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Association between health-promoting behaviour patterns and nutritional risk among colorectal cancer survivors: a cross-sectional study in a primary care setting

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Abstract

Background

Colorectal cancer survivors may experience persistent nutritional problems, but the association between their health-promoting behaviour patterns and nutritional risk is poorly understood.

Methods

We conducted a cross-sectional study in a primary care setting in Shanghai, China. Latent profile analysis identified patterns of health-promoting behaviour, and logistic regression examined their associations with nutritional risk.

Results

Of 207 questionnaires distributed, 203 valid responses were analysed; 58.62% of participants were men and 60.1% were aged ≥ 70 years. Three profiles were identified: high-level (n = 29, 14.3%), moderate-level (n = 91, 44.8%), and low-level (n = 83, 40.9%). Nutritional risk was present in 27.09% of participants, with prevalences of 42.2%, 18.7%, and 10.3% in the low-level, moderate-level, and high-level profiles, respectively ($p < 0.001$). Compared with the low-level profile, the moderate-level and high-level profiles had lower adjusted odds of nutritional risk (odds ratio [OR] 0.31, 95% CI 0.14–0.67; and OR 0.10, 95% CI 0.02–0.34, respectively). Participants aged ≥ 70 years had higher odds than those aged ≤ 60 years (OR 5.25, 95% CI 1.21–33.41). A longer time since diagnosis was associated with lower odds of nutritional risk.

Conclusions

These findings suggest that survivors with low levels of health-promoting behaviour may warrant closer nutritional assessment in primary care. Longitudinal studies are needed to clarify the direction of these associations.

Introduction

Advances in screening and treatment have improved survival after colorectal cancer, and more people are living with and beyond the disease (1). Colorectal cancer is also one of the most commonly diagnosed malignancies in China (2). Longer survival, however, does not necessarily mean better quality of life. After completing treatment, survivors may still have unmet needs related to symptom management, nutrition, and psychosocial support (3, 4). Identifying modifiable factors associated with these needs could help guide long-term survivorship care in community and primary care settings.

Health-promoting behaviour includes diet, physical activity, stress management, health responsibility, and interpersonal support, all of which are modifiable aspects of survivorship care (5). Diet, physical activity, and weight management have been associated with recurrence, mortality, and health-related quality of life among colorectal cancer survivors (6, 7). These behaviours often occur together, and examining them separately may overlook differences in overall behavioural patterns and their associations with health outcomes (8). Person-centred approaches have been used to examine combinations of health behaviours in cancer survivors (9, 10). Latent profile analysis (LPA) uses continuous indicators to identify subgroups with distinct profiles. These profiles may help identify supportive-care needs and inform tailored interventions.

Nutritional problems can persist after colorectal cancer treatment. Surgery, radiotherapy, and chemotherapy can affect digestive function and contribute to diarrhoea, malabsorption, and reduced appetite. Nutritional status and health-promoting behaviour may also influence each other: nutritional problems may limit healthy behaviours, while poor diet and other behavioural patterns may worsen nutritional status. A meta-analysis of 35 studies involving 9278 colorectal cancer survivors reported an overall malnutrition prevalence of 47.78% (11). Treatment-related adverse effects may further compromise nutritional status (12). Malnutrition is associated with impaired immune function, greater treatment toxicity, and poorer survival (11, 12). Nutritional screening helps identify people who may benefit from further nutritional assessment and support (13, 14). The extent to which hospital-based findings apply to community-dwelling survivors remains unclear, as does the association between multidimensional health-promoting behaviour patterns and nutritional risk in primary care.

This cross-sectional study aimed to identify profiles of health-promoting behaviour among community-dwelling colorectal cancer survivors and examine their association with nutritional risk. We also examined sociodemographic and clinical factors associated with nutritional risk. The findings may help identify survivors who need further nutritional assessment and inform health-promotion and nutritional-support strategies in primary care.

Methods

Study design and participants

Colorectal cancer survivors were recruited by convenience sampling from Changning District, Shanghai, China. Participants were eligible if they were aged 18 years or older, had a histopathological diagnosis of colorectal cancer, had completed initial treatment (surgery, radiotherapy, or chemotherapy) at least 6 months earlier, and were aware of their condition and willing to participate. Survivors with severe post-treatment complications, cognitive or psychiatric disorders, or an inability to complete or tolerate the assessment were excluded. The study was approved by the Ethics Committee of Beixinjing Community Health Service Center, Changning District (approval no. BXJ2020-06-08), and conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent before enrolment.

Sample size estimation

Sample size planning used a rule of thumb of 5–10 participants per variable for multivariable analysis. The calculation included 18 variables: 9 from the general information questionnaire, 6 from the Health-Promoting Lifestyle Profile II (HPLP-II) (15), and 3 from the Nutritional Risk Screening 2002 (NRS-2002) (16). Using 10 participants per variable gave a minimum sample size of 180. Allowing for an anticipated non-response rate of approximately 10%, the target was set at 200 participants.

Measurement instruments

Health-promoting behaviour was assessed using the HPLP-II, which contains 52 items across six domains: health responsibility, exercise, interpersonal relationships, stress management, spiritual growth, and nutrition. The validated Chinese version of HPLP-II used here has been previously published and has shown good reliability and validity (15). Each item is rated on a 4-point Likert scale (1–4). Item scores are summed to give a total score of 52–208, with higher scores indicating more frequent health-promoting behaviours. For descriptive purposes, total scores were classified a priori as poor (52–90), fair (91–129), good (130–168), or excellent (169–208). For comparison across domains, domain scores were also expressed as a percentage of the maximum possible score.

Nutritional risk was assessed using the Nutritional Risk Screening 2002 (NRS-2002). Kondrup et al. and an ad hoc working group of the European Society for Parenteral and Enteral Nutrition (ESPEN) developed the tool using evidence from 128 controlled clinical trials. In China, the NRS-2002 has been issued as a national health industry standard (WS/T 427–2013) (16). The final screening score combines impaired nutritional status (0–3 points) and disease severity as an indicator of increased nutritional requirements (0–3 points). Participants aged 70 years or older receive one additional point. Total scores range from 0 to 7, with scores of ≥ 3 indicating nutritional risk.

Sociodemographic and clinical characteristics were also collected, including age, sex, marital status, employment status, educational attainment, monthly household income per capita, clinical stage, stoma status, and time since cancer diagnosis.

Data collection

Trained investigators administered the cross-sectional questionnaire survey. Before distributing questionnaires, they explained the study purpose, rationale, and completion requirements using standardised information and obtained informed consent. Participants completed the questionnaires anonymously, with investigators available to answer questions. For participants who needed assistance, a trained investigator read each item aloud neutrally and recorded the responses verbatim. Completed questionnaires were checked on site, and participants were invited to fill in any missing responses.

Quality control

Participants were selected according to the inclusion and exclusion criteria, and a pilot survey was conducted. Questionnaires were administered and collected on site. Those with missing items or uniform or patterned responses were excluded as invalid. Two investigators entered the data independently and cross-checked the entries against each questionnaire.

Statistical analysis

Data were entered independently by two investigators into Microsoft Excel 2019 (Microsoft Corporation, Redmond, WA, USA), checked for accuracy, and analysed using R version 4.4.2 (R Core Team, Vienna, Austria). Continuous variables are reported as mean (standard deviation) or median (interquartile range), as appropriate, and categorical variables as frequency (percentage). LPA of the six HPLP-II domain scores was used to identify health-promoting behaviour profiles. Model selection considered the Bayesian information criterion, entropy, and interpretability. Participant characteristics were compared across the three selected profiles. Continuous variables were compared using one-way analysis of variance when the assumptions of normality and homogeneity of variance were met; otherwise, the Kruskal-Wallis test was used. Categorical variables were compared using Pearson's χ^2 test, or Fisher's exact test (Fisher-Freeman-Halton extension for r × c tables) when any expected cell count was below 5; the test used for each variable is indicated in Table 1. Factors associated with nutritional risk were examined using Firth's penalized logistic regression (logistf package in R), which yields finite odds ratio estimates in the presence of sparse data or complete separation; 95% confidence intervals were derived from the profile penalized likelihood, and p values from penalized likelihood ratio tests. Variables with $p < 0.05$ in univariable analyses were entered into a multivariable Firth logistic regression model, and results are reported as odds ratios with 95% confidence intervals. Exploratory subgroup analyses were conducted by sex and primary tumour site, with separate unadjusted models fitted within each subgroup. All tests were two-sided, with $p < 0.05$ considered statistically significant.

Table 1
Sociodemographic and clinical characteristics of participants by health-promoting behaviour profile

Characteristic	Health-promoting behaviour profiles				
	Low-level (n = 83)	Moderate-level (n = 91)	High-level (n = 29)	Total (n = 203)	p value
Ethnicity					—
Han	83 (100.0%)	91 (100.0%)	29 (100.0%)	203 (100.0%)	
Ethnic minority	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Age					0.039
≤ 60 years	3 (3.6%)	12 (13.2%)	6 (20.7%)	21 (10.3%)	
61–69 years	30 (36.1%)	23 (25.3%)	7 (24.1%)	60 (29.6%)	
≥ 70 years	50 (60.2%)	56 (61.5%)	16 (55.2%)	122 (60.1%)	
Sex					0.002
Male	59 (71.1%)	50 (54.9%)	10 (34.5%)	119 (58.6%)	
Female	24 (28.9%)	41 (45.1%)	19 (65.5%)	84 (41.4%)	
Marital status					0.018
Married	63 (75.9%)	83 (91.2%)	26 (89.7%)	172 (84.7%)	
Unmarried, divorced, or widowed	20 (24.1%)	8 (8.8%)	3 (10.3%)	31 (15.3%)	
Education					0.014
Primary school or below	18 (21.7%)	8 (8.8%)	2 (6.9%)	28 (13.8%)	
Junior high school	37 (44.6%)	57 (62.6%)	14 (48.3%)	108 (53.2%)	
Senior high / technical secondary	24 (28.9%)	18 (19.8%)	7 (24.1%)	49 (24.1%)	
College degree or above	4 (4.8%)	8 (8.8%)	6 (20.7%)	18 (8.9%)	
Employment status					0.018

Data are n (%). Class 1 corresponds to the moderate-level profile with low exercise; Class 2 to the high-level profile; and Class 3 to the low-level profile. p values are from Pearson's χ^2 test, or from Fisher's exact test (Fisher-Freeman-Halton extension for r × c tables) when any expected cell count was below 5 (age, marital status, education, employment status, occupation, clinical stage, and treatment). No test was performed for ethnicity because all participants were of Han ethnicity. Rectal cancer includes 3 participants with synchronous colon and rectal cancer.

Characteristic	Health-promoting behaviour profiles				
	Low-level (n = 83)	Moderate-level (n = 91)	High-level (n = 29)	Total (n = 203)	p value
Retired	81 (97.6%)	85 (93.4%)	26 (89.7%)	192 (94.6%)	
On medical leave	2 (2.4%)	0 (0.0%)	1 (3.4%)	3 (1.5%)	
Employed	0 (0.0%)	6 (6.6%)	2 (6.9%)	8 (3.9%)	
Occupation					0.019
Office staff	30 (36.1%)	39 (42.9%)	17 (58.6%)	86 (42.4%)	
Worker	42 (50.6%)	43 (47.3%)	9 (31.0%)	94 (46.3%)	
Self-employed	2 (2.4%)	7 (7.7%)	3 (10.3%)	12 (5.9%)	
Other	9 (10.8%)	2 (2.2%)	0 (0.0%)	11 (5.4%)	
Income (RMB/month)					0.185
≤ 6000	19 (22.9%)	28 (30.8%)	9 (31.0%)	56 (27.6%)	
6001–9000	43 (51.8%)	39 (42.9%)	8 (27.6%)	90 (44.3%)	
> 9000	21 (25.3%)	24 (26.4%)	12 (41.4%)	57 (28.1%)	
Time since diagnosis					0.025
< 1 year	26 (31.3%)	15 (16.5%)	9 (31.0%)	50 (24.6%)	
1–5 years	25 (30.1%)	40 (44.0%)	15 (51.7%)	80 (39.4%)	
> 5 years	32 (38.6%)	36 (39.6%)	5 (17.2%)	73 (36.0%)	
Cancer type					0.892
Colon cancer	51 (61.4%)	59 (64.8%)	18 (62.1%)	128 (63.1%)	
Rectal cancer	32 (38.6%)	32 (35.2%)	11 (37.9%)	75 (36.9%)	
Clinical stage					0.073
Stage 0-I	7 (8.4%)	4 (4.4%)	1 (3.4%)	12 (5.9%)	
Stage II	14 (16.9%)	23 (25.3%)	6 (20.7%)	43 (21.2%)	

Data are n (%). Class 1 corresponds to the moderate-level profile with low exercise; Class 2 to the high-level profile; and Class 3 to the low-level profile. p values are from Pearson's χ^2 test, or from Fisher's exact test (Fisher-Freeman-Halton extension for r × c tables) when any expected cell count was below 5 (age, marital status, education, employment status, occupation, clinical stage, and treatment). No test was performed for ethnicity because all participants were of Han ethnicity. Rectal cancer includes 3 participants with synchronous colon and rectal cancer.

Characteristic	Health-promoting behaviour profiles				
	Low-level (n = 83)	Moderate-level (n = 91)	High-level (n = 29)	Total (n = 203)	p value
Stage III	13 (15.7%)	8 (8.8%)	4 (13.8%)	25 (12.3%)	
Stage IV	11 (13.3%)	3 (3.3%)	0 (0.0%)	14 (6.9%)	
Undetermined	38 (45.8%)	53 (58.2%)	18 (62.1%)	109 (53.7%)	
Treatment					0.069
Surgery	29 (34.9%)	44 (48.4%)	14 (48.3%)	87 (42.9%)	
Surgery plus adjuvant therapy	47 (56.6%)	46 (50.5%)	15 (51.7%)	108 (53.2%)	
Non-surgical treatment	7 (8.4%)	1 (1.1%)	0 (0.0%)	8 (3.9%)	
Stoma					0.065
Yes	20 (24.1%)	13 (14.3%)	2 (6.9%)	35 (17.2%)	
No	63 (75.9%)	78 (85.7%)	27 (93.1%)	168 (82.8%)	
Nutritional risk					< 0.001
Yes	35 (42.2%)	17 (18.7%)	3 (10.3%)	55 (27.1%)	
No	48 (57.8%)	74 (81.3%)	26 (89.7%)	148 (72.9%)	

Data are n (%). Class 1 corresponds to the moderate-level profile with low exercise; Class 2 to the high-level profile; and Class 3 to the low-level profile. p values are from Pearson's χ^2 test, or from Fisher's exact test (Fisher-Freeman-Halton extension for r × c tables) when any expected cell count was below 5 (age, marital status, education, employment status, occupation, clinical stage, and treatment). No test was performed for ethnicity because all participants were of Han ethnicity. Rectal cancer includes 3 participants with synchronous colon and rectal cancer.

Results

Health-promoting behaviour patterns among community-dwelling colorectal cancer survivors

Between September 18 and November 30, 2024, 207 questionnaires were distributed. Of these, 203 were valid and included in the analysis, yielding an effective response rate of 98.07%. Men accounted for 58.62% of participants. The mean age was 71.36 years (SD 9.14; range 42–90). Participant characteristics are summarised in Table 1.

The mean total HPLP-II score was 124.35 (SD 19.31), within the fair category (Table S1). Scores were classified as excellent in 4 participants (1.97%), good in 69 (33.99%), fair in 127 (62.56%), and poor in 3 (1.48%). When expressed as a percentage of the maximum possible domain score, scores were highest for nutrition and lowest for exercise.

Among the models evaluated, the three-profile model had the lowest Bayesian information criterion (BIC) and was selected for interpretation (Table S2). The high-level profile (n = 29, 14.3%) had the highest scores across all six domains, including a health responsibility score of 29.83. The moderate-level profile (n = 91, 44.8%) had intermediate scores across domains and a relatively low exercise score of 12.77. The low-level profile (n = 83, 40.9%) had the lowest scores across all domains, including scores of 17.53 for spiritual growth and 9.73 for exercise (Table S3). Figure 1 shows the domain scores for each profile as line and radar plots.

Participant characteristics by health-promoting behaviour profile

Participant characteristics differed across profiles in age, sex, marital status, education, employment status, occupation, and time since diagnosis (Table 1). Participants aged 60 years or younger were less common in the low-level profile (3.6%) than in the moderate-level (13.2%) or high-level (20.7%) profile (p = 0.039). Women accounted for 65.5% of the high-level profile, whereas men accounted for 71.1% of the low-level profile (p = 0.002). Participants who were unmarried, divorced, or widowed were more common in the low-level profile (24.1%) than in the moderate-level (8.8%) or high-level (10.3%) profile (p = 0.018). A college degree or above was most common in the high-level profile (20.7%; p = 0.014), and current employment was reported only in the moderate-level (6.6%) and high-level (6.9%) profiles (p = 0.018). The high-level profile had the largest proportion of office staff (58.6%; p = 0.019). A time since diagnosis of more than 5 years was less common in the high-level profile (17.2%) than in the low-level (38.6%) or moderate-level (39.6%) profile (p = 0.025). No statistically significant differences were found for income, cancer type, clinical stage, treatment, or stoma status (p > 0.05).

The prevalence of nutritional risk differed across profiles (p < 0.001): 42.2% in the low-level profile, 18.7% in the moderate-level profile, and 10.3% in the high-level profile. Thus, lower levels of health-promoting behaviour were associated with a higher prevalence of nutritional risk.

Univariable logistic regression of factors associated with nutritional risk

Univariable Firth logistic regression examined associations of nutritional risk with profile membership, age, sex, marital status, education, employment status, occupation, income, time since diagnosis, cancer type, clinical stage, treatment, and stoma status (Table 2). Compared with the low-level profile, the moderate-level profile had lower odds of nutritional risk (OR 0.32, 95% CI 0.16–0.62; p < 0.001), as did the high-level profile (OR 0.18, 95% CI 0.05–0.53; p = 0.001). Participants aged 70 years or older had higher

odds than those aged 60 years or younger (OR 3.55, 95% CI 1.06–18.37; p = 0.039). Compared with a time since diagnosis of less than 1 year, durations of 1–5 years (OR 0.27, 95% CI 0.12–0.56; p < 0.001) and more than 5 years (OR 0.09, 95% CI 0.03–0.22; p < 0.001) were associated with lower odds. Sex, marital status, education, employment status, occupation, income, cancer type, clinical stage, treatment, and stoma status were not statistically significantly associated with nutritional risk (p > 0.05).

Table 2
Univariable Firth logistic regression of factors associated with nutritional risk

Variable	Category	Events/N	OR (95% CI)	p value
LPA profile	Low-level	35/83	Reference (1.00)	
	Moderate-level	17/91	0.32 (0.16–0.62)	< 0.001
	High-level	3/29	0.18 (0.05–0.53)	0.001
Age	≤ 60 years	2/21	Reference (1.00)	
	61–69 years	15/60	2.66 (0.72–14.36)	0.150
	≥ 70 years	38/122	3.55 (1.06–18.37)	**0.039**
Sex	Male	34/119	Reference (1.00)	
	Female	21/84	0.84 (0.44–1.57)	0.583
Marital status	Married	47/172	Reference (1.00)	
	Unmarried/divorced/widowed	8/31	0.96 (0.39–2.17)	0.917
Education	Primary school or below	9/28	Reference (1.00)	
	Junior high school	31/108	0.83 (0.35–2.08)	0.688
	Senior high / technical secondary	12/49	0.68 (0.25–1.90)	0.461
	College degree or above	3/18	0.46 (0.10–1.76)	0.266
Employment status	Not employed	55/195	Reference (1.00)	
	Employed	0/8	0.15 (0.00-1.23)	0.085

Events/N = number of participants at nutritional risk / total number in the category. Odds ratios were estimated using Firth's penalized logistic regression; confidence intervals are profile penalized likelihood intervals, and p values are from penalized likelihood ratio tests. A lower confidence limit of 0.00 reflects rounding to two decimal places; the unrounded value is greater than zero. OR = odds ratio; CI = confidence interval; LPA = latent profile analysis.

Variable	Category	Events/N	OR (95% CI)	p value
Occupation	Office staff	26/86	Reference (1.00)	
	Worker	25/94	0.84 (0.44–1.60)	0.590
	Self-employed	2/12	0.54 (0.10–2.05)	0.389
	Other	2/11	0.60 (0.11–2.31)	0.480
Income (RMB/month)	≤ 6000	10/56	Reference (1.00)	
	6001–9000	26/90	1.82 (0.83–4.23)	0.138
	> 9000	19/57	2.24 (0.96–5.47)	0.062
Time since diagnosis	< 1 year	28/50	Reference (1.00)	
	1–5 years	20/80	0.27 (0.12–0.56)	**< 0.001**
	> 5 years	7/73	0.09 (0.03–0.22)	**< 0.001**
Cancer type	Colon cancer	37/128	Reference (1.00)	
	Rectal cancer	18/75	0.79 (0.40–1.49)	0.461
Clinical stage	Stage 0-I	2/12	Reference (1.00)	
	Stage II	13/43	1.86 (0.45–10.64)	0.407
	Stage III	12/25	3.89 (0.89–23.31)	0.072
	Stage IV	6/14	3.21 (0.62–21.36)	0.167
	Undetermined	22/109	1.08 (0.29–5.90)	0.917

Events/N = number of participants at nutritional risk / total number in the category. Odds ratios were estimated using Firth's penalized logistic regression; confidence intervals are profile penalized likelihood intervals, and p values are from penalized likelihood ratio tests. A lower confidence limit of 0.00 reflects rounding to two decimal places; the unrounded value is greater than zero. OR = odds ratio; CI = confidence interval; LPA = latent profile analysis.

Variable	Category	Events/N	OR (95% CI)	p value
Treatment	Surgery	19/87	Reference (1.00)	
	Surgery plus adjuvant therapy	32/108	1.49 (0.79–2.89)	0.223
	Non-surgical treatment	4/8	3.51 (0.84–14.85)	0.085
Stoma	With stoma	14/35	Reference (1.00)	
	Without stoma	41/168	0.48 (0.23–1.04)	0.062

Events/N = number of participants at nutritional risk / total number in the category. Odds ratios were estimated using Firth's penalized logistic regression; confidence intervals are profile penalized likelihood intervals, and p values are from penalized likelihood ratio tests. A lower confidence limit of 0.00 reflects rounding to two decimal places; the unrounded value is greater than zero. OR = odds ratio; CI = confidence interval; LPA = latent profile analysis.

Multivariable logistic regression of factors associated with nutritional risk

Profile membership, age, and time since diagnosis met the criterion of $p < 0.05$ in univariable analyses and were entered into the multivariable Firth logistic regression model (Table 3). Each remained associated with nutritional risk after mutual adjustment. Compared with the low-level profile, the moderate-level profile had 69% lower odds of nutritional risk (adjusted OR 0.31, 95% CI 0.14–0.67; $p = 0.003$), and the high-level profile had 90% lower odds (adjusted OR 0.10, 95% CI 0.02–0.34; $p < 0.001$). Participants aged 70 years or older had higher odds than those aged 60 years or younger (adjusted OR 5.25, 95% CI 1.21–33.41; $p = 0.025$). Compared with a time since diagnosis of less than 1 year, durations of 1–5 years (adjusted OR 0.24, 95% CI 0.10–0.55; $p < 0.001$) and more than 5 years (adjusted OR 0.04, 95% CI 0.01–0.13; $p < 0.001$) were associated with lower odds. In exploratory analyses stratified by sex and cancer type, the point estimates were in the same direction as the overall association, although several confidence intervals included the null value (Table 4).

Table 3
Multivariable Firth logistic regression of factors associated with nutritional risk

Variable	Category	Events/N	Adjusted OR (95% CI)	p value
LPA profile	Low-level	35/83	Reference (1.00)	
	Moderate-level	17/91	0.31 (0.14–0.67)	0.003
	High-level	3/29	0.10 (0.02–0.34)	< 0.001
Age	≤ 60 years	2/21	Reference (1.00)	
	61–69 years	15/60	1.60 (0.33–10.38)	0.577
	≥ 70 years	38/122	5.25 (1.21–33.41)	0.025
Time since diagnosis	< 1 year	28/50	Reference (1.00)	
	1–5 years	20/80	0.24 (0.10–0.55)	< 0.001
	> 5 years	7/73	0.04 (0.01–0.13)	< 0.001

Events/N = number of participants at nutritional risk / total number in the category. Odds ratios were estimated using Firth's penalized logistic regression and are mutually adjusted for profile membership, age, and time since diagnosis. OR = odds ratio; CI = confidence interval.

Table 4
Subgroup analyses of the association between health-promoting behaviour profiles and nutritional risk

Subgroup	LPA profile	Events/N	OR (95% CI)	p value
Male	Low-level	25/59	Reference (1.00)	
	Moderate-level	9/50	0.31 (0.12–0.72)	0.006
	High-level	0/10	0.06 (0.00-0.54)	0.007
Female	Low-level	10/24	Reference (1.00)	
	Moderate-level	8/41	0.35 (0.11–1.04)	0.058
	High-level	3/19	0.29 (0.06–1.11)	0.072
Colon cancer	Low-level	21/51	Reference (1.00)	
	Moderate-level	13/59	0.41 (0.18–0.93)	0.032
	High-level	3/18	0.32 (0.08–1.06)	0.063
Rectal cancer	Low-level	14/32	Reference (1.00)	
	Moderate-level	4/32	0.20 (0.05–0.64)	0.006
	High-level	0/11	0.06 (0.00-0.49)	0.005

Events/N = number of participants at nutritional risk / total number in the subgroup and profile. Odds ratios were estimated using Firth's penalized logistic regression fitted separately within each subgroup, without adjustment for other covariates. OR = odds ratio; CI = confidence interval; LPA = latent profile analysis. A lower confidence limit of 0.00 reflects rounding to two decimal places; the unrounded value is greater than zero.

Discussion

We identified three health-promoting behaviour profiles among community-dwelling colorectal cancer survivors. These profiles differed mainly in overall behaviour levels. The proportion screening positive for nutritional risk was highest in the low-level profile and lowest in the high-level profile, and profile membership remained associated with nutritional risk after adjustment for age and time since diagnosis. Older participants and those with a shorter time since diagnosis also had higher odds of nutritional risk. The findings suggest that behavioural assessment may help characterise survivors' needs during nutritional care, although its clinical value requires further evaluation.

The mean total HPLP-II score was 124.35 (SD 19.31), within the fair range. As percentages of the maximum possible domain scores, nutrition was highest (70.75) and exercise lowest (37.84). Survivors may pay particular attention to diet after gastrointestinal cancer, but their reasons for engaging in these behaviours were not assessed. Lower exercise scores indicate less frequent reported activity rather than failure to meet a specific exercise guideline. Postoperative symptoms and concerns about exercise safety may discourage activity. Evidence on the safety and feasibility of exercise in colorectal cancer

provides a basis for addressing such concerns (17). Participants aged ≥ 70 years accounted for 60.1% of the sample. Reduced physical capacity may be relevant in this group, and previous research has linked frailty to poorer survival after colorectal cancer (18). Individualised guidance may help survivors select appropriate activities and sustain participation, an issue also addressed in studies of physical-activity maintenance after exercise interventions (19). Stress management and spiritual growth may warrant attention in community care, although HPLP-II scores in these domains do not establish the presence of anxiety or depression.

NRS-2002 screening identified nutritional risk in 27.09% of participants. This figure represents screening positivity, not the prevalence of diagnosed malnutrition. Nutritional care remains relevant after survivors return to the community, as illustrated by a trial of personalised nutritional support (20). Evidence from colorectal cancer nutrition guidelines (21) and postoperative nutritional care (22) also informs care across the treatment pathway, although findings from hospital populations may not apply directly to community-dwelling survivors. In our study, the moderate- and high-level behavioural profiles were associated with lower odds of nutritional risk than the low-level profile. Several explanations are possible. Dietary difficulties and reduced activity may contribute to nutritional problems, while fatigue and poor appetite associated with nutritional problems may limit participation in health-promoting activities. Unmeasured health or social factors could also influence both. These possibilities cannot be distinguished by the present cross-sectional data. The profiles describe co-occurring behavioural and nutritional needs; they do not establish that changing profile membership would reduce nutritional risk.

The associations with age and time since diagnosis need cautious interpretation. NRS-2002 assigns an additional point to participants aged ≥ 70 years, so the age association may partly reflect the scoring rule itself. It cannot be interpreted solely as evidence of an independent biological effect of ageing. Participants with a longer time since diagnosis had lower odds of nutritional risk. Recovery from treatment-related symptoms or adaptation of eating habits could contribute to this pattern, but selective survival and differences between recently diagnosed and long-term survivors are also possible explanations. The comparison between individuals at one time point does not show that nutritional risk declines within individuals over time. Subgroup estimates by sex and tumour site were directionally similar to the overall association. However, sparse events and wide confidence intervals limit their precision, and the results do not establish differences in the association between subgroups. In primary care, the observed profiles could be explored alongside social circumstances and health behaviours (23), survivors' nutritional information needs and beliefs (24), and the relationship between dietary changes and quality of life (25). Such work could inform the design of support tailored to survivors' needs, but intervention benefits cannot be inferred from the present study.

Several limitations affect interpretation. Convenience sampling from one Shanghai subdistrict limits generalisability, and self-reported behaviours may be affected by recall or social desirability. The cross-sectional design cannot establish temporal sequence or exclude reverse causation and residual confounding. The suitability of NRS-2002 for community-dwelling survivors requires consideration because it was developed for hospital nutritional risk screening; its age component also complicates

interpretation of age as an associated factor. Assigning each participant to a single latent profile may overlook classification uncertainty, and the small high-level profile limits precision. Neither the profiles nor their ability to predict future nutritional risk were externally validated. Larger studies in other community settings should assess the reproducibility of the profiles. Longitudinal studies and intervention trials are needed to determine whether changes in behaviour precede improvements in nutritional outcomes.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Beixinjing Community Health Service Center, Changning District (approval no. BXJ2020-06-08), and conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent before enrolment.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Author Contribution

Xuan WANG, Yue ZHAO, and Li XIE had full access to the study data and take responsibility for the integrity of the data and the accuracy of the analyses. Li XIE and Yue ZHAO conceived and designed the study. Xuan WANG and Li XIE acquired, analysed, and interpreted the data, drafted the manuscript, and obtained funding. Zhen TONG, Huiling ZENG, Mengjiao ZHANG, Weijun SHI, and Jianxin LI contributed to data collection and curation. Yinzhu ZHUANG, Wei ZHAO, and Shukang RAO contributed to data checking and interpretation of the findings. Li XIE is the guarantor. All authors critically revised the manuscript for important intellectual content, approved the final version for publication, and agree to be accountable for all aspects of the work.

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Data Availability

The datasets generated and analysed during this study are available from the corresponding author on reasonable request.

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Figures

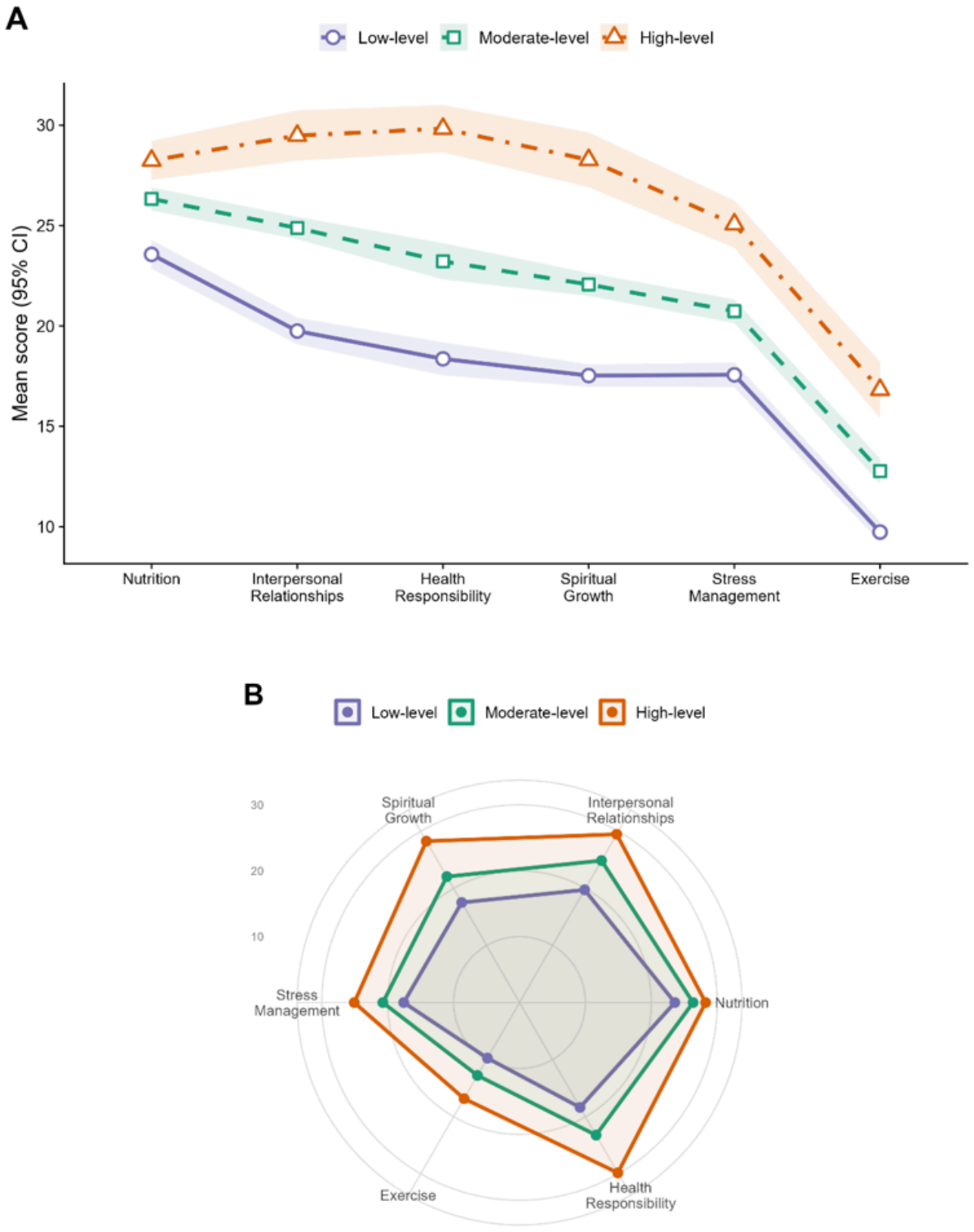


Figure 1

Health-promoting behaviour profiles based on the six Health-Promoting Lifestyle Profile II (HPLP-II) domains.

(A) Mean raw domain scores (lines and points) with 95% confidence intervals (shaded bands) for each latent profile. (B) Mean raw domain scores shown as a radar plot.

Supplementary Files

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- SupplementaryMaterials20261001.docx