001-025-02925-5] [Medline: 40717075]
52. Hall JW, Canada TW, Mansfield PF. Changes in serum prealbumin as a marker for nitrogen balance in surgical oncology patients. Support Care Cancer. Oct 18, 2023;31(12):639. [doi: 10.1007/s00520-023-08091-w] [Medline: 37851171]
53. Parikh PM, Aggarwal S, Biswas G, et al. Practical clinical consensus guidelines for the management of cancer associated anemia in low- and middle-income countries. South Asian J Cancer. Apr 2023;12(2):93-99. [doi: 10.1055/s-0043-1771445] [Medline: 37969669]

Abbreviations

CENTRAL: Cochrane Central Register of Controlled Trials
CRC: colorectal cancer
EORTC: European Organisation for Research and Treatment of Cancer
GRADE: Grading of Recommendations Assessment, Development, and Evaluation
MD: mean difference
mHealth: mobile health
NRCT: nonrandomized controlled trial
PG-SGA: Patient-Generated Subjective Global Assessment
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PRISMA-S: Preferred Reporting Items for Systematic Reviews and Meta-Analyses literature search extension
PROSPERO: International Prospective Register of Systematic Reviews
QLQ-C30: Core Quality of Life
QoL: quality of life
RCT: randomized controlled trial
RoB 2: Risk of Bias 2
ROBINS-I: Risk of Bias in Non-Randomized Studies of Interventions
TP: total protein

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