



Health-related quality of life and lifestyle in long-term survivors of colorectal cancer and a matched non-cancer reference group

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Abstract

Objective To compare the long-term health status of a group of survivors of colorectal cancer (CRC) with a reference group of individuals who did not have cancer. We determined the physical, mental, and general health-related quality of life (HRQoL); overall morbidities and CRC-specific morbidities related to the delayed effects of treatment; and maintenance of a healthy lifestyle in these two groups.

Methods This descriptive cross-sectional study was conducted from 2016 to 2019 in the Balearic Islands (Spain). CRC patients who were diagnosed from 2011 to 2012 and survived at least 5 years were randomly selected from the Majorca and Eivissa-Formentera cancer registries. The reference group consisted of individuals matched for gender and age who had no history of cancer.

Results We examined 201 CRC survivors and 199 matched individuals without cancer. The global analysis showed that the two groups had similar scores in the physical and mental components of the Short Form 12 (SF-12) HRQoL scale and in general health status. The CRC survivors had significantly higher prevalence of general comorbidity and CRC-specific comorbidity. Multivariate analyses and calculation of odds ratios (ORs) showed that the groups had similar physical HRQoL (Model 1, OR: 1.01, 95% CI: 0.99–1.03), mental HRQoL (Model 2, OR: 0.99, 95% CI: 0.66–1.01), and general HRQoL (Model 3, OR: 1.67, 95% CI: 0.39–1.13). However, the long-term CRC survivors had significantly greater ORs for an increased overall comorbidity index, number of CRC-specific comorbidity, and obesity in all three models ($P < 0.05$).

Conclusions The CRC survivors and individuals without cancer had similar HRQoL, suggesting that CRC survivors do not need additional services that aim to improve HRQoL. Nonetheless, health care providers should be pro-active when caring for CRC survivors, because they are more likely to present with certain comorbidity and less likely to follow a healthy lifestyle.

Keywords Colorectal cancer · Long-term survivor · Quality-of-life · Lifestyle · Comorbidity

Introduction

The survival rate of European patients with colorectal cancer (CRC) has steadily increased during recent decades [1], and at 7 years after diagnosis, these patients currently have a

mortality rate similar to the general population [2]. Hence, long-term survivors of CRC now account for a significant percentage of the overall population. However, long-term survivors of CRC can experience impaired health-related quality-of-life (HRQoL) due to a delayed onset of physical difficulties and symptoms that are related to cancer treatment [3–5]. In addition, some studies suggested that individuals who survived cancer can suffer emotional distress, anxiety, and depression because of the fear of cancer recurrence and the need for further tests [6, 7]. Some CRC survivors have a psychological nature that may help them cope with the possible recurrence of cancer and to re-establish a normal daily life during the survival period. For example, an optimistic disposition can influence the appraisal of stressful events and help an individual to manage and more easily adjust to stressful events [8]. Another important psychological

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characteristic is resilience, defined as the ability to make positive adaptations when faced with adversity [9].

In parallel, survivors need to maintain a healthy lifestyle, decrease exposure to risk factors that led to the original cancer, and prevent other serious diseases. Several studies suggested that adoption of a healthy lifestyle after the diagnosis of CRC, such as engaging in physical activity and eating a healthy diet, may improve clinical outcome, decrease the risk of recurrence, and prolong survival [10, 11]. Moreover, engaging in physical activity and adopting a healthy lifestyle can also improve the HRQoL of cancer survivors [12–14].

Thus, cancer survivors should receive effective management of treatment-related problems, rehabilitation, and follow-up care, and should also engage in activities that improve HRQoL [15]. Many countries have tried to improve the health of long-term cancer survivors through survivorship care plans, but these plans are not available in many countries [15, 16]. The Spanish Ministry of Health reported that most survivorship health plans in Spain are isolated initiatives that lack long-term stability [17]. It is, therefore, important to examine the long-term consequences of CRC in Spain and to identify issues that need more attention during follow-up in regions where there are no survivorship care plans. Jansen et al. suggested comparing matched groups of individuals—one group of CRC survivors and a reference group without cancer—to exclude the effects of age and gender [4].

The goal of the present study was to assess the long-term health status of CRC survivors by comparing them to a matched reference group of individuals who did not have cancer. We compared the physical, mental, and general HRQoL of these two groups, and focused on the prevalence of overall morbidities and CRC-specific morbidities that are related to the delayed effects of oncology treatment, and the maintenance of a healthy lifestyle.

Methods

This descriptive, cross-sectional study was conducted in the islands of Majorca and Eivissa-Formentera (Spain) from November 2016 to January 2019. The group of CRC survivors consisted of randomly selected patients who were diagnosed with CRC between 2011 and 2012 at public hospitals in Majorca and consecutive patients at the Eivissa public hospital during the same period. All CRC survivors were identified in the Majorca cancer registry and the Eivissa Hospital cancer registry. At the time of inclusion, all patients were cancer-free for at least 5 years after the primary diagnosis and treatment [17]. Patients with metastatic CRC and those receiving active treatment were excluded. Patients who were treated exclusively at private hospitals were also

excluded, because of the limited access to these patients and their clinical records.

The reference group consisted of individuals who had no history of cancer. These participants were matched to the CRC group in terms of age (± 5 years) and gender, and were registered in the same general practitioner (GP) list. Individuals were excluded if their health status prevented an interview or if they were not registered with a GP.

After CRC survivors were identified, the research staff contacted their GPs to verify eligibility. The GPs were then asked to identify a patient without cancer who had a similar age and the same gender from the patient list. The GPs then contacted the individuals in both groups by telephone to request participation in the study. An interview was arranged in the health centre or at home, and each participant signed an informed consent document. Sample size calculation was based on HRQoL score (Short Form 12, SF-12), and was established to enable detection of statistically significant inter-group differences of 7.3 points at the 95% confidence level, with each group having a standard deviation of 25 points, at a power of 80%. This calculation indicated the need for 185 survivors (CRC group) and 185 controls (reference group).

Study measurements

The interviewer-administered questionnaire was initially developed and administered to 5 CRC survivors in a pilot study. This questionnaire assessed sociodemographic factors (age, sex, relationship status, and level of education on the date of the interview), HRQoL (SF-12 score), general health status, dispositional optimism, resilience, use of psychiatric medications, general and CRC-related comorbidity, and health-related behaviours.

Data on CRC were collected from the two cancer registries, and included date of diagnosis and cancer stage. Other diseases, including cancer recurrence and receipt of a colostomy, were obtained by review of hospital and primary care records.

HRQoL was assessed using the Spanish version of the SF-12 (version 2), which considers the physical and mental components of HRQoL [18, 19]. This questionnaire contains 12 items, and patient responses to each question were recorded using a Likert-type scale that assessed 8 domains: physical activities, social activities, usual role activities, bodily pain, general mental health, emotional problems, vitality, and general health status. These eight sub-scales provided the basis for calculation of two summary measures: the Physical Component Summary and the Mental Component Summary. A higher score represented better function for each summary measure and each sub-scale. General health status was evaluated by asking: ‘How do you evaluate

your health at this moment?’ The possible answers were ‘excellent’, ‘very good’, ‘good’, ‘regular’, and ‘bad’.

Dispositional optimism or a predisposition for optimism was measured using the Revised Life Orientation Test (LOT-R) adapted for the Spanish population [20, 21]. This test contains 10 items, with each item having 5 possible answers ranging from 0 (‘completely disagree’) to 4 (‘completely agree’).

Resilience was examined using the Brief Resilient Coping Scale (BRCS) adapted and validated for the Spanish population [22, 23]. This scale has 4 items, with each item having an answer ranging from 1 (‘it absolutely does not describe me’) to 5 (‘it describes me well’). The total score ranges from 4 to 20; a score of 13 or less indicates low resilience, scores of 14 to 16 indicate normal resilience, and a score of 17 or more indicates high resilience.

Use of psychiatric medications was determined by asking the patient about the use of antidepressants and anxiolytic medications.

General co-morbidity was assessed using the combined comorbidity index for CRC [24]. CRC-specific comorbidity was assessed by recording cancer recurrence, colostomy, and secondary adverse effects (erectile dysfunction, urinary incontinence, diabetes, diarrhoea or constipation, peripheral neuropathy, cardiac ischemia, and hypertension).

Health-related behaviours were assessed by asking patients about their behaviours during the previous 12 months. Diet was assessed using the Prevention with Mediterranean Diet (PREDIMED) questionnaire, which has 14 items; a score less than 9 indicated inadequate adherence and a score of 9 or more indicated adequate adherence [25]. Physical activity during the previous week was measured using the Spanish version of the Minnesota Leisure Time Physical Activity Questionnaire (VREM), which was validated for adults [26]. The six items in the VREM are walking, gardening, and sport, dancing or going upstairs, shopping by foot, and cleaning the house. The Spanish language Short Version of the Minnesota Leisure Time Physical Activity Questionnaire (VREM), which is based on the metabolic equivalents of task (MET) of different physical activities, was used to assess physical activity during a 14-day period. Based on questionnaire score, an individual was classified as sedentary (< 1200 METs), moderately active (1250–2999 METs), active (3000–4999 METs), or very active (> 5000 METs).

Statistical analysis

A descriptive analysis of all variables was performed. A bivariate analysis was used to compare CRC survivors and the reference group in terms of HRQoL variables, general and specific comorbidity, and health-related behaviours. The Kolmogorov–Smirnov test was used to determine the

distribution of continuous variables; the Mann–Whitney *U* test was used for comparisons of continuous variables with non-normal distributions and the t-test was used for comparisons of continuous variables with normal distributions. The chi-square test was used for comparisons of categorical variables.

Three multivariate logistic regression models were used to compare the CRC survivors and reference group: physical HRQoL (Model 1), mental HRQoL (Model 2), and general health status (Model 3). Co-variables with statistical significance ($P < 0.020$) in the bi-variate analysis (relationship status, level of education, body mass index, physical activity, compliance with the Mediterranean diet, currently smoking, Brief Resilient Coping Scale (BRCS) score, comorbidity index, and CRC-specific comorbidity) were entered into the logistic regression using the backward elimination method. The Hosmer–Lemeshow test was used to measure goodness of fit of each model.

For these multivariate analyses, the number of CRC-specific comorbidity was recorded as 0, 1, or 2 or more. All statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA), and a *P*-value of 0.05 was considered significant.

Results

We initially identified 320 potentially eligible CRC survivors. We excluded 18 subjects who did not attend primary care, 23 who had no clinical records from primary care, 51 who died, 2 who refused to participate, 12 who had newly diagnosed cancer, and 6 who had CRC metastasis, and finally enrolled 201 CRC survivors. Two individuals in the age- and gender-matched reference group subsequently decided not to participate, so there were 199 individuals in the matched reference group. These two groups had similar sociodemographic characteristics (gender, age, level of education, and marital status). Most of the CRC survivors had stage II (32.1%) or stage III (39.0%) cancer, 20.5% of them had a colostomy, and only three (1.7%) had cancer recurrence (Table 1).

We then examined the different dimensions of health in the two groups (Table 2). The specific dimensions in SF12 were similar in the two groups, although the social function score was significantly higher in the CRC survivors ($P = 0.01$). The two groups also had similar scores for general health status, and about seven of ten of participants in each group reported health status as good, very good, or excellent. The two groups were also similar in terms of dispositional optimism, resilience and use of psychiatric medications. Notably, CRC survivors reported more comorbidity ($P < 0.01$) and were more likely to report treatment-related adverse effects, particularly erectile dysfunction, urinary

Table 1 Characteristics of long-term survivors of CRC and the matched reference group

	CRC survivors (<i>n</i> = 201)	Reference group (<i>n</i> = 199)	P value
	N (%)	N (%)	
Sex			
Female	82 (40.8)	84 (42.2)	0.77
Male	119 (59.2)	115 (57.8)	
Age, years			
< 65	48 (24.1)	49 (25.4)	0.77
≥ 65	151 (75.9)	144 (74.6)	
Relationship status			
Couple	151 (75.9)	136 (68.3)	0.19
Single	48 (24.1)	63 (31.7)	
Education			
None	56 (28.3)	38 (19.2)	0.07
Primary school	82 (41.4)	105 (53.0)	
Secondary school	30 (15.2)	31 (15.7)	
University	30 (15.2)	24 (12.1)	
CRC stage			
0	8 (4.3)	NA	
I	39 (20.9)		
II	60 (32.1)		
III	73 (39.0)		
IV	7 (3.7)		
Stoma			
Yes	40 (20.5)	NA	
No	155 (79.5)		
Recurrence			
Yes	3 (1.7)	NA	
No	171 (98.3)		
Years since diagnosis			
Mean (± SD)	6.9 (± 0.7)	NA	
Median (interquartile range)	6.7 (6.3–7.4)		

NA not applicable

incontinence, constipation, and cardiac ischemia (all $P < 0.05$).

We then compared the health-related lifestyles in the two groups (Table 3). The results show that CRC survivors were less physically active ($P = 0.04$) and had a higher prevalence of obesity ($P = 0.04$). However, the two groups had similar compliance with the Mediterranean diet ($P = 0.20$) and similar numbers of former smokers ($P = 0.46$). At the time of the interview, the two groups also had similar numbers of current smokers ($P = 0.14$) and were also similar in terms of alcohol consumption ($P = 0.61$).

We used three multivariate models to compare the two groups (Table 4). The results showed that the CRC survivors and the reference group did not differ significantly in overall

physical HRQoL (Model 1), overall mental HRQoL (Model 2), and overall general health status (Model 3). However, in each of these three models, the CRC survivors had a significantly greater prevalence of obesity (all $P < 0.05$), a higher co-morbidity index (all $P < 0.05$), and more CRC-specific comorbidity (all $P < 0.05$).

Discussion

To our knowledge, the present study is one of only a few studies performed in Spain that compared the HRQoL of long-term survivors of CRC with a matched non-cancer reference group. Our unadjusted comparison showed no significant differences between these two groups with respect to physical HRQoL, mental HRQoL, general health status, dispositional optimism, and resilience. However, compared to the reference group, CRC survivors showed proportion of individual with obesity, a higher co-morbidity index and more treatment-related comorbidity (constipation, urinary incontinence, erectile dysfunction, and coronary ischemia). Multivariate analysis also showed that these two groups had similar overall physical HRQoL, overall mental HRQoL, and general health status, although the CRC survivors had a higher comorbidity index and higher rate of treatment-specific comorbidity.

Many previous studies have examined the HRQoL in long-term survivors of CCR, but these studies were generally cross-sectional and did not use matched comparison groups. Our results are in line with the results of studies that examined cancer survivors 5 or more years after cancer diagnosis. For example, the physical HRQoL and social HRQoL were reported as globally satisfactory or even better than in a reference group in the Netherlands (206 cases and 225 controls), Canada (296 long-term CRC survivors and 255 matched controls), the USA (403 cases and 401 controls) [27–29], and in other regions, including Spain, that compared cancer survivors with population normative values [30–33]. The possible reason for the similar HRQoL in cancer survivors and a non-cancer reference group could be simply because the negative effects of cancer and cancer treatment decrease over time. Also, Chambers et al. and Donahue et al. suggested that CRC cancer survivors may develop a ‘response shift’ as an adaptive process, and therefore report a good HRQoL and low psychological distress despite experiencing the negative effects of cancer and its treatment [34, 35].

In contrast, some other investigations showed that long-term survivors of CRC had worse HRQoL than a reference group. For example, Caravatti et al. examined 442 cases and 1181 controls in France and observed that the CRC survivors had poorer social function than controls [36]. Studies by Domati et al. in Italy and by Thong et al. in Germany

Table 2 Quality of life, health status, and comorbidity measures of long-term survivors of CRC and the matched reference group

	CRC survivors (n = 201) Mean (\pm sd)	Reference group (n = 199) Mean (\pm sd)	P value
SF-12			
Physical function	45.78 (\pm 12.69)	47.74 (\pm 11.39)	0.15
Physical role	46.77 (\pm 13.47)	48.68 (\pm 12.27)	0.27
Bodily pain	48.62 (\pm 13.07)	47.71 (\pm 13.01)	0.23
General health	43.87 (\pm 11.74)	42.77 (\pm 11.34)	0.30
Vitality	57.51 (\pm 13.19)	59.48 (\pm 12.33)	0.08
Social function	21.45 (\pm 11.33)	19.01 (\pm 8.25)	0.01
Emotional role	48.92 (\pm 12.51)	50.82 (\pm 10.58)	0.16
Mental health	54.66 (\pm 12.04)	56.22 (\pm 9.95)	0.34
Physical component summary	44.64 (\pm 12.76)	45.01 (\pm 11.95)	0.84
Mental component summary	47.48 (\pm 9.23)	48.36 (\pm 7.93)	0.32
LOT-R			
	21.85 (\pm 4.23)	22.32 (\pm 4.45)	0.28
	N (%)	N (%)	
General health status			
Excellent/very good/good	142 (70.6)	134 (68.4)	0.62
Regular/bad	59 (29.4)	62 (31.6)	
BRCS			
Low resilience	55 (27.5)	52 (26.5)	0.18
Normal resilience	77 (38.5)	61 (31.1)	
High resilience	68 (34.0)	83 (42.3)	
Psychiatric medication (yes)	66 (34.2)	59 (30.1)	0.38
Comorbidity Index			
No comorbidity (0–1)	102 (52.6)	137 (71.7)	< 0.01
Low comorbidity (2)	34 (17.5)	28 (14.7)	
High comorbidity (\geq 3)	58 (29.9)	26 (13.6)	
Erectile dysfunction (yes)	18 (9.2)	6 (3.1)	< 0.01
Urinary incontinence (yes)	41 (20.9)	6 (3.1)	< 0.01
Diarrhea (yes)	8 (4.01)	3 (1.6)	0.13
Constipation (yes)	12 (6.1)	4 (2.1)	0.04
Peripheral neuropathy (yes)	10 (5.1)	7 (3.7)	0.48
Cardiac ischemia (yes)	16 (8.2)	3 (1.6)	< 0.01
Hypertension (yes)	102 (52.0)	94 (48.5)	0.48

SF-12 short form 12, *LOT-R* revised life orientation test, *BRCS* brief resilient coping scale

showed that the social and physical function of cancer survivors were worse than in peers from a control group [37, 38]. Jansen et al. performed a longitudinal study that assessed a cohort of CRC patients at 1, 3, 5, and 10 years after diagnosis [39]. They found that measures of fatigue, physical pain, cognitive function, and global HRQoL were worse between years 3 and 10, and that these adverse outcomes were associated with a younger age at diagnosis. However, physical function and specific symptoms in the cancer survivors were similar to general population norms [39].

A systematic review showed that a significant proportion of CRC survivors experienced clinically increased levels of anxiety and depressive symptoms and reduced mental well-being throughout the trajectory of the illness [7]. However, our CRC survivors and matched reference

group showed no differences in depression and psychological distress. Notably, we found that the long-term survivors of CRC had similar results in the SF12 mental health component, and in the use of antidepressants and anti-anxiety medications. Thus, our results are similar to those of a previous study conducted in Spain, which found that anxiety and depression in cancer survivors decreased over time, and that these conditions had similar or even lower prevalence rates than in a normative population [40]. Our two groups also showed no differences in dispositional optimism or resilience, although the CRC survivors had better social function, in agreement with Hart et al. [28]. This result is possibly related to the increased social support that CRC survivors receive during the periods of

Table 3 Health-related behaviors of long-term survivors of CRC and the matched reference group

	CRC survivors (n = 201) N (%)	Reference group (n = 199) N (%)	P value
Physical activity (VREM)			
Sedentary	48 (25.0)	31 (16.3)	0.04
Moderately active	44 (22.9)	55 (28.9)	
Active	43 (22.4)	32 (16.8)	
Very active	57 (29.7)	72 (37.9)	
Body mass index			
Low/normal/overweight	110 (65.9)	125 (76.2)	0.04
Obese	57 (34.1)	39 (23.8)	
Mediterranean diet			
Not adequate	99 (49.3)	85 (42.9)	0.20
Adequate	102 (50.7)	113 (57.1)	
Tobacco consumption			
Ever smoked (yes)	112 (55.7)	102 (52.0)	0.46
Currently smoking (yes)	34 (16.9)	45 (22.7)	0.14
Alcoholic drinks			
Never	44 (22.1)	46 (23.1)	0.61
≤ 1 per month	29 (14.6)	23 (11.6)	
2–4 per month	29 (14.6)	30 (15.1)	
2–3 per week	19 (9.5)	28 (14.1)	
≥ 4 per week	78 (39.2)	72 (36.2)	

VREM Spanish short version of the minnesota leisure time physical activity questionnaire

diagnosis, treatment, and follow-up, because the benefits of this support may persist during their period of survival.

The differences between HRQoL physical, social and mental dimensions among these many studies may reflect the different characteristics of study populations, and whether patients with cancer recurrence or metastatic disease were included. As an example, the studies that most converge with our results are those that use a group of cancer-free individuals as referents, matched for variables such as age and sex. However, these studies also suffer from problems such as a low response rate, which in many cases is approximately 50%. The possibility that individuals with worse HRQoL did not respond cannot be excluded [27–29, 36]. In studies that do not converge, such as those by Thong, Domati, and Jansen, there is a particular selection of comparative population. For example, in Jansen's case [39], the controls do not belong to the same birth cohort, and the different follow-up periods for the cases are different from those for the population controls. Also in Domati's study, the comparative controls refer to the Italian population without limiting the age group [37]. While in Thong's study, almost 20% of all participants had not undergone surgery for primary treatment, which is highly unlikely [38].

Table 4 Multivariate logistic regression analysis of the odds ratios of different outcomes in CRC survivors relative to the reference group*

	OR (95% CI)	P value
Model 1: Physical HRQoL		
Physical component (SF-12)	1.01 (0.99–1.03)	0.15
BMI		0.02
Low/normal/overweight	1	
Obese	1.85 (1.08–3.15)	
Comorbidity index		
No comorbidity	1	
Low comorbidity	1.02 (0.52–1.98)	0.95
High comorbidity	2.52 (1.33–4.78)	< 0.01
CRC-specific comorbidity		
0	1	
1	1.72 (1.03–2.88)	0.03
≥ 2	5.63 (2.54–12.50)	< 0.01
Hosmer–Lemeshow test, p = 0.86		
Model 2: Mental HRQoL		
Mental Component (SF-12)	0.99 (0.66–1.01)	0.50
BMI		0.04
Low/normal/overweight	1	
Obesity	1.75 (1.03–2.95)	
Comorbidity index		
No comorbidity	1	0.95
Low comorbidity	1.02 (0.52–1.98)	< 0.01
High comorbidity	2.39 (1.27–4.49)	
CRC specific comorbidity		
0	1	
1	1.64 (0.98–2.75)	0.05
≥ 2	5.37 (2.43–11.89)	< 0.01
Hosmer–Lemeshow test, p = 0.90		
Model 3: General Health Status		
General Health status	0.67 (0.39–1.13)	0.13
BMI		0.03
Low/normal/overweight	1	
Obesity	1.77 (1.04–3.00)	
Comorbidity Index		
No comorbidity	1	
Low comorbidity	0.99 (0.51–1.99)	0.99
High comorbidity	2.59 (1.37–4.89)	< 0.01
CRC-specific comorbidity		
0	1	
1	1.79 (1.07–2.99)	0.02
≥ 2	5.63 (2.54–12.50)	< 0.01
Hosmer–Lemeshow test, p = 0.35		

OR odds ratio, CI confidence interval

*Adjusted by relationship status, level of education, current smoking, and BRCS

The two areas in which our long-term CRC survivors had higher deficits were general co-morbidity and treatment-related morbidities. Other studies of CRC survivors also reported disruptions of bowel function, which often manifest as constipation or diarrhoea [5, 29, 32, 38, 39]. However, the prevalence of diarrhoea was similar in our two groups. Our CRC survivors had greater prevalence rates of erectile dysfunction and urinary incontinence, consistent with some studies [5, 36] but inconsistent with others [28]. Additionally, our long-term CRC survivors had a greater prevalence of ischemic coronary disease than the matched reference group, in contrast with the results of a large study of cancer survivors that examined the risk of cardiovascular disease and cancer recurrence [41]. Other studies showed that co-morbidity was a key factor related to HRQoL, independently of a diagnosis of cancer [5, 38]. It is difficult to explain why the CRC survivors and controls had similar HRQoL scores, but that the CRC survivors had a significantly higher general comorbidity index and more CRC-specific comorbidity. One explanation could be that the broad HRQoL scales we used were not sufficiently specific to capture differences in the two groups, in contrast to other more cancer-specific HRQoL scales, such as the EORTC QLQ-30. Another explanation could be that cancer survivors develop increased resilience in face of adversity and seek to maintain sufficient social support, leading to more positive self-evaluations [27]. We suggest that clinicians should inform CRC survivors that bowel dysfunction and other specific symptoms may be long-lasting problems, and should provide them with adequate treatments and interventions that allow them to cope with these specific problems.

Contrary to our expectations, the lifestyle of CRC survivors was not better than that of the reference group. In particular, the CRC survivors had significantly decreased physical activity and a significantly higher prevalence of obesity; they also had less compliance with the Mediterranean diet (although this was not statistically significant). The two groups were similar in terms of use of tobacco and alcohol, but 16.9% of CRC survivors were current smokers and 39.2% consumed 4 or more drinks per week. Similarly, a recent study showed that cancer survivors were more likely to have a high BMI, be former smokers, and engage in less physical activity [42]. Greater adherence to not smoking may be due to the general recognition that tobacco is risk factor for cancer as greater efforts have also been devoted by public health organizations and healthcare professionals to providing interventions to reduce consumption [43]. Low adherence to healthy diet and physical activity among survivors is common as described in a systematic review [44]. It could be explained by individual barriers to engage these behaviors. Survivors describe uncertainty about how to implement lifestyle changes or declare poor support from health care providers. Some others view behavior changes as

unnecessary with some arguing that non modifiable factors contributed more to their cancer diagnosis than lifestyle-related factors [45, 46].

Additionally, it is difficult for a person to permanently change his or her lifestyle, so it is possible that some CRC survivors initially changed some habits, but could not sustain these changes over time. In fact, Tollosa et al. found that recent survivors reported better adherence to healthy behaviours than long-term survivors [44]. These results were confirmed in a 2022 longitudinal study, which showed that many CRC cancer survivors did not change their lifestyle after diagnosis, especially diet and BMI, but those who did make changes had a better HRQoL [14]. Together with our results, this suggests that health care providers should offer lifestyle counselling to long-term survivors of CRC so that they can achieve a better HRQoL throughout the cancer continuum.

Strengths and limitations

Our study has several strengths, especially the high response rates by the CRC survivors and subjects in the reference group, and our use of an age- and sex-matched reference group. We also adjusted for demographic and other factors in the multivariate analysis and used validated instruments to measure HRQoL. However, our study also has some limitations. First, we evaluated HRQoL using a cross-sectional design, rather than a longitudinal evaluation as recommended by Mosher et al. [7]. It is, therefore, necessary to perform longitudinal studies with larger samples to identify the trajectories of physical HRQoL and psychological HRQoL in CRC survivors. We did not measure socioeconomic status (social class, income, occupation, etc.) and this can be an important social determinant of health that could have impacted the outcome, thereby limiting internal validity of this study. Instead, we used education as a proxy of social class. Finally we have not differentiated between CRC survivors based on treatment type because our aim was mainly to compare HRQoL of CRC survivors with that of non-cancer population. We are conscious that long-term effects may vary among patients depending of the treatment received and their consequences in HRQoL.

We also did not measure fatigue, an important symptom and secondary effect of cancer treatment that has been frequently analysed in other studies. Our findings are also based on data from patients who were diagnosed with CRC from 2011 to 2012; the diagnosis and treatment of CRC have evolved since then, so our results may not be applicable to patients who have received more recent diagnoses of CRC. Finally, our sample size was insufficient to perform a separate analysis of the effects of different cancer treatments and of different cancer locations within the bowel on HRQoL.

Conclusions

We found that the overall HRQoL of long-term CRC survivors was comparable to that of age- and sex-matched individuals who did not have cancer, although the CRC survivors had persistent physical symptoms and a higher comorbidity index. A higher co-morbidity index was independently associated with status as a CRC survivor but was unrelated to diet and physical activity. Most long-term survivors of CRC do not need specific health care services, but health care providers should be alert to their specific symptoms and health needs during follow-up. In parallel, it is important to monitor the health-related behaviours of CRC survivors and to provide interventions that improve lifestyle and HRQoL during the follow-up period.

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Author contributions Magdalena Esteva and Sebastià March conceptualized the study. Magdalena Esteva, Sebastià March, Maria Martín-Rabadan and Elena Torres-Solera designed the research, coordinated data acquisition and information management. Joana Ripoll performed the statistical analysis and data interpretation. Magdalena Esteva and Joana Ripoll wrote the original draft. All authors reviewed and edited all draft versions and the final one and approved it for submission.

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Data availability Data are available by request to Joana Ripoll: joana.ripoll@ibsalut.es.

Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical approval This study was approved by the Majorca Primary Care Research Committee (PI11/12) and by the Balearic Islands Ethical Committee (IB11-3367). All participants received information about the study during the initial interview and provided signed informed consent before participation.

Informed consent The GPs contacted the individuals in both groups by telephone to request participation in the study. An interview was arranged in the health centre or at home, and each participant signed an informed consent document.

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