



## **Predictors of preparedness for recovery following colorectal cancer surgery: a latent class trajectory analysis**

Downloaded from: <https://research.chalmers.se>, 2026-04-05 19:56 UTC

Citation for the original published paper (version of record):

Sawatzky, R., Larsdotter, C., Carlsson, E. et al (2023). Predictors of preparedness for recovery following colorectal cancer surgery: a latent class trajectory analysis. *Acta Oncologica*, 62(12): 1625-1634.  
<http://dx.doi.org/10.1080/0284186X.2023.2269303>

N.B. When citing this work, cite the original published paper.

# Predictors of preparedness for recovery following colorectal cancer surgery: a latent class trajectory analysis

Richard Sawatzky, Cecilia Larsdotter, Eva Carlsson, Monica Pettersson, Elisabeth Kenne Sarenmalm, Frida Smith, Jonas Nygren, Lara Russell & Joakim Öhlén

**To cite this article:** Richard Sawatzky, Cecilia Larsdotter, Eva Carlsson, Monica Pettersson, Elisabeth Kenne Sarenmalm, Frida Smith, Jonas Nygren, Lara Russell & Joakim Öhlén (03 Nov 2023): Predictors of preparedness for recovery following colorectal cancer surgery: a latent class trajectory analysis, Acta Oncologica, DOI: [10.1080/0284186X.2023.2269303](https://doi.org/10.1080/0284186X.2023.2269303)

**To link to this article:** <https://doi.org/10.1080/0284186X.2023.2269303>



© 2023 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



[View supplementary material](#)



Published online: 03 Nov 2023.



[Submit your article to this journal](#)



Article views: 220



[View related articles](#)



[View Crossmark data](#)

## Predictors of preparedness for recovery following colorectal cancer surgery: a latent class trajectory analysis

Richard Sawatzky<sup>a,b,c</sup>, Cecilia Larsdotter<sup>d</sup>, Eva Carlsson<sup>c,e</sup>, Monica Pettersson<sup>c,f</sup>, Elisabeth Kenne Sarenmalm<sup>c,g</sup>, Frida Smith<sup>h,i</sup>, Jonas Nygren<sup>j,k</sup>, Lara Russell<sup>b</sup> and Joakim Öhlén<sup>c,l</sup>

<sup>a</sup>School of Nursing, Trinity Western University, Langley, Canada; <sup>b</sup>Centre for Advancing Health Outcomes, St. Paul's Hospital, Vancouver, Canada; <sup>c</sup>Institute of Health and Care Sciences, and Centre for Person-Centred Care (GPCC), Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden; <sup>d</sup>Sophiahemmet University, Stockholm, Sweden; <sup>e</sup>Department of surgery, Sahlgrenska University Hospital, Gothenburg, Sweden; <sup>f</sup>Hybrid and Intervention, Sahlgrenska University Hospital, Gothenburg, Sweden; <sup>g</sup>Skaraborg Hospital, Skövde, Sweden; <sup>h</sup>Regional Cancer Centre West, Western Sweden Healthcare Region, Goteborg, Sweden; <sup>i</sup>Technology Management and Economics, Chalmers University of Technology, Gothenburg, Sweden; <sup>j</sup>Department of Surgery, Ersta Hospital, Stockholm, Sweden; <sup>k</sup>Department of Clinical Sciences, Danderyd Hospital, Karolinska Institutet, Stockholm, Sweden; <sup>l</sup>Palliative Centre, Sahlgrenska University Hospital Västra Götaland Region, Gothenburg, Sweden

### ABSTRACT

**Aim:** With an interest in providing knowledge for person-centred care, our overall goal is to contribute a greater understanding of diversity among patients in terms of their preparedness before and up to six months after colorectal cancer surgery. Our aim was to describe and provide a tentative explanation for differences in preparedness trajectory profiles.

**Material and methods:** The study was explorative and used prospective longitudinal data from a previously published intervention study evaluating person-centred information and communication. The project was conducted at three hospitals in Sweden. Patient-reported outcomes measures, including the Longitudinal Preparedness for Colorectal Cancer Surgery Questionnaire, were collected before surgery, at discharge, and four to six weeks, three months, and six months after surgery. Clinical data were retrospectively obtained from patients' medical records. We used latent class growth models (LCGMs) to identify latent classes that distinguish subgroups of patients who represent different preparedness trajectory profiles. To determine the most plausible number of latent classes, we considered statistical information about model fit and clinical practice relevance. We used multivariable regression models to identify variables that explain the latent classes.

**Results:** The sample ( $N = 488$ ) comprised people with a mean age of 68 years ( $SD = 11$ ) of which 44% were women. Regarding diagnoses, 60% had colon cancer and 40% rectal cancer. The LCGMs identified six latent classes with different preparedness for surgery and recovery trajectories. The latent classes were predominantly explained by differences in age, sex, physical classification based on comorbidities, treatment hospital, global health status, distress, and sense of coherence (comprehensibility and meaningfulness).

**Conclusion:** Contrary to the received view that emphasizes standardized care practices, our results point to the need for adding person-centred and tailored approaches that consider individual differences in how patients are prepared before and during the recovery period related to colorectal cancer surgery.

### ARTICLE HISTORY

Received 20 July 2023  
Accepted 5 October 2023

### KEYWORDS



Colorectal neoplasms; health communication; longitudinal studies; patient acceptance of health care; patient-centred care; quality of life


## Background

There is an interest in identifying people who have different needs for support from health care professionals during recovery from surgery as a means to provide knowledge to inform person-centred care. This study investigates individual differences in patients' trajectories of their preparedness for cancer surgery and their recovery afterwards.

Recovery for patients undergoing colorectal cancer surgery (CRCS) has been characterized by variability and

complexity [1,2]. The experiential changes patients go through following CRCS [3,4] correspond to 'recovery' as regaining control over biopsychosocial functions while striving to return to the preoperative level of independence in daily living and optimum well-being [5]. Following CRCS, patients go through a complex transition from overcoming the surgery to recovery [6,7], which is characterized by physical powerlessness, dependency on others, difficulties with food intake [8] and altered bowel function [8,9]. Such distress

**CONTACT** Öhlén Joakim  joakim.ohlen@gu.se  Institute of Health and Care Sciences, Sahlgrenska Academy, University of Gothenburg, P.O.Box 457, SE-40530 Gothenburg, Sweden

 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/0284186X.2023.2269303>.

© 2023 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

has been related to emotional, cognitive and behavioural dimensions [7], as well as physical symptoms, physical functioning, and psychological, social and activity dimensions [6]. To cope, patients may need support in preparing for what might be expected [1,10], and to obtain an understanding of bodily changes immediately after surgery (e.g., pain, bowel problems and/or stoma), following discharge from the hospital, and during subsequent phases of recovery [1].

In this way, preparedness for surgery and recovery implies a forward-directed activity to address challenges and changes that might come [11,12] following surgery, and this may facilitate management of daily life at home and understanding of the meaning of the cancer diagnosis [13]. Further, research suggests that preparedness is a multidimensional construct that includes a) searching for and making use of information, b) understanding and being involved in the care process, c) making sense of the recovery process, and d) support and access to health care [14].

The recovery process is progressive but not the same for all patients undergoing CRCS [1,15]. Various intersecting factors may influence in what ways patients are prepared for recovery. Research indicates that most patients are satisfied with CRCS related communication [16] and will have completed the recovery process six months after surgery [8]. However, especially patients with rectal cancer and those receiving ostomy are expected to have a longer period of recovery [17], which is in line with various biomedical factors known to influence patients' recovery [18,19]. In addition, there are other intersecting factors that may influence patients' CRCS recovery, including various aspects of their quality of life [3]. As a result of differences in the ways patients are prepared prior to surgery and their trajectories of preparedness following surgery, patients may have different needs for support. This implies that patients may undergo different recovery trajectories that are shaped by multiple intersecting factors.

Interventions to support a successful recovery are typically based on evidence of what works best for most patients undergoing CRCS, on average. To develop tailored and person-centred interventions [20] and the generation of relevant hypotheses, there is a clinical interest in increasing knowledge about possibilities to better identify patients pre-surgery who are likely to experience undesirable patterns of preparedness for the recovery following surgery and who may have unmet needs. However, knowledge about different types of preparedness for recovery trajectories and factors associated with those trajectories is limited. A latent class analysis approach has been recommended for investigating heterogeneity in cancer populations, primarily to distinguish between demographic profiles [21–23], but also differences in patients' perceived health and their quality of life [24,25]. Latent class trajectory analysis may be considered a statistical approach that resonates with person-centredness in that it seeks to accommodate individual differences, and heterogeneity [26]. Rather than assuming homogeneity, as is the case for conventional variable-centred analyses, latent class analysis identifies

unobserved subgroups (classes) based on similarities in patterns of data; thus the subgroups are not assumed to be known beforehand [23].

### **Aim and objectives**

With a goal to contribute a greater understanding of diversity among patients in terms of their preparedness before and up to six months after CRCS, our aim is to provide a tentative explanation for differences in their preparedness trajectories. We hypothesised that preparedness trajectories are heterogeneous (i.e., there are multiple preparedness trajectory profiles). Specific objectives are to:

1. Distinguish unobserved subgroups (classes) of patients that represent different preparedness trajectory profiles, and
2. explore which demographic, diagnostic, treatment and care, and self-reported measures (health status, symptoms, sense of coherence) known pre-surgery may explain the different preparedness trajectories.

### **Material and methods**

This explorative study used prospective longitudinal data within an intervention study evaluating person-centred information and communication as compared to usual care in a non-randomised controlled before-and-after design (Registered at <https://www.clinicaltrials.gov> ID: NCT03587818) [27].

### **Settings**

The project was conducted at three hospitals in Sweden: one local-, one regional-, and one university-hospital. The care process in each hospital followed national and international guidelines. All patients had consultations with a surgeon and a registered nurse (patients with ostomy also with an enterostomal therapist) before surgery, before discharge and during their recovery. The Enhanced Recovery After Surgery (ERAS) multi-model perioperative care pathway was used at each hospital to enhance patients' physiological functioning pre- and post-surgery [18], and the local hospital was certified as an international centre of excellence in ERAS.

In the original clinical trial, patients in the intervention group were provided person-centred communication by means of a written, interactive patient education material and communication in a dialogue format. The effect evaluation was negative regarding overall preparedness for surgery and recovery (the primary outcome), while some intervention effects were detected for preparedness dimensions (searching for and making use of information, making sense of the recovery), role functioning, and patients' behaviour in contacting their assigned cancer "contact nurse" (a.k.a. nurse navigator) instead of contacting a nurse on duty at the ward or visiting the emergency department [27].

## Participants

Patients undergoing elective surgery for colorectal cancer were consecutively sampled from November 2012 to June 2015 in surgical departments at the three hospitals (see above). Patients were excluded from the study if one or more of the below mentioned criteria was present: preoperative chemotherapy, long-term preoperative radiation, diagnosed metastasis, post-surgical diagnosis of benign tumours, undergoing emergency surgery, having reduced cognitive function, and inability to communicate in Swedish. Out of 671 patients eligible for inclusion, 488 gave informed written consent to participate and were included in this analysis (including both control and intervention groups) [27].

## Measures and data collection

An overview of the constructs measured and the specific measurement instruments used (including domains, response scales, calculation of summary scores, and internal consistency reliability) is given in Table 1, and includes Swedish versions of the following measures: 1) preparedness for surgery and recovery measured using the Longitudinal Preparedness for Colorectal Cancer Surgery Questionnaire (PCSQ) [14,28], 2) health and quality of life (QoL) domains measured using the EORTC QLQ-C30 version 3.0 [29,30], 3) clinically significant distress measured on the one-item scale of the National Comprehensive Cancer Network Distress Thermometer (DT; Version 1.2013) [31,32], and 4) coping capacity as meaningfulness, manageability, and comprehensibility evaluated with the Sense of Coherence short-version scale (SOC 13 items) [33].

The following clinical variables were retrospectively obtained from patients' medical records: cancer diagnosis according to ICD-10 (Revision, 2016), ASA classification pertaining to physical status due to comorbidities before surgery, as assessed by a responsible anaesthesiologist [34], type of surgery [35], tumour staging [36], presence of adjuvant therapy post-surgery, length of hospital stay (number of days) in relation to the CRCS), number of phone calls to a cancer contact nurse pre-surgery and after discharge, number of visits to an emergency room after discharge, and number of hospital re-admissions. To compare the sample to the national population of people undergoing CRCS, anonymised data for selected variables during the study period were retrieved from the Swedish Register for Colorectal Cancer (Supplementary Table 3).

Questionnaires were distributed to the participants in person at the hospital and by post. Data collection was performed before surgery, at discharge, and four to six weeks, three months, and six months after surgery (see Supplementary Table). Clinical data were retrieved from patients' electronic medical records. Monitoring of patient inclusion was performed by dedicated research nurses. Data entry was performed twice (for further details see [27]).

## Statistical methods

For Objective 1 we used latent class growth models to identify subgroups (latent classes) that represent different

preparedness trajectory profiles [37,38]. We specified the models to account for non-linear trajectories by estimating change over time (slopes) for each time period. The trajectories of the four PCSQ dimensions were estimated simultaneously with correlated intercepts and slopes. For purposes of model identification, the intercepts of all trajectories were held constant at zero and the variances were estimated to be equal within each of the latent classes. Full information maximum likelihood was used to accommodate missing data on the PCSQ domains at one or more of the time points.

We determined the number of latent classes based on model fit, entropy (i.e., uncertainty in latent class membership), identification of classes that clearly distinguish different trajectories, and classes that are differentiated by demographic and clinical characteristics. Relative model fit was assessed based on the Bayesian Information Criterion (BIC) and by conducting bootstrapped (BLRT) and Vuong-Lo-Mendell-Rubin (VLMR) likelihood ratio tests to sequentially compare K and K-1 class models [39]. To determine the optimal number of classes, we considered clinical practice relevance (i.e., notably different trajectory profiles), as well as the statistical results.

To address Objective 2, we first described the sample and latent classes by comparing differences in demographic, diagnostic, treatment and care, and self-reported measures (health status, symptoms, sense of coherence). This was accomplished by conducting bivariate analyses using the "DCAT method" for categorical variables and the modified Bolck-Croon-Hagenaars (BCH) method procedures for continuous variables while accounting for uncertainty in latent class membership (entropy) [40,41]. To identify those variables that explain latent class membership, we subsequently conducted multivariable regressions using the 3-step procedure, while only considering those variables that were known pre-surgery [40,42]. We were guided by the purposeful variable selection approach to identify the variables that are most explanatory of latent class membership [43]. This includes first identifying all variables that are associated with latent class membership at  $p < 0.25$  or that are considered to be theoretically relevant. Subsequent multivariable regression analyses involved iteratively entering and removing variables and retaining only those variables with coefficient p-values of  $< 0.05$  or variables that resulted in a change of coefficient values greater than 20% for any of the other variables. We followed a hierarchical approach by first considering only the demographic variables, then adding the diagnosis and treatment variables, followed by the perceived health, symptoms and sense of coherence variables. Multiple imputation was used to accommodate a relatively small amount of missing data on the explanatory variables.

## Ethical considerations

Initially, oral information about the study was given to eligible patients at the three hospitals by a surgeon or registered nurse, and then written information was given to those interested. Before written consent was obtained from the participants, they were given the opportunity to pose

**Table 1.** Distributions of patient characteristics for the full sample and the six latent classes.

Variables	N	% / mean	Class 1 30.2%	Class 2 23.6%	Class 3 23.1%	Class 4 12.5%	Class 5 5.6%	Class 6 4.9%	$\chi^2$ (p) <sup>a</sup>
<b>Demographics</b>									
Sex (% female)	488	44	38	53	39	47	53	49	5.7 (.334)
Age (mean) <sup>b</sup>	483	68	69	68	67	69	67	70	1.9 (.860)
Employment (%)	476								12.2 (.270)
Working		32	30	35	34	26	35	24	
Retired		66	69	64	62	74	59	70	
Other		2	1	1	4	0	5	6	
Education (%)	473								15.9 (.388)
Elementary school		27	27	27	22	37	26	21	
High school		23	19	23	28	11	43	21	
University/college		32	39	30	27	35	19	41	
Other		18	15	20	23	17	13	16	
Cohabiting (% Yes)	470	72	77	66	73	72	73	59	3.3 (.769)
Having a partner (% Yes)	488	76	80	70	78	75	84	63	3.4 (.636)
Native language (% Swedish)	436	88	90	91	83	86	82	86	2.9 (.712)
Country of birth (% Swedish)	476	85	86	93	81	78	75	85	5.4 (.374)
Parents' country of birth (% Both Sweden)	476	82	87	88	78	66	80	85	7.1 (.217)
<b>Diagnoses</b>									
Type of cancer (% colon cancer)	477	60	38	40	40	43	34	51	1.6 (.900)
Tumour stage (%)	457								44.6 (.000)
I/II		31	32	39	28	26	20	29	
III		61	58	55	64	64	79	63	
IV		8	11	6	8	10	1	7	
ASA Class (% ASA 3/ASA 4)	485	19	86	86	72	74	86	78	8.4 (.134)
Presence of other cancer diagnosis in addition to the CRC (% Yes)	486	14	13	17	14	13	13	12	0.6 (.987)
<b>Treatments and care</b>									
Hospital (%)	488								85.3 (.000)
I (University hospital)		54	32	55	68	87	26	79	
II (Regional hospital)		19	21	23	13	6	44	17	
III (Local hospital)		27	48	23	19	8	30	4	
Type of surgery (%)	487								4.3 (.932)
Rectal resection		24	22	23	21	34	27	30	
Abdominoperineal rectal resection, or larger resection of colon with ostomy		15	15	16	18	5	14	16	
Rectal-sigmoid resection, or right hemicolectomy		61	63	61	62	61	60	54	
Laparoscopic surgery (% Yes)	487	29	30	34	25	24	40	13	8.3 (.142)
Ostomy (% Yes)	486	39	38	43	37	33	36	51	1.4 (.925)
Intervention (% Yes)	488	49	53	46	50	40	57	42	3.1 (.681)
# times in contact with assigned cancer contact nurse at the outpatient clinic before surgery (%):	486								15.6 (.113)
0		18	25	22	12	7	32	9	
1		48	43	48	53	48	41	45	
2/3		34	32	29	35	46	27	46	
# times in contact with assigned cancer contact nurse over the phone before surgery (%)	486								34.6 (.003)
0		50	40	49	52	68	59	56	
1		29	33	35	20	27	20	34	
2		13	16	11	19	3	5	6	
>=3		8	12	5	10	2	16	4	
Days of hospital stay (mean) <sup>c</sup>	487	7.5	7.0	8.0	7.0	8.2	7.2	8.6	6.4 (.265)
Presence of reoperation(s) (% Yes)	482	8	5	12	4	10	25	0	42.8 (.000)
At least one readmission (% Yes)	442	24	20	22	27	35	46	17	5.7 (.338)
Adjuvant chemotherapy (% Yes)	480	29	29	22	24	43	27	50	7.0 (.218)
<b>Self-perceived health</b>									
Global Health (mean: 0–100)	476	70.1	77.7	67.0	65.0	73.7	65.5	52.6	49.9 (.000)
Physical functioning (mean: 0–100)	474	85.4	88.2	84.2	81.6	85.5	89.8	81.5	10.3 (.067)
Role functioning (mean: 0–100)	470	80.0	86.1	74.3	74.4	84.7	80.9	71.1	15.6 (.008)
Emotional functioning (mean: 0–100)	476	72.5	79.2	67.4	68.3	78.6	72.9	58.1	30.7 (.000)
Cognitive functioning (mean: 0–100)	476	86.4	90.9	84.8	81.5	88.3	88.1	76.5	19.0 (.002)
Social functioning (mean: 0–100)	476	84.3	89.5	82.2	77.5	90.2	82.5	80.1	22.5 (.000)
Financial difficulties (% yes)	470	11	7	8	17	8	9	36	29.3 (.015)
<b>Symptoms</b>									
Distress thermometer (mean: 0-10)	408	3.1	2.4	3.8	3.6	2.8	2.6	4.8	33.9 (.000)
Fatigue (mean: 0-100)	474	27.9	23.7	29.8	33.4	22.4	33.3	35.0	14.0 (.016)
Nausea (mean: 0-100)	476	4.8	3.9	5.2	4.7	4.2	4.7	12.4	5.6 (.353)
Pain (mean: 0-100)	476	16.7	13.0	18.5	20.8	13.8	16.3	25.8	9.3 (.101)
Dyspnoea (% Yes)	469	41	38	45	54	34	29	50	51.9 (.000)

(continued)

Table 1. Continued.

Variables	N	% / mean	Class 1 30.2%	Class 2 23.6%	Class 3 23.1%	Class 4 12.5%	Class 5 5.6%	Class 6 4.9%	$\chi^2$ (p) <sup>a</sup>
Insomnia (% Yes)	473	59	43	68	69	43	62	<b>72</b>	28.8 (.017)
Appetite (% Yes)	474	31	28	38	36	12	39	<b>45</b>	63.1 (.000)
Constipation (% Yes)	474	27	19	27	26	38	<b>50</b>	41	54.6 (.000)
Diarrhoea (% Yes)	476	42	36	39	<b>53</b>	44	38	51	107.4 (.000)
<i>Sense of coherence</i>									
Meaningfulness (mean: 1–7)	466	4.2	4.1	4.2	4.2	4.0	4.3	<b>4.4</b>	9.3 (.100)
Manageability (mean: 1–7)	465	4.3	4.3	4.4	4.3	4.3	<b>4.5</b>	4.2	5.4 (.372)
Comprehensibility (mean: 1–7)	464	4.9	<b>5.3</b>	4.8	4.7	5.1	4.8	4.5	39.0 (.000)

**Notes.** Bolded fonts indicate the highest values among the classes.

<sup>a</sup>Wald chi-square test comparing differences across the six classes.

<sup>b</sup>Age range: 32–92 years.

<sup>c</sup>Calculated based on natural logarithm of days and subsequently exponentiated.

questions and talk with a nurse about what participation involved. Patients were instructed to contact the research nurses or researchers for questions about their participation, and emphasis was given to the voluntary nature of participating.

## Results

### Description of the participants

The sample ( $n = 488$ ) comprised people with a mean age of 68 years (SD = 11, range 32–92) of which 44% were women, 66% were retired, 72% were cohabiting, and 85% were born in Sweden (see Table 1). Regarding diagnoses, 60% had colon cancer, and 40% had rectal cancer. Further, 61% had tumour stage III (versus stages I, II, or IV), and 81% had ASA class I or II (i.e., healthy or mild systematic disease), versus ASA class 3 or 4 (i.e., severe systemic disease). Most patients (54%) received care in the university hospital, had a rectal-sigmoid resection or right hemicolectomy (61%), had open (non-laparoscopic) surgery (71%), and did not receive an ostomy (61%). Between timepoints 2 and 3, 71% of patients received adjuvant chemotherapy. The vast majority of patients had no re-operation (92%) and no re-admission (76%). As compared to the national population of people undergoing CRCs the sample had patients who were slightly younger, and more likely to have colon cancer, higher tumour stages, lower ASA classes, and an ostomy (Supplementary Table 3).

### Latent preparedness trajectories

Heterogeneity in patients' preparedness for surgery and recovery over time was observed (Figure 1). The latent class analysis identified six latent classes representing different preparedness for surgery and recovery trajectories profiles (see Table 2). Although the bootstrapped likelihood ratio test and BIC values suggest the possibility of 7 latent classes, one of the classes represented only 13 people, the model produced estimation errors, and there was no trajectory profile that was distinctly different from those based on the 6-class model. Conversely, the 6-class model revealed a 6<sup>th</sup> trajectory profile that was distinctly different from the 5-class model.

The six classes were observed to vary in levels of preparedness pre-surgery and over time (Figure 2). The trajectories of the four domains relative to each other were similar in all classes, with higher levels of understanding and involvement in care and for support and access to care, and lower levels of searching for and making use of information and making sense of recovery.

The classes had distinctly different preparedness trajectory profiles (see Figure 1). The largest class, Class 1 (30% of the sample), had the profile with the overall highest level of preparedness both before surgery (T0) and over time (T1–T4). Class 2 (23% of the sample) had a profile of high levels of preparedness before surgery (T0) and a gradual decrease at all of the following time points (T1–4), as well as slightly lower preparedness six months after surgery compared to Class 1. Class 3 (23% of the sample) had a profile of moderate levels of preparedness pre-surgery (T1) that were about the same level as in Class 2 at six months after the surgery. This class had relatively consistent levels of preparedness over time. Class 4 (13% of the sample) had a high level of preparedness before surgery (T0) with a decrease in preparedness at discharge from the hospital (T1) but almost returned to the pre-surgery levels of preparedness three months after (T3). Class 5 (6.0% of the sample) also had a profile of a high level of preparedness before surgery (T0), with a marked decrease in preparedness 4–6 weeks after surgery and an increase in preparedness six months after the surgery (T4), which was almost at the levels in Class 2. Class 6 (5.0% of the sample; the smallest class) had the lowest levels of preparedness both pre-surgery and over time as compared to the other classes. The trajectory profile in this class was unique in that there was a marked decrease in the dimension "Searching for and making use of information" before surgery (T0) to the time of discharge (T1), whereas "Making sense of recovery" was relatively more stable.

### Variables associated with latent preparedness trajectories

There were no differences in demographic variables across the six latent classes (see Table 1). However, the latent classes differed with respect to tumour stage (but none of the other diagnostic variables), the hospital, occurrence of re-operation, and times in contact with the assigned cancer

nurse (but no other treatment care variables). There were also differences across the latent classes for several of the self-perceived health dimensions, including role, emotional, cognitive and social functioning, and financial difficulties. Global health differed across the latent classes but not physical functioning. There were also differences in the severity of most symptoms, including distress, fatigue, dyspnoea, insomnia, appetite, constipation, and diarrhoea (but not pain and nausea). Regarding sense of coherence, there were differences across the latent classes at the level of comprehensibility, but not the other two dimensions (meaningfulness and manageability).

Results of the multivariable logistic regression analyses suggest that the latent classes (i.e., representing different preparedness trajectories profiles) are predominantly explained by differences in age, sex, ASA classification, treatment hospital, global health, distress, and comprehensibility and meaningfulness (see Figure 3). Even though the confidence intervals for several of the variables (including age, sex, ASA classification and SOC meaningfulness) span the nominal value of 1, the removal of these variables resulted in substantial changes in the coefficients of other explanatory variables. With respect to diagnoses, only ASA classification was retained, with people in latent classes 4 and 3 having greater odds and people in class 2 lower odds of having higher ASA classification (i.e., lower

physical status due to comorbidities) relative to people in class 1. For the treatment and care variables, only hospital was retained as an explanatory variable. Patients' trajectories of preparedness were in part explained by the different hospitals where they received care, with patients in classes 2, 3, 4, and 6 having lower odds of having received care in the regional hospital. Latent class membership was also explained by global health scores, with people in classes 2, 3, 5 and 6 being less likely to have higher scores relative to class 1. However, none of the other domains of self-perceived health were retained in the final model. With respect to sense of coherence, latent class membership was predominantly explained by comprehensibility, with people in class 1 having higher comprehensibility scores relative to any of the other classes. Additionally, although the latent classes are similar with respect to meaningfulness, this variable was retained because of its associations with other explanatory variables in the final model (i.e., removing this variable resulted in substantial differences in the coefficients for several of the variables).

## Discussion

Our results reveal that trajectories of preparedness before colorectal cancer surgery and during six months after are not homogeneous. We distinguished six different preparedness

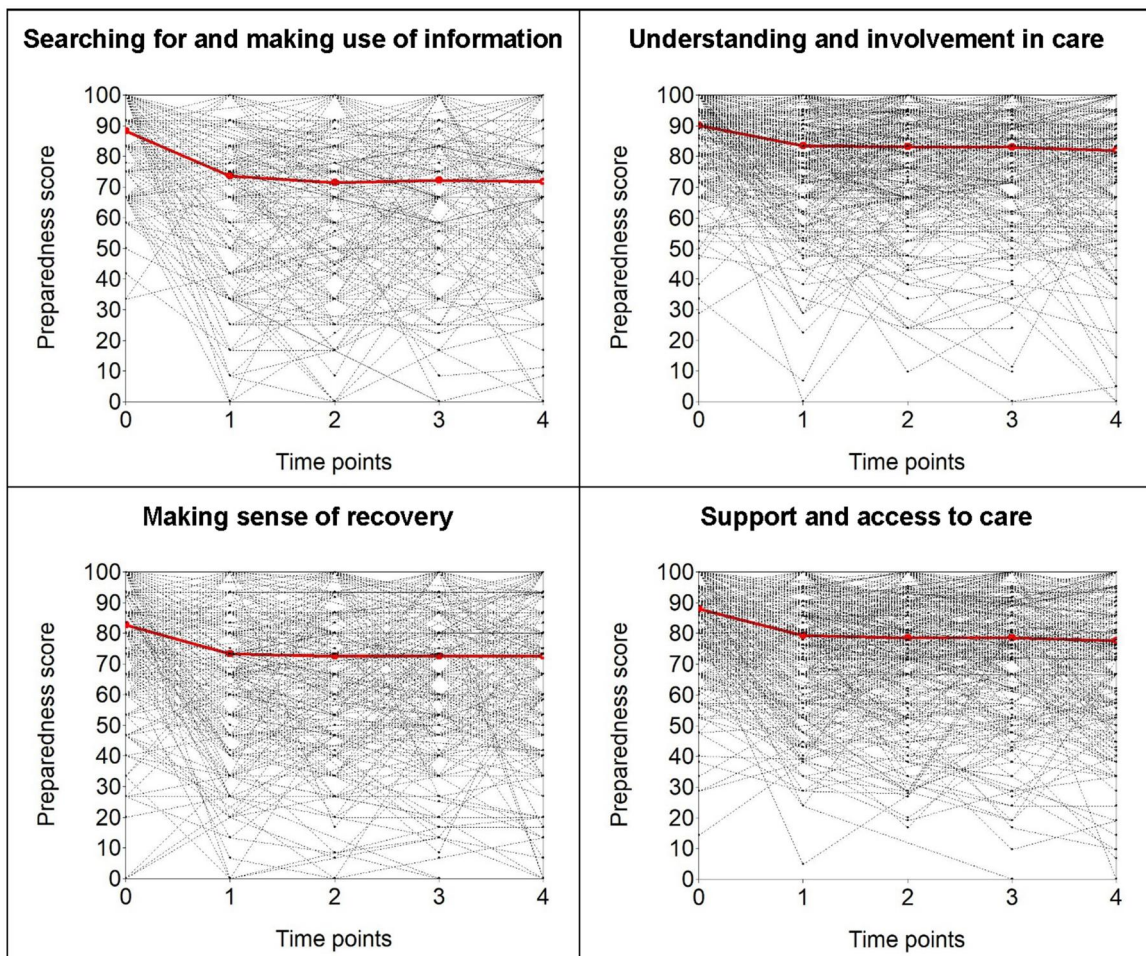


Figure 1. Average and observed individual preparedness for surgery and recovery trajectories.

**Table 2.** Fit statistics and class proportions for latent classes models.

K	P	LL	BIC	VLMR <i>p</i> -value	BLRT <i>p</i> -value	Entropy	Class proportions <sup>a</sup>						
							Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7
1	50	-33095	66501				1						
2 <sup>b</sup>	71	-32537	65513	.000	.000	0.91	0.31	0.69					
3	92	-32348	65265	.075	.000	0.85	0.11	0.29	0.60				
4	113	-32177	65054	.495	.000	0.83	0.16	0.49	0.06	0.29			
5	134	-32048	64926	.244	.000	0.82	0.05	0.25	0.27	0.30	0.13		
6	155	-31961	64882	.513	.000	0.82	0.06	0.24	0.23	0.30	0.05	0.13	
7 <sup>b</sup>	176	-31884	64858	.507	.000	0.81	0.29	0.06	0.03	0.27	0.12	0.10	0.14

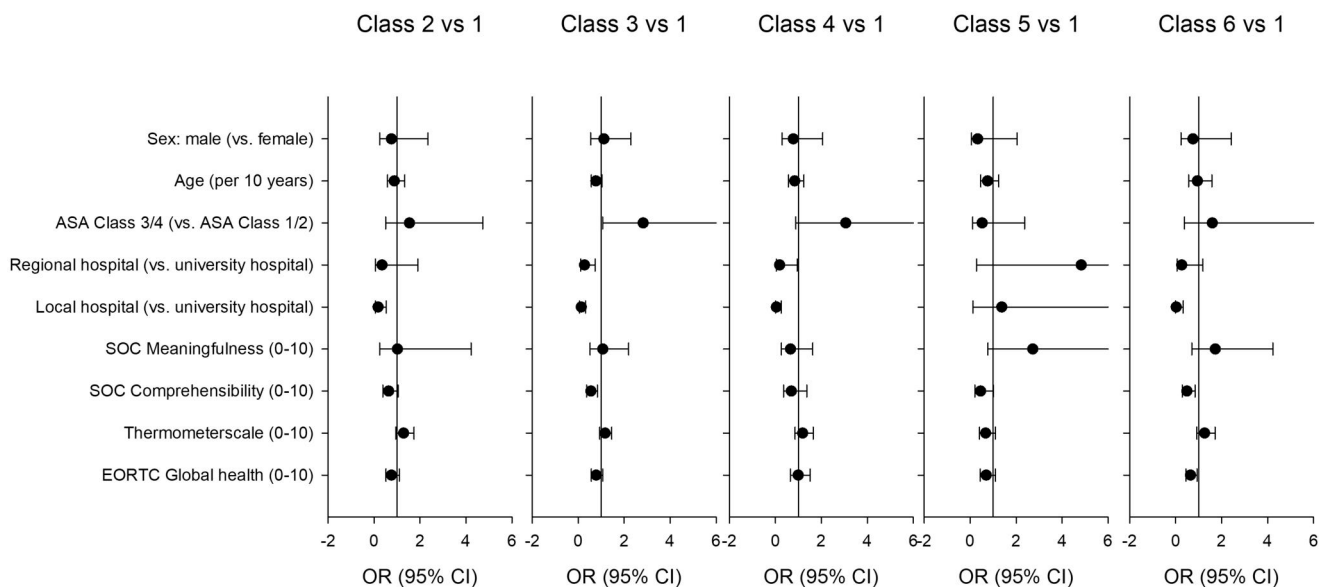
**Notes.** *N* = 488, *K* = Number of latent classes in the model. *P* = number of estimated parameters. LL = log likelihood. BIC = Bayesian information criterion (sample-size adjusted). VLMR *p*-value = Vuong-Lo-Mendell-Rubin likelihood ratio test *p*-value.

<sup>a</sup>Probability of latent class membership predicted by the model.

<sup>b</sup>Unreliable estimation due to non-positive definite matrix.



**Figure 2.** Six classes representing different preparedness for surgery and recovery trajectory profiles.



**Figure 3.** Odds ratios for the variables that explain different preparedness for surgery and recovery trajectories profiles represented by the six latent classes.

**Note.** To facilitate comparison, all continuous variables were rescaled to range from 0 to 10.

trajectory profiles explained by differences in patients' age, sex, physical health status and their reports of global health, distress, comprehensibility and meaningfulness as dimensions of coping capacity, and also type of hospital. Contrary to expectation, demographic characteristics, type of cancer, physical and social functioning, and pain were not associated with latent class membership. Moreover, the conventional biomedical variables (type of cancer, surgery etc.) were found to be less explanatory of a patient's preparedness for surgery and recovery following surgery, an example being that undergoing surgery and receiving a stoma were not associated with the latent classes.

The overall results point to a need for different strategies to support patients throughout the illness trajectory. People generally feel more prepared before surgery, but this declines after surgery. Quite a few people have a need for additional support at or following discharge to manage when they are at home. Taken together, this highlights the importance of eliciting and assessing how people are doing from their point of view, for example, by using patient reported outcome measures and narrative interviews. The identification of comprehensibility and meaningfulness among the predictors suggests that the patient's personal resources could influence their preparedness. In this way, it would be important to take patients' internal resources into account in both consultation conversations and when measuring patient-reported outcomes, and not only focus on the more common symptoms and dimensions of QoL. However, there is always a risk of stigmatizing individuals with lower sense of coherence as incapable or frail on group level. This may bring about overly protective care initiatives that in turn will be counterproductive towards the idea of trusting and allowing individuals to be resourceful and capable. In response, person-centred communication [44] and the development of novel interventions is suggested.

Cancer rehabilitation policy, for example, as described in Swedish national guidelines, emphasizes actions to address multidimensional aspects of patients' needs. This places the person with the illness within their social context and takes a holistic view with long term strategies. With the idea of cancer rehabilitation beginning at the time of diagnosis (a.k.a. prehabilitation) [45], this concept can be well aligned with the findings of this study on supporting patients' preparedness. If vulnerable individuals can be identified early, resources can be better apportioned and hopefully improve outcomes concerning the issues of cancer rehabilitation. Since a Turkish version of the PCSQ suggests ability to differentiate highly prepared patients from those less prepared [46], the PCSQ could be evaluated for the purpose of being used as part of patient assessment in practice.

### Limitations

The sample is relatively small for this type of analysis. In addition, there are many other individual differences that are not represented in the sample, which may lead to other trajectories in other samples. Thus, replication studies are strongly recommended. Further, the exclusion criteria imply

the sample was selected in ways that excluded the most vulnerable patients, who may also have been less inclined to participate. For example, patients undergoing emergency surgery, who have reduced cognitive function, or who received pre-surgery anti-tumoral treatments might contribute to additional heterogeneity in preparedness trajectory profiles.

The analysis is explorative, with the goal to stimulate further person-centred theoretical development and research that draws attention to heterogeneity and individual differences [47,48]. We explored the plausibility of heterogeneity in preparedness trajectories and whether we could get some insights into explanations of heterogeneity as an impetus for motivating a research agenda and challenging the conventional nomothetic approach to focus only on population averages. These types of analyses have sometimes been referred to as a quantitative approach to intersectionality research [49]. Thus, interpretations should be made along the lines of inferences based on qualitative research. Strong claims about clinical application would be premature.

### Conclusion

Overall, the result shows that patients' preparedness trajectories are heterogeneous; these variations in patients' trajectories reveal differences that are of importance for both pre and post cancer surgery care. A suggested hypothesis generated from the results is that individual differences in preparedness trajectories exist not only because of clinical differences, but also because of differences in ways how people perceive their health and their social living circumstances. Contrary to the received view emphasising standardised care practices, our results point to the need for person-centred and tailored approaches that consider individual differences in how patients are prepared before and during recovery from colorectal cancer surgery. The results suggest consideration of patients' perceptions of their health and coping capacity when tailoring pre- and post-operative care to individual patients' situations, thus emphasizing the need for person-centred care.

### Acknowledgments

Thank you to all the professionals involved for all efforts made to support the project and for invaluable contributions by: the research nurse assistants Matilda Örn, Anneli Ringström, Marina Modin and Nina Blommé; to the facilitators Anna Garpenbeck, Karin Hassel, Anna Johansson, Sabina Kalabic, Gunilla Kokko, Lotta Kämpe, Simona Magnusson, Monika Silebäck and Stefan Skullman; to co-investigators Febe Friberg, Lars-Christier Hydén, Karl Kodeda, Dimitrios Kokkinakakis, Sylvia Määttä and Catarina Wallengren, and to Lena Hansson Ström and Marie Tauson for initiating the discussion and paving the way for the project.

### Ethical approval

Approval from the Regional Ethical Review Board in Gothenburg was obtained (Dnr 536-12).

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Funding

This work was supported by the Centre for Person-Centred Care at the University of Gothenburg (GPCC; funded by the Swedish Government's grant for Strategic Research Areas – Care Sciences and co-funded by the University of Gothenburg, Sweden), and The Healthcare Board, Region Västra Götaland (Hälsa- och sjukvårdsstyrelsen), Sweden. This research was undertaken, in part, thanks to funds from the Canada Research Chairs (CRC) program supporting Dr. Sawatzky's CRC in Person-Centered Outcomes.

## Data availability statement

Data cannot be shared publicly because the questionnaires include sensitive data about health status. The ethical approval by the Regional Ethical Review Board in Gothenburg, Sweden includes a statement that the data will be kept in a private repository. Requests for the data used in our analyses can be made to Swedish National Data Service [✉](mailto:snd@gu.se) [snd@gu.se](mailto:snd@gu.se).

## References

- [1] Taylor C, Richardson A, Cowley S. Restoring embodied control following surgical treatment for colorectal cancer: a longitudinal qualitative study. *Int J Nurs Stud.* 2010; 47(8):946–956. doi: [10.1016/j.ijnurstu.2009.12.008](https://doi.org/10.1016/j.ijnurstu.2009.12.008).
- [2] Jakobsson J, Kumlien C. Everyday challenges following hospital discharge. A multi-method study identifying and describing areas of concern for patients during the first month after colorectal cancer surgery. *Nurs Open.* 2023;10(4):2172–2181. doi: [10.1002/nop2.1465](https://doi.org/10.1002/nop2.1465).
- [3] Foster C, Haviland J, Winter J, et al. Pre-surgery depression and confidence to manage problems predict recovery trajectories of health and wellbeing in the first two years following colorectal cancer: results from the CREW cohort study. *PLOS One.* 2016; 11(5):e0155434. doi: [10.1371/journal.pone.0155434](https://doi.org/10.1371/journal.pone.0155434).
- [4] Winterling J, Wasteson E, Glimelius B, et al. Substantial changes in life: perceptions in patients with newly diagnosed advanced cancer and their spouses. *Cancer Nurs.* 2004;27(5):381–388. doi: [10.1097/00002820-200409000-00008](https://doi.org/10.1097/00002820-200409000-00008).
- [5] Allvin R, Berg K, Idvall E, et al. Postoperative recovery: a concept analysis. *J Adv Nurs.* 2007;57(5):552–558. doi: [10.1111/j.1365-2648.2006.04156.x](https://doi.org/10.1111/j.1365-2648.2006.04156.x).
- [6] Jakobsson J, Idvall E, Kumlien C. Patient characteristics and surgery-related factors associated with patient-reported recovery at 1 and 6 months after colorectal cancer surgery. *Eur J Cancer Care (Engl).* 2017; 26(6):e12715. doi: [10.1111/ecc.12715](https://doi.org/10.1111/ecc.12715).
- [7] Norlyk A, Harder I. Recovering at home: participating in a fast-track colon cancer surgery programme. *Nurs Inq.* 2011; 18(2): 165–173. doi: [10.1111/j.1440-1800.2011.00519.x](https://doi.org/10.1111/j.1440-1800.2011.00519.x).
- [8] Jakobsson J, Idvall E, Kumlien C. The lived experience of recovery during the first 6 months after colorectal cancer surgery. *J Clin Nurs.* 2017; 26(23–24):4498–4505. doi: [10.1111/jocn.13780](https://doi.org/10.1111/jocn.13780).
- [9] Mekhael M, Larsen HM, Lauritzen MB, et al. Bowel dysfunction following pelvic organ cancer: a prospective study on the treatment effect in nurse-led late sequelae clinics. *Acta Oncol.* 2023; 62(1):70–79. doi: [10.1080/0284186X.2023.2168214](https://doi.org/10.1080/0284186X.2023.2168214).
- [10] Smith F, Öhlén J, Persson LO, et al. Daily assessment of stressful events and coping in early post-operative recovery after colorectal cancer surgery. *Eur J Cancer Care.* 2018;27(2):e12829. doi: [10.1111/ecc.12829](https://doi.org/10.1111/ecc.12829).
- [11] Friberg F, Andersson EP, Bengtsson J. Pedagogical encounters between nurses and patients in a medical ward—a field study. *Int J Nurs Stud.* 2007;44(4):534–544. doi: [10.1016/j.ijnurstu.2005.12.002](https://doi.org/10.1016/j.ijnurstu.2005.12.002).
- [12] Hebert RS, Prigerson HG, Schulz R, et al. Preparing caregivers for the death of a loved one: a theoretical framework and suggestions for future research. *J Palliat Med.* 2006;9(5):1164–1171. doi: [10.1089/jpm.2006.9.1164](https://doi.org/10.1089/jpm.2006.9.1164).
- [13] Lithner M, Klefsjard R, Johansson J, et al. The significance of information after discharge for colorectal cancer surgery—a qualitative study. *BMC Nurs.* 2015;14(1):36. doi: [10.1186/s12912-015-0086-6](https://doi.org/10.1186/s12912-015-0086-6).
- [14] Carlsson E, Pettersson M, Öhlén J, et al. Development and validation of the preparedness for colorectal cancer surgery questionnaire: PCSQ-pre 24. *Eur J Oncol Nurs.* 2016;25:24–32. doi: [10.1016/j.ejon.2016.09.002](https://doi.org/10.1016/j.ejon.2016.09.002).
- [15] Scherer S, Jansen L, Boakye D, et al. Changes in health-related outcomes among colorectal cancer patients undergoing inpatient rehabilitation therapy: a systematic review of observational and interventional studies. *Acta Oncol.* 2021;60(1):124–134. doi: [10.1080/0284186X.2020.1828620](https://doi.org/10.1080/0284186X.2020.1828620).
- [16] Walming S, Asplund D, Block M, et al. Patients with rectal cancer are satisfied with in-hospital communication despite insufficient information regarding treatment alternatives and potential side-effects. *Acta Oncol.* 2018;57(10):1311–1317. doi: [10.1080/0284186X.2018.1484158](https://doi.org/10.1080/0284186X.2018.1484158).
- [17] Carlsson E, Berndtsson I, Hallén A-M, et al. Concerns and quality of life before surgery and during the recovery period in patients with rectal cancer and an ostomy. *J Wound Ostomy Continence Nurs.* 2010;37(6):654–661. doi: [10.1097/WON.0b013e3181f90f0c](https://doi.org/10.1097/WON.0b013e3181f90f0c).
- [18] Kehlet H, Wilmore DW. Evidence-based surgical care and the evolution of fast-track surgery. *Ann Surg.* 2008; 248(2):189–198. doi: [10.1097/SLA.0b013e31817f2c1a](https://doi.org/10.1097/SLA.0b013e31817f2c1a).
- [19] Lv L, Shao YF, Zhou YB. The enhanced recovery after surgery (ERAS) pathway for patients undergoing colorectal surgery: an update of meta-analysis of randomized controlled trials. *Int J Colorectal Dis.* 2012; 27(12):1549–1554. doi: [10.1007/s00384-012-1577-5](https://doi.org/10.1007/s00384-012-1577-5).
- [20] Friberg F, Wallengren C, Håkanson C, et al. Exploration of dynamics in a complex person-centred intervention process based on health professionals' perspectives. *BMC Health Serv Res.* 2018; 18(1):441. doi: [10.1186/s12913-018-3218-3](https://doi.org/10.1186/s12913-018-3218-3).
- [21] Ishino FAM, Odame EA, Villalobos K, et al. A national study of colorectal cancer survivorship disparities: a latent class analysis using SEER (surveillance, epidemiology, and end results) registries. *Front Public Health.* 2021;9:111.
- [22] Strong C, Ji CS, Liang W, et al. Heterogeneous demographic and cultural profiles of non-adherent Chinese-American patients to colorectal cancer screening: a latent class analysis. *Cancer Nurs.* 2014;37(2):106–113. doi: [10.1097/NCC.0b013e3182888b5b](https://doi.org/10.1097/NCC.0b013e3182888b5b).
- [23] Ishino FAM, Odame EA, Villalobos K, et al. Applying latent class analysis on cancer registry data to identify and compare health disparity profiles in colorectal cancer surgical treatment delay. *J Public Health Manag Pract.* 2022;28(2):E487.
- [24] Clouth FJ, Moncada-Torres A, Geleijnse G, et al. Heterogeneity in quality of life of long-term colon cancer survivors: a latent class analysis of the population-based PROFILES registry. *Oncologist.* 2021;26(3):e492–e499. doi: [10.1002/onco.13655](https://doi.org/10.1002/onco.13655).
- [25] Kenzik KM, Martin MY, Fouad MN, et al. Health-related quality of life in lung cancer survivors: latent class and latent transition analysis. *Cancer.* 2015;121(9):1520–1528. doi: [10.1002/cncr.29232](https://doi.org/10.1002/cncr.29232).
- [26] Muthén B, Muthén LK. Integrating person-centered and variable-centered analyses: growth mixture modeling with latent trajectory classes. *Alcohol: clin Exp Res.* 2000;24(6):882–891.
- [27] Öhlén J, Sawatzky R, Pettersson M, et al. Preparedness for colorectal cancer surgery and recovery through a person-centred information and communication intervention—A quasi-experimental longitudinal design. *PLOS One.* 2019;14(12):e0225816. doi: [10.1371/journal.pone.0225816](https://doi.org/10.1371/journal.pone.0225816).
- [28] Sawatzky R, Russell L, Friberg F, et al. Longitudinal person-centered measurement: a psychometric evaluation of the preparedness for colorectal cancer surgery questionnaire (PCSQ).

- Patient Educ Couns. 2017;100(5):827–835. doi: [10.1016/j.pec.2016.11.010](https://doi.org/10.1016/j.pec.2016.11.010).
- [29] Aaronson NK, Ahmedzai S, Bergman B, et al. The European organization for research and treatment of cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology. *J Natl Cancer Inst*. 1993;85(5):365–376. doi: [10.1093/jnci/85.5.365](https://doi.org/10.1093/jnci/85.5.365).
- [30] Derogar M, van der Schaaf M, Lagergren P. Reference values for the EORTC QLQ-C30 quality of life questionnaire in a random sample of the Swedish population. *Acta Oncol*. 2012; 51(1):10–16. doi: [10.3109/0284186X.2011.614636](https://doi.org/10.3109/0284186X.2011.614636).
- [31] Donovan KA, Grassi L, McGinty HL, et al. Validation of the distress thermometer worldwide: state of the science. *Psychooncology*. 2014;23(3):241–250. doi: [10.1002/pon.3430](https://doi.org/10.1002/pon.3430).
- [32] Sarenmalm EK, Nasic S, Håkanson C, et al. Swedish version of the distress thermometer: validity evidence in patients With colorectal cancer. *J Natl Compr Canc Netw*. 2018;16(8):959–966. doi: [10.6004/jnccn.2018.7027](https://doi.org/10.6004/jnccn.2018.7027).
- [33] Eriksson M, Lindström B. Validity of Antonovsky's sense of coherence scale: a systematic review. *J Epidemiol Community Health*. 2005; 59(6):460–466. doi: [10.1136/jech.2003.018085](https://doi.org/10.1136/jech.2003.018085).
- [34] Anesthesiologists APSCSMSo. [www.asahq.org](http://www.asahq.org). Accessed June 30, 2023. 2014.
- [35] statistics NCoSPNHw. [www.nhwstat.org](http://www.nhwstat.org). Accessed June 30, 2023.
- [36] Control TCoMTUfIC. [www.uicc.org](http://www.uicc.org). Accessed. June 30, 2023.
- [37] Ram N, Grimm KJ. Growth mixture modeling: a method for identifying differences in longitudinal change among unobserved groups. *Int J Behav Dev*. 2009;33(6):565–576. doi: [10.1177/0165025409343765](https://doi.org/10.1177/0165025409343765).
- [38] Heck RH, Thomas SL. An introduction to multilevel modeling techniques: MLM and SEM approaches using mplus. Third edition. ed. New York, NY: Routledge, Taylor & Francis Group; 2015.
- [39] Nylund KL, Asparouhov T, Muthén BO. Deciding on the number of classes in latent class analysis and growth mixture modeling: a monte carlo simulation study. *Struct Equ Modeling: A Multidiscipli J*. 2007;14(4):535–569. doi: [10.1080/10705510701575396](https://doi.org/10.1080/10705510701575396).
- [40] Asparouhov T, Muthén B. Auxiliary variables in mixture modeling: three-step approaches using M plus. *Mplus Web Notes No 15*. 2014;<http://www.statmodel.com> Assessed. June 30, 2023.
- [41] Lanza ST, Tan X, Bray BC. Latent class analysis with distal outcomes: a flexible model-based approach. *Struct Equ Modeling*. 2013;20(1):1–26. doi: [10.1080/10705511.2013.742377](https://doi.org/10.1080/10705511.2013.742377).
- [42] Bakk Z, Kuha J. Relating latent class membership to external variables: an overview. *Br J Math Stat Psychol*. 2021;74(2):340–362. doi: [10.1111/bmsp.12227](https://doi.org/10.1111/bmsp.12227).
- [43] Hosmer DW, JrLemeshow S, Sturdivant RX. Jr. Model-building strategies and methods for logistic regression. In: Hosmer DW, Lemeshow S, Sturdivant RX, editors. *Applied logistic regression* (Vol. 398). Hoboken (NJ): John Wiley & Sons; 2013. p. 89–151.
- [44] Öhlén J, Friberg F. Person-centred conversations in nursing and health: a theoretical analysis based on perspectives on communication. *Nurs Philos*. 2023;24(3):e12432. doi: [10.1111/nup.12432](https://doi.org/10.1111/nup.12432).
- [45] Molenaar CJ, van Rooijen SJ, Fokkenrood HJ, et al. Prehabilitation versus no prehabilitation to improve functional capacity, reduce postoperative complications and improve quality of life in colorectal cancer surgery. *Cochrane Database Syst Rev*. 2022;5(5):Cd013259. doi: [10.1002/14651858.CD013259.pub2](https://doi.org/10.1002/14651858.CD013259.pub2).
- [46] Sutsunbuloglu E, Vural F, Altintas SB, et al. Psychometric properties of the Turkish version of The Preparedness for Colorectal Cancer Surgery Questionnaire (PCSQ-TR). *J Perianesth Nurs*. 2022; 37(5):640–645. doi: [10.1016/j.jjapan.2021.10.010](https://doi.org/10.1016/j.jjapan.2021.10.010).
- [47] Howard MC, Hoffman ME. Variable-centered, person-centered, and person-specific approaches: where theory meets the Method. *Organ Res Meth*. 2018;21(4):846–876. doi: [10.1177/1094428117744021](https://doi.org/10.1177/1094428117744021).
- [48] McCormack B, Dulmen Sv, Eide H, et al *Person-centred healthcare research*. Chichester: John Wiley & Sons Ltd.; 2017.
- [49] Bauer GR, Churchill SM, Mahendran M, et al. Intersectionality in quantitative research: a systematic review of its emergence and applications of theory and methods. *SSM Popul Health*. 2021;14: 100798. doi: [10.1016/j.ssmph.2021.100798](https://doi.org/10.1016/j.ssmph.2021.100798).