Lifestyle and quality of life in colorectal cancer survivors

Chloe Grimmett · John Bridgewater ·
Andrew Steptoe · Jane Wardle

Abstract

Purpose As cancer survival rates improve, there is growing interest in the role of lifestyle in longer-term health and quality of life (QoL). This study examined the prevalence of health-related behaviours, and the associations between health behaviours and QoL, in colorectal cancer survivors.

Methods Patients diagnosed with colorectal cancer within the last 5 years identified from five London (UK) hospitals ($N = 495$) completed a survey that included measures of fruit and vegetable (F&V) intake, physical activity, smoking status and alcohol consumption. The EORTC-QLQ-C30 questionnaire was used to index QoL.

Results The majority of respondents were overweight/obese (58%), not physically active (<5 bouts of moderate activity per week; 82%) and ate fewer than five portions of F&V a day (57%). Few were smokers (6%) or heavy drinkers (weekly alcohol units >21 for men and >14 for women; 8%). Physical activity showed the strongest association with functional QoL and was also associated with lower fatigue, pain and insomnia ($P < 0.05$). F&V intake was associated with higher global QoL and physical, role and cognitive function ($P < 0.05$). Using a total health behaviour score (calculated by assigning one point for each of the following behaviours: not smoking, consuming ≥5 portions of F&V a day, being physically active and having moderate alcohol consumption), there was a linear relationship with global QoL, physical function and fatigue ($P < 0.05$).

Conclusion A high proportion of colorectal cancer survivors in the UK have suboptimal health behaviours, and this is associated with poorer QoL.

Keywords Quality of life · Cancer survivors · Colorectal cancer · Health behaviours

Abbreviations

CRC	Colorectal cancer
QoL	Quality of life
F&V	Fruit and vegetables
EORTC-QLQ-C30	Quality of life was assessed with the European Organization for Research and Treatment of Cancer Quality of life questionnaire, version C30

C. Grimmett (✉) · J. Wardle
Health Behaviour Research Centre, Department of
Epidemiology and Public Health, University College London,
1-19 Torrington Place, London WC1E 6BT, UK
e-mail: c.grimmett@ucl.ac.uk

J. Bridgewater
Cancer Institute, University College London, Paul O'Gorman
Building, Huntley Street, London WC1E 6BT, UK

A. Steptoe
Psychobiology Group, Department of Epidemiology and Public
Health, University College London, 1-19 Torrington Place,
London WC1E 6BT, UK

Introduction

Colorectal cancer (CRC) is one of the most common cancers worldwide [1] and the third most common in the United Kingdom, with over 100 new cases diagnosed every day [2]. Lifestyle factors contribute to the high incidence, with recent estimates suggesting that 32% of cancers in men and 18% in women could be prevented if the population increased fruit and vegetable (F&V) intake, decreased red meat intake, exercised for 30 min five times a week, consumed alcohol in moderation, and maintained a

healthy weight [3]. Smoking is also a risk factor for the development of CRC [4].

Improvements in early detection and treatment have resulted in a doubling in the 5-year survival for CRC since the 1970s, to over 50% [2]. While this is heartening for anyone facing a CRC diagnosis, there is growing recognition that cancer survivors not only have impairments in quality of life (QoL) [5–7] but are also at risk of developing a second primary cancer, cardiovascular disease and other serious chronic diseases [8, 9]. Recent research suggests better survival in CRC survivors who are more physically active [10, 11], not overweight [12] and consume a less 'western style' diet [13]. Physical activity and F&V consumption have also been associated with better QoL in CRC survivors [14–17].

Recommendations from the World Cancer Research Fund are that cancer survivors should follow the same cancer prevention guidelines as the general population: maintain a healthy weight, engage in regular physical activity, eat at least five portions of F&V a day, limit alcohol consumption and do not smoke [18]. Given that cancer survivors are at increased risk of chronic diseases to which health behaviours make a contribution, these recommendations may be even more important than in the general population. Several studies from the US and Australia have examined the prevalence of health behaviours in cancer survivors [15, 19–22]. Most found that no more than a third of CRC survivors met physical activity recommendations, but this was broadly similar to the general population and to survivors of other cancers such as breast, prostate and bladder. Fewer studies have investigated F&V consumption, but results show that intake is at or below population levels; again, this is similar to consumption levels observed for other cancer sites [15, 20]. In contrast, smoking rates tend to be lower in CRC survivors than in the general population [15, 20, 22, 23]. They are also lower than among survivors of some other cancers including cervical and uterine [20]. Heavy drinking rates also appear to be lower in CRC survivors than general population levels [20, 22, 23]. Only one study has examined the prevalence of health behaviours in cancer survivors in the United Kingdom. Physical activity was slightly lower among cancer survivors compared to those without a history of the disease, but current smoking rates and alcohol consumption were similar to the general population. Unfortunately, results were not presented by cancer site [24].

Several studies have shown that physical activity is associated with a favourable QoL [14–17, 24, 25], and there is some evidence for a similar association with F&V intake, as well as a negative association with smoking [15], but there do not appear to be any studies examining associations with alcohol consumption, nor have any of these studies been conducted in UK samples. In addition, most health behaviour studies use generic (rather than cancer-specific) measures of QoL, making it difficult to draw conclusions about associations between health behaviours and cancer-specific symptoms such as fatigue, nausea, pain and sleep disturbances. In addition, studies that do use a cancer-specific measure [17, 26] do not always present analysis by QoL subdomain and therefore provide limited insight into cancer-specific symptoms [17]. It has also been suggested that cancer-specific measures are more sensitive than generic measures when examining cancer survivors [27], and where a relationship exists, stronger associations are likely to be found [28].

The aims of the present study were (1) to assess the prevalence of health behaviours in a sample of CRC survivors in the United Kingdom and (2) to examine associations between health behaviours and QoL using a cancer-specific measure (the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire, version C30). Based on previous research, we hypothesised that health behaviours would be suboptimal in this group and that adherence to healthful behaviours would be associated with higher QoL.

Methods

Participants

Colorectal cancer patients with a diagnosis of non-metastatic disease, who were up to 5 years post-diagnosis, were identified from five London hospitals. Letters were sent to the GP of each patient informing them of the study and asking them to withdraw the patient if they deemed it inappropriate to contact them (e.g. they were terminally ill, deceased, suffering severe cognitive decline, would be distressed to receive a questionnaire). Eligible patients ($N = 1,006$) were sent an invitation to participate in a questionnaire study of lifestyle and QoL. There was no incentive for returning the questionnaire. The study received approval from UCLH NHS Trust Clinical Ethics Research Ethics Committee.

Measures

Demographics

Participants were asked to report age, sex and current employment status. Socioeconomic status (SES) was indexed using a combination of material circumstances and education (car ownership vs. not, home ownership vs. not, university-level education vs. not). The sum of these items generated a score between 0 (no deprivation) and 3 (high

deprivation), which for analyses was dichotomised into 0 versus ≥ 1. This measure has been recommended when the majority of participants are retired and occupation and income are not as reflective of SES as in younger adults [29]. Date of diagnosis was obtained from case records where available and was also self-reported. Comorbidities were self-reported using a checklist option from the Health Survey for England (HSE) 2005 [30]. Cancer recurrence (has your cancer recurred?) and current treatment status (are you currently receiving cancer treatment?) were self-reported.

Physical activity

Physical activity was assessed with the Godin Leisure Time and Exercise Questionnaire [31]. It asks about frequency of episodes of mild, moderate and vigorous intensity exercise lasting for at least 15 min (bouts), during an average week. Duration of each exercise bout was not assessed, and so activity status was categorised as taking part in five or more bouts of moderate/vigorous activity a week versus fewer.

Fruit and vegetables

Fruit and vegetable intake was assessed with a two-item measure asking about the number of portions of F&V a week (including examples of portion size). Response options ranged from '0 to 2 a week' to 'more than 5 per day', and responses were categorised into at least 5 versus less than 5 portions a day. This measure has been used previously and has been validated against objective measures of vitamin status [32].

Smoking status

Smoking status was assessed using a single item 'do you smoke cigarettes at all nowadays'. Those who responded negatively were asked whether they had ever smoked cigarettes regularly (at least 1 per day). This classification distinguished current smokers, ex-smokers and never smokers and has been validated in data from the HSE. For these analyses, participants were categorised as current versus non-smokers (including ex-smokers).

Alcohol consumption

Alcohol use was assessed with the question 'do you drink alcohol nowadays'. For those who answered 'yes', weekly intake was assessed by asking 'how many of the following do you usually drink per week: small (125 ml) glass of wine, half pint of beer/lager/cider, pub measure (25 ml) of spirits' (from the HSE). Respondents were classified as non-drinkers, moderate drinkers (weekly alcohol units ≥ 1 and ≤ 21 for men and ≥ 1 and ≤ 14 for women) and heavy drinkers (>21 units for men and >14 units for women).

Weight status

Height and weight were reported for calculation of body mass index (kg/m^2), which was classified as overweight/obese (BMI ≥ 25 kg/m^2) or normal weight (BMI < 25 kg/m^2).

Quality of life

Quality of life was assessed with the European Organization for Research and Treatment of Cancer Quality of Life questionnaire, version C30 [33]. The EORTC-QLQ-C30 questionnaire measures physical, role, emotional, social and cognitive functioning, as well as global QoL and three symptom types, fatigue, pain and nausea/vomiting. There are also single symptom items for dyspnoea, appetite loss, insomnia, constipation and diarrhoea. The scale has been used previously with CRC survivors [34] and has acceptable reliability [33]. For all scales, scores range from 0 to 100. For the global and functional scales, higher scores reflect favourable QoL, whereas higher symptom scale scores indicated more symptoms.

Statistical analysis

Descriptive statistics were used to characterise the sample and examine the prevalence of health behaviours. Regression models were used to examine the dependence of QoL function subscales and fatigue on individual health behaviours (including body weight), adjusting for demographic and medical factors. Unstandardised regression coefficients were obtained to indicate the size of effects. QoL scores were not normally distributed; therefore, bootstrapping was used with 1,500 replications to obtain reliable significance tests and confidence intervals (CIs). Bootstrapping also adjusts for clustering by hospital. Adjusted means with standard errors (SE) and P values are presented. Scores on the symptom subscales (excluding fatigue) were skewed, so results were dichotomised into any versus no symptoms. Logistic regressions, adjusting for clustering by hospital, were used to assess whether symptom subscales differed for those engaging in healthful behaviours versus not (controlling for demographic and medical factors). Adjusted odds ratios (OR) with 95% CIs and P values are reported.

A pragmatic health behaviour score was calculated by assigning one point for each of the following behaviours: not smoking, consuming ≥ 5 portions of F&V a day, being physically active and having moderate alcohol consumption

[35]. Regression analysis (with adjustment and bootstrapped *P* values and CIs as above) examined associations between the health behaviour score and QoL subscales. Logistic regression was used to examine whether symptom subscales varied by health behaviour score, adjusting for demographic and medical covariates. We did not include weight in the health behaviour score because although it is influenced by energy balance, lower weight may be due to illness rather than lifestyle.

Results

Participant characteristics

A total of 1,006 questionnaires were sent out and 495 returned (49% response rate), of which four were excluded for being incomplete, and 12 because the patient reported a cancer other than colorectal; final $N = 479$. The questionnaire included the consent form, and therefore no data were available on non-responders. The average age of respondents was 68 years (range 31–97), 59% were male, 90% were white, 20% had experienced a cancer recurrence, and 16% were currently receiving treatment (see Table 1).

Association between health behaviours and quality of life

Health behaviour results are shown in Table 2. More than half the respondents (57%) were consuming fewer than 5 portions of F&V a day, over half (58%) were overweight or obese, and the majority (82%) were not physically active. However, very few were current smokers (6%) or heavy drinkers (8%), and 27% were non-drinkers.

Table 3 presents the associations between health behaviours and QoL subscales and fatigue. Participants who were physically active had higher global ($P = 0.003$), physical ($P = <0.001$), role ($P = 0.007$), cognitive ($P = 0.037$), and social QoL scores ($P = 0.024$), as well as lower fatigue ($P = 0.004$). Those who ate ≥5 portions of F&V a day had higher global ($P = <0.001$), physical ($P = 0.002$), role ($P = 0.021$) and cognitive scores ($P = 0.004$). Effects were in the other direction for weight, with overweight survivors having higher cognitive scores ($P = 0.032$) and lower levels of fatigue ($P = 0.039$). Non-drinkers had lower physical ($P = 0.030$), role ($P = 0.039$) and social ($P = 0.034$) scores, and higher fatigue ($P = 0.026$) compared to moderate drinkers. There were no significant associations between QoL and either smoking or heavy drinking.

Logistic regression was used to examine associations between health behaviours and symptoms. Respondents who were physically active reported less pain: 26% versus

Table 1 Demographic characteristics

Characteristic	Men (n = 284)	Women (n = 194)
Age in years (SD)	66.75 (10.86)	69.37 (11.24)
Missing n = 6		
Deprivation: N (%)		
0 (low)	153 (57)	74 (41)
1	66 (25)	69 (39)
2	40 (15)	27 (15)
3 (high)	8 (3)	9 (5)
Missing n = 33		
Ethnicity: N (%)		
White	257 (92)	174 (90)
None white	23 (8)	19 (10)
Missing n = 6		
Comorbidities: N (%)		
0	133 (48)	66 (36)
1	85 (31)	70 (39)
>1	60 (22)	46 (25)
Missing n = 19		
Time since diagnosis in years (SD)	2.06 (1.45)	2.15 (1.52)
Missing n = 0		
Recurrence: N (%)	66 (25)	30 (16)
Missing n = 20		
Receiving treatment: N (%)	50 (18)	23 (13)
Missing n = 26		

45% (OR = 0.41, 95% CI, 0.27–0.61) and less sleep disruption; 39 versus 52%; (OR = 0.45, 95% CI, 0.37–0.56). Participants eating ≥5 portions of F&V a day had less constipation than those eating less; 20 versus 30% (OR 0.50; 95% CI, 0.26–0.96). Normal-weight individuals had more nausea than those who were overweight or obese, 21 versus 16% (OR 2.12; CI, 1.33–3.36); more loss of appetite, 21 versus 17% (OR 2.02; 95% CI, 1.37–2.96); and less dyspnoea, 31 versus 41% (OR 0.70; 95% CI, 0.55–0.89). Non-drinkers had more loss of appetite; 29% versus 16% (OR 1.77; 95% CI 1.25–2.51) and more diarrhoea 35 versus 27% (OR 1.37; 95% CI 1.01–1.68) compared to moderate drinkers. There were no other significant associations with symptoms.

Associations between health behaviour score and quality of life

The health behaviour score was created by adding one point for each healthy behaviour. Only five respondents scored 0 on the health behaviour score; therefore, for analysis they were combined with those scoring one. Significant linear trends were found between health behaviour

Table 2 Prevalence of health behaviours

Health behaviour	Men N (%)	Women N (%)
Activity		
≥5 sessions per week	56 (20)	28 (15)
<5 sessions per week	214 (80)	157 (85)
Missing $n = 23$		
Fruit and vegetables		
≥5 portions of F&V a day	97 (36)	95 (52)
<5 portions of F&V a day	171 (64)	88 (48)
Missing $n = 27$		
Smoking status		
Current smokers	24 (9)	4 (2)
Ex-smokers	141 (52)	78 (44)
Never smokers	105 (39)	97 (54)
Missing $n = 29$		
Alcohol		
Non-drinkers	54 (21)	64 (37)
Moderate drinkers	183 (70)	99 (58)
Heavy drinkers[a]	24 (9)	9 (5)
Missing $n = 46$		
BMI		
Normal weight (<25 kg/m^2)	111 (41)	76 (43)
Overweight (≥25 to <30 kg/m^2)	112 (42)	64 (36)
Obese (>30 kg/m^2)	46 (17)	37 (21)
Missing $n = 33$		

[a] >21 units per week for men, >14 units per week for women

score and global QoL and physical function (Fig. 1). A significant negative linear trend was also found for fatigue ($P = 0.001$). The linear trend approached significance for role function ($P = 0.06$). Logistic regression revealed that higher health behaviour scores were associated with less pain (OR 0.64; 95% CI 0.53–0.80, $P = 0.001$), less dyspnoea (OR 0.65; 95% CI 0.55–0.80, $P < 0.001$) and less constipation (OR 0.76; 95% CI 0.60–0.96, $P = 0.020$).

Discussion

In this sample of CRC survivors, smoking and heavy drinking were relatively infrequent, but intake of F&V and frequency of physical activity were low, and prevalence of overweight was high. To set these results in context, we compared them with population data for older adults from the recent HSE 2008 [36]. General population figures show that only 20% of men and 17% of women were physically active five times a week, which was strikingly similar to the 20 and 15% rates in this sample. The other four health behaviours were broadly positive in cancer survivors compared with the general population. The proportion

meeting the 5-a-day target for F&V consumption was 42%, which was higher than the 30% of older adults in the HSE. Prevalence of smoking (6%) was considerably lower than in a recent population sample of English cancer survivors (15%) [24], and lower than in the general UK population at this age group (13%). Heavy drinking was also infrequent compared with population levels, although 46 participants did not give consumption levels.

Comparing these results with findings from Australia and the US reveal some similarities. Absolute rates of physical activity were higher in CRC survivors from Australia and the US (32 and 39%) [15, 16], but activity levels in the general population are comparably higher there [37], as are physical activity levels among survivors of other cancers sites, e.g. breast and prostate [15]. Smoking rates in CRC survivors in Australia (8%) and the US (9%) are also lower than in the general population [15, 22] and in one of the few studies of alcohol consumption, CRC survivors in Australia also reported low consumption [17]. There is evidence of similarly low levels of alcohol consumption among survivors of numerous other cancer sites [20]. In contrast, F&V consumption in the present study is higher than previously reported, both among CRC samples and survivors of other cancers [14, 15].

The lower levels of smoking and alcohol consumption and higher F&V intake compared with the general population may be because the survivors in this sample had made positive lifestyle changes following diagnosis. Early research suggested that cancer survivors often made spontaneous changes to their lifestyle [38], but recent prospective studies addressing behaviour change have produced mixed results. One Norwegian study reported no notable changes in F&V intake, physical activity or alcohol [39], although another US study [40] found increases in vegetable consumption and physical activity. No comparative data are available in a UK sample.

Quality-of-life scores were comparable to scores from the EORTC Reference Value Manual for CRC survivors of a similar age, except that emotional function scores were 11 points higher in our sample [41]. Survivors who were physically active had better scores for global QoL and all functional subdomains except emotional and cognitive function, as well as lower levels of fatigue, pain and insomnia. Previous studies have consistently shown a positive association between physical activity and general QoL. The results from this study are also consistent with the few studies that present data on QoL subdomains [16, 42], although one failed to find an association with functional QoL [42]. F&V intake was also associated with better global QoL, physical, role and social function, which is similar to findings from the large US study that included 1,918 CRC patients [15] although that study did not present results on QoL subdomains.
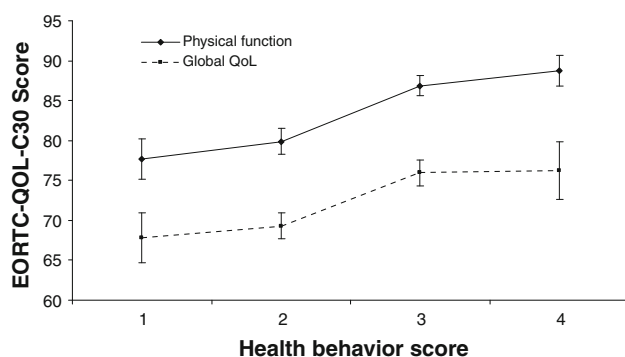
Table 3 Association between quality-of-life subscales and health behaviours

| | Adjusted quality-of-life score (0–100) Means (SE) | | | |
| | Physical activity | | Regression coefficient (95% CI)[a] | P value |
	≥5 sessions per week	<5 sessions per week		
Global quality of life	77.34 (2.25)	70.36 (1.13)	6.98 (2.06–11.90)	0.005
Physical function	90.11 (1.48)	81.77 (0.98)	8.34 (4.92–11.76)	<0.001
Role function	87.87 (2.36)	81.82 (1.43)	6.04 (0.65–11.44)	0.028
Social function	83.39 (2.98)	76.56 (1.46)	6.83 (0.30–13.37)	0.040
Fatigue[b]	19.27 (2.49)	26.58 (1.18)	−7.30 (−12.67 to −1.92)	0.008
	Fruit and vegetable intake			
	≥5 portions a day	<5 portions a day		
Global quality of life	75.26 (1.37)	67.71 (1.47)	7.54 (3.61–11.48)	<0.001
Physical function	85.88 (1.10)	80.18 (1.29)	5.70 (2.28–9.12)	0.001
Role function	86.25 (1.70)	78.75 (1.83)	7.40 (2.61–12.38)	0.003
Cognitive function	88.02 (1.28)	82.51 (1.37)	5.51 (1.73–9.29)	0.004
Fatigue	22.85 (1.64)	28.34 (1.65)	−5.49 (−10.14 to −0.84)	0.021
	Alcohol consumption			
	No alcohol	Moderate alcohol intake[c]		
Physical function	78.50 (1.98)	83.56 (1.07)	−5.07 (−9.65 to −.485)	0.030
Role function	76.06 (3.28)	83.86 (1.57)	−7.80 (−15.20 to −.390)	0.039
Social function	71.19 (3.51)	79.38 (1.51)	−8.18 (−15.73 to −.626)	0.034
Fatigue	30.75 (2.71)	23.76 (1.32)	6.99 (.82–13.17)	0.026

[a] Adjusted for age, sex, SES, comorbidities, recurrence, current treatment and time since diagnosis

[b] Higher scores of fatigue indicates a higher degree of that symptom

[c] Moderate alcohol intake: >1 and <14 units for women, >1 and <21 units for men

Fig. 1 Association between health behaviour score and quality of life

they excluded normal-weight survivors, so the observed differences came from comparisons of overweight and obese subgroups. The seemingly protective effect in our study most likely reflects lower weight being a consequence of symptoms and post-operative complications.

We found no significant association between smoking and QoL, unlike previous studies [14, 43]. The trends were in the same direction but our sample had too few current smokers to have adequate statistical power. We also found no association between heavy drinking and QoL. Non-drinkers had lower functional QoL and higher fatigue, as has been reported in healthy populations of older adults [44, 45], but in head and neck cancer samples non-drinkers have been found to have worse QoL [43]; research is clearly warranted.

A composite positive health behaviour score showed a clear linear relationship with QoL, with differences in scores indicating a moderate effect compared with those observed in clinical settings [46]. This is also the first study to examine the association between number of health behaviours and fatigue and cancer symptoms, and

We found few significant associations between BMI and QoL subscales, with the exception of cognitive function, and similar null findings have been reported elsewhere [39]. Being overweight/obese was however associated with *better* cognitive function and *less* pain, nausea, loss of appetite and fatigue. This contrasts with results from a previous study of a mixed diagnosis group [15, 42], but

demonstrated a favourable result. Three other studies have found a similar cumulative effect of health behaviours on general QoL in cancer survivors [14, 15, 42], and together these studies support the case for promoting multiple behaviour change among cancer survivors.

This study had a number of limitations. The response rate was only 49%, and although this is comparable to other studies [15, 22, 27], it still limits generalisability, as does the limited number of responses from those in socially disadvantaged groups. The study was cross-sectional, which made it impossible to draw causal inferences concerning the relationship between health behaviours and QoL, but bidirectional effects are likely. For example, there is evidence from healthy populations that physical activity has favourable effects on well-being (see Bize et al. for review) [47], but at the same time, fatigue and pain are likely to be disincentives to activity. Reliance on self-reported health behaviours is likely to over-estimate physical activity and F&V consumption, and under-estimate alcohol and smoking. Data concerning types of treatment received by participants would also have enhanced this study as would complete clinical data on date of diagnosis. In addition, creating the health behaviour score by simply adding the behaviours together gives equal weight to each behaviour and although this method has been used in previous studies [14, 15], it may not accurately reflect the true associations between QoL. Future work to investigate creation of weighted scores would add to this literature.

On the positive side, this is the first UK study to investigate health behaviours and QoL in CRC survivors and to include novel data on QoL subdomains and cancer symptoms. It is also one of only a handful to examine associations between multiple health behaviours and QoL. Cancer survivors did not have poorer health behaviours than general population samples, but both physical activity levels and F&V intake were suboptimal, and lower levels of health behaviours were associated with significantly poorer QoL. Given that cancer survivors are at increased risk of diseases with an established behavioural aetiology and there is emerging evidence for a protective effect of health-related behaviours on cancer survival [10, 11, 13], health behaviour change in the growing population of CRC survivors is an important area for research. A small number of studies have demonstrated promising results [48, 49], but the challenges of intervention delivery are widely acknowledged. More research is needed to determine the most effective means of encouraging behaviour change in this vulnerable group. This research priority is supported at UK government level with the National Cancer Survivorship Initiative calling for a greater focus on recovery, health and well-being after cancer treatment, including support for engagement in healthful behaviours [50].

References

1. Boyle, P., & Langman, J. S. (2000). ABC of colorectal cancer—epidemiology. *British Medical Journal, 321*(7264), 805–808.
2. Cancer Research UK. (2007). *Cancer Research UK: Survival statistics*. Cancer Research UK. Internet http://info.Cancer researchuk.org/cancerstats/survival/.
3. Parkin, D., Olsen, A., & Sasieni, P. (2009). The potential for prevention of colorectal cancer in the UK. *European Journal of Cancer Prevention, 18*(3), 179–190.
4. Giovannucci, E. (2001). An updated review of the epidemiological evidence that cigarette smoking increases risk of colorectal cancer. *Cancer Epidemiology, Biomarkers and Prevention, 10*(7), 725–731.
5. Arden-Close, E., Pacey, A., & Eiser, C. (2010). Health-related quality of life in survivors of lymphoma: A systematic review and methodological critique. *Leukemia & Lymphoma, 51*(4), 628–640.
6. Baker, F., Haffer, S. C., & Denniston, M. (2003). Health-related quality of life of cancer and noncancer patients in medicare managed care. *Cancer, 97*(3), 674–681.
7. Ernst, J., Peuker, M., Schwarz, R., Fischbeck, S., & Beutel, M. E. (2009). Long-term survival of adult cancer patients from a psychosomatic perspective—literature review and consequences for future research. *Zeitschrift fur Psychosomatische Medizin und Psychotherapie, 55*(4), 365–381.
8. Carver, J. R., Shapiro, C. L., Ng, A., Jacobs, L., Schwartz, C., Virgo, K. S., et al. (2007). American Society of Clinical Oncology clinical evidence review on the ongoing care of adult cancer survivors: Cardiac and pulmonary late effects. *Journal of Clinical Oncology, 25*(25), 3991–4008.
9. Fossa, S. D., Dahl, A. A., & Loge, J. H. (2003). Fatigue, anxiety, and depression in long-term survivors of testicular cancer. *Journal of Clinical Oncology, 21*(7), 1249–1254.
10. Meyerhardt, J. A., Giovannucci, E. L., Holmes, M. D., Chan, A. T., Chan, J. A., Colditz, G. A., et al. (2006). Physical activity and survival after colorectal cancer diagnosis. *Journal of Clinical Oncology, 24*(22), 3527–3534.
11. Meyerhardt, J. A., Heseltine, D., Niedzwiecki, D., Hollis, D., Saltz, L. B., Mayer, R. J., et al. (2006). Impact of physical activity on cancer recurrence and survival in patients with stage III colon cancer: Findings from CALGB 89803. *Journal of Clinical Oncology, 24*(22), 3535–3541.
12. Calle, E. E., Rodriguez, C., Walker-Thurmond, K., & Thun, M. J. (2003). Overweight, obesity, and mortality from cancer in a prospectively studied cohort of US adults. *New England Journal of Medicine, 348*(17), 1625–1638.
13. Meyerhardt, J. A., Niedzwiecki, D., Hollis, D., Saltz, L. B., Hu, F. B., Mayer, R. J., et al. (2007). Association of dietary patterns with cancer recurrence and survival in patients with stage III colon cancer. *Journal of the American Medical Association, 298*(7), 754–764.
14. Blanchard, C. M., Stein, K. D., Baker, F., Dent, M. F., Denniston, M. M., Courneya, K. S., et al. (2004). Association between

current lifestyle behaviors and health-related quality of life in breast, colorectal, and prostate cancer survivors. *Psychology & Health, 19*(1), 1–13.

15. Blanchard, C. M., Courneya, K. S., & Stein, K. (2008). Cancer survivors' adherence to lifestyle behavior recommendations and associations with health-related quality of life: Results from the American Cancer Society's SCS-II. *Journal of Clinical Oncology, 26*(13), 2198–2204.

16. Lynch, B. M., Cerin, E., Owen, N., & Aitken, J. F. (2007). Associations of leisure-time physical activity with quality of life in a large, population-based sample of colorectal cancer survivors. *Cancer Causes and Control, 18*(7), 735–742.

17. Lynch, B. M., Cerin, E., Owen, N., Hawkes, A. L., & Aitken, J. F. (2008). Prospective relationships of physical activity with quality of life among colorectal cancer survivors. *Journal of Clinical Oncology, 26*(27), 4480–4487.

18. World Cancer Research Fund/American Institute for Cancer Research. (2007). *Food, nutrition, physical activity, and the prevention of cancer: A global perspective*. Washington DC: AICR.

19. Bellizzi, K. M., Rowland, J. H., Arora, N. K., Hamilton, A. S., Miller, M. F., & Aziz, N. M. (2009). Physical activity and quality of life in adult survivors of Non-Hodgkin's lymphoma. *Journal of Clinical Oncology, 27*(6), 960–966.

20. Coups, E. J., & Ostroff, J. S. (2005). A population-based estimate of the prevalence of behavioral risk factors among adult cancer survivors and noncancer controls. *Preventive Medicine, 40*, 702–711.

21. Eakin, E. G., Youlden, D. R., Baade, P. D., Lawler, S. P., Reeves, M. M., Heyworth, J. S., et al. (2007). Health behaviors of cancer survivors: Data from an Australian population-based survey. *Cancer Causes and Control, 18*(8), 881–894.

22. Hawkes, A. L., Lynch, B. M., Youlden, D. R., Owen, N., & Aitken, J. F. (2008). Health behaviors of Australian colorectal cancer survivors, compared with noncancer population controls. *Supportive Care in Cancer, 16*(10), 1097–1104.

23. Bellizzi, K. M., Rowland, J. H., Jeffery, D. D., & McNeel, T. (2005). Health behaviors of cancer survivors: Examining opportunities for cancer control intervention. *Journal of Clinical Oncology, 23*(34), 8884–8893.

24. Grimmett, C., Wardle, J., & Steptoe, A. (2009). Health behaviours in older cancer survivors in the English Longitudinal Study of Ageing. *European Journal of Cancer, 45*(12), 2180–2186.

25. Courneya, K. S., Friedenreich, C. M., Quinney, H. A., Fields, A. L. A., Jones, L. W., & Fairey, A. S. (2003). A randomized trial of exercise and quality of life in colorectal cancer survivors. *European Journal of Cancer Care, 12*(4), 347–357.

26. Steginga, S. K., Lynch, B. M., Hawkes, A., Dunn, J., & Aitken, J. (2009). Antecedents of domain-specific quality of life after colorectal cancer. *Psycho-Oncology, 18*(2), 216–220.

27. Gil, K. M., Von Gruenigen, V. E., Frasure, H. E., Grandon, M., Hopkins, M. P., & Jenison, E. L. (2004). Simultaneous measurement of cancer specific quality of life and general health status in gynaecologic malignancies. *Journal of Clinical Oncology, 22*(14S), 8253.

28. Patwardhan, M. B., Samsa, G. P., McCrory, D. C., Fisher, D. A., Mantyh, C. R., Morse, M. A., Prosnitz, R. G., Cline, K. E., Gray, R. N. (2006) *Cancer care quality measures: Diagnosis and treatment of colorectal cancer*. Evidence report/technology assessment No. 138. (Prepared by the Duke Evidence-based Practice Center under Contract No. 290-02-0025) AHRQ Publication No. 06-E002. Rockville, MD: Agency for Healthcare Research and Quality.

29. Wardle, J., Farrell, M., Hillesden, M., Jarvis, M., Sutton, S., & Thorogood, M. (1999). Smoking, drinking, physical activity and screening uptake and health inequalities. In D. Gorden, M. Shaw,

& D. D. S. Dorling (Eds.), *Inequalities in health* (pp. 213–239). Bristol: Policy Press.

30. Craig, R., & Mindell, J. (2007). *Health survey for England 2005*, Volume 5, Methodology and documentation. London. United Kingdom: National Centre for Social Research.

31. Godin, G., Jobin, J., & Bouillon, J. (1986). Assessment of leisure-time exercise behavior by self-report—a concurrent validity study. *Canadian Journal of Public Health-Revue Canadienne de Sante Publique, 77*(5), 359–362.

32. Steptoe, A., Perkins-Porras, L., Rink, E., Hilton, S., & Cappuccio, F. P. (2004). Psychological and social predictors of changes in fruit and vegetable consumption over 12 months following behavioral and nutrition education counseling. *Health Psychology, 23*(6), 574–581.

33. Aaronson, N. K., Ahmedzai, S., Bergman, B., Bullinger, M., Cull, A., Duez, N. J., et al. (1993). The European-Organization-For-Research-And-Treatment-Of-Cancer Qlq-C30—a quality-of-life instrument for use in international clinical-trials in oncology. *Journal of the National Cancer Institute, 85*(5), 365–376.

34. Ulander, K., Jeppsson, B., & Grahn, G. (1997). Quality of life and independence in activities of daily living preoperatively and at follow-up in patients with colorectal cancer. *Supportive Care in Cancer, 5*(5), 402–409.

35. Khaw, K. T., Wareham, N. J., Bingham, S., Welch, A., Luben, R. N., & Day, N. E. (2008). Combined impact of health behaviours and mortality in men and women: The EPIC-Norfolk prospective population study. *PLoS Medicine, 5*(11), e12.

36. NHS information centre for health and social care. (2009). *Health Survey for England: 2008 trend tables*.

37. Armstrong, T., Bauman, A., & Davies, J. (2000). *Physical activity patterns of Australian adults: Results of the 1999 National Physical Activity Survey*. Canberra: National Institute of Health and Welfare.

38. Demark-Wahnefried, W., Peterson, B. L., McBride, C. M., Lipkus, I. M., & Clipp, E. (2000). Current health behaviors and readiness to pursue life-style changes among men and women diagnosed with early stage prostate and breast carcinomas. *Cancer, 88*, 674–684.

39. Skeie, G., Hjartaker, A., Braaten, T., & Lund, E. (2009). Dietary change among breast and colorectal cancer survivors and cancer-free women in the Norwegian Women and Cancer cohort study. *Cancer Causes and Control, 20*(10), 1955–1966.

40. Satia, J. A., Campbell, M. K., Galanko, J. A., James, A., Carr, C., & Sandler, R. S. (2004). Longitudinal changes in lifestyle behaviors and health status in colon cancer survivors. *Cancer Epidemiology, Biomarkers and Prevention, 13*(6), 1022–1031.

41. Fayers, P., Weeden, S., Curran, D., & On behalf of the EORTC Quality of Life Study Group. (1998). EORTC QLQ-C30 reference values. In EORTC (Ed.) Brussels.

42. Mosher, C. E., Sloane, R., Morey, M. C., Snyder, D. C., Cohen, H. J., Miller, P. E., et al. (2009). Associations between lifestyle factors and quality of life among older long-term breast, prostate, and colorectal cancer survivors. *Cancer, 115*(17), 4001–4009.

43. Duffy, S. A., Terrell, J. E., Valenstein, M., Ronis, D. L., Copeland, L. A., & Connors, M. (2002). Effect of smoking, alcohol, and depression on the quality of life of head and neck cancer patients. *General Hospital Psychiatry, 24*(3), 140–147.

44. Chan, A. M., von Muhlen, D., Kritz-Silverstein, D., & Barrett-Connor, E. (2009). Regular alcohol consumption is associated with increasing quality of life and mood in older men and women: The Rancho Bernardo Study. *Maturitas, 62*(3), 294–300.

45. Lang, I. L., Wallace, R., Huppert, F., & Melzer, D. (2007). Moderate alcohol consumption in older adults is associated with better cognition and well-being than abstinence. *Age and Ageing, 36*, 256–261.

46. King, M. T. (1996). The interpretation of scores from the EORTC quality of life questionnaire QLQ-C30. *Quality of Life Research, 5*(6), 555–567.

47. Bize, R., Johnson, J. A., & Plotnikoff, R. C. (2007). Physical activity level and health-related quality of life in the general adult population: A systematic review. *Preventive Medicine, 45*(6), 401–415.

48. Demark-Wahnefried, W., Morey, M. C., Clipp, E. C., Snyder, D. C., Sloane, R., Pieper, C. F., et al. (2005). Results of project LEAD (Leading the Way in Exercise and Diet)—a trial testing an intervention of telephone-counseling and mailed materials in improving physical functioning among older breast and prostate cancer survivors. *Journal of Clinical Oncology, 23*(16), 763S.

49. Morey, M. C., Snyder, D. C., Sloane, R., Cohen, H. J., Peterson, B., Hartman, T. J., et al. (2009). Effects of home-based diet and exercise on functional outcomes among older, overweight long-term cancer survivors RENEW: A randomized controlled trial. *Journal of the American Medical Association, 301*(18), 1883–1891.

50. Department of Health, Macmillan Cancer Support, NHS Improvement. (2010). *National Cancer Survivorship Initiative (NCSI) vision.*