

Keywords: cancer survivors; behaviours; diet; smoking; physical activity; obesity

Diet, exercise, obesity, smoking and alcohol consumption in cancer survivors and the general population: a comparative study of 16 282 individuals

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Background: Cancer survivors may be particularly motivated to improve their health behaviours.

Methods: We compared health behaviours and obesity in cancer survivors with the general population, using household survey and cancer registry data.

Results: Cancer survivors were more likely than those with no history of cancer to eat fruit and vegetables (OR_{adj} 1.41, 95% CI 1.19–1.66), less likely to engage in physical activity (OR_{adj} 0.79, 95% CI 0.67–0.93) and more likely to have stopped smoking (OR_{adj} 1.25, 95% CI 1.09–1.44).

Conclusions: Most health-related behaviours were better in cancer survivors than the general population, but low physical activity levels may be amenable to health promotion interventions.

There may be opportunities to change the health behaviours of cancer survivors to reduce the risk of further malignancies, other preventable diseases and to improve cancer-related and overall survival. However, it is not known whether cancer survivors are likely to have better, similar, or worse health behaviours than the general population and therefore whether they should be targeted for health improvement interventions.

It might be expected that many cancer patients have health-related behaviours, which contributed to the development of their malignancy (Mayer *et al*, 2007; Mayer and Carlson, 2011). However, having been diagnosed with cancer, patients may be motivated to change their behaviour (Bassett *et al*, 2012). These effects are opposing and may explain why researchers have found few significant differences in health behaviours among cancer survivors compared with the general population (Courneya, 2003; Coups and Ostroff, 2005; Courneya *et al*, 2008; Rogers *et al*, 2008; Fairley *et al*, 2010).

It is thought that some changes in health behaviours may be spontaneously provoked by the diagnosis of cancer and interactions

with health-care professionals, so called ‘teachable moments’ (Demark-Wahnefried *et al*, 2005, 2006). Research on whether changes in health behaviours do occur is limited and much of the work has focused on female breast cancer survivors (Alfano *et al*, 2009; Littman *et al*, 2010; Sprague *et al*, 2010).

To inform these issues we describe health behaviours (fruit and vegetable consumption, physical activity, smoking and alcohol consumption) and obesity in cancer survivors compared with people with no history of cancer and people who subsequently developed cancer.

MATERIALS AND METHODS

Data and health behaviour definitions. We obtained data from Scottish Health Surveys in 1995, 1998, 2003 and 2008. These are cross-sectional nationally representative general health surveys from Scotland, UK (population 5.2 million); details of these surveys

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Received 3 June 2014; revised 22 October 2014; accepted 27 October 2014; published online 27 November 2014

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are described elsewhere (Corbett *et al*, 2009). Approval was obtained from all participating Health Boards' ethics committees.

The surveys were linked to the national Scottish Cancer Registry to identify whether a participant had received a cancer diagnosis up to December 2008. Cancer was defined as all invasive malignancies (International Classification of Diseases, Revision 10, C00-C96). Individual cancer sites were defined as lung (ICD-10 C33-34), breast (C50), bowel (C18-20) and prostate (C61).

Behavioural and anthropometric risk factors were dichotomized so that they either did or did not satisfy the following criteria: ≥ 5 -a-day-combined consumption of fruit and vegetables equals 5 or more 80 g or 2.8 oz portions per day; obese-nurse-measured body mass index $\geq 30 \text{ kg m}^{-2}$; ≥ 2 h physical activity/week-physical activity includes home-based activities, walking, sports and exercise, and activity at work; alcohol > recommended-weekly consumption exceeds 21 units for men and 14 units for women (1 unit = 10 ml or 8 g or 0.35 fl oz ethanol); former smoker and former drinker, as self-reported at the time of survey.

An area-based measure of socio-economic deprivation, the Scottish Index of Multiple Deprivation (SIMD) was employed (Scottish Index of Multiple Deprivation: Background and Methodology. The Scottish Government, 2012). This uses seven domains (employment, income, health, education, access to services, crime and housing) to rank geographic areas, from which we used quintiles from 1 (most deprived) to 5 (least deprived).

Analysis and statistical methods. Exploratory descriptive analyses using χ^2 -tests, independent sample *t*-tests and binary logistic regressions were carried out. Adjusted, multivariable analyses with each dichotomous behaviour variable as the dependant variable and age, sex and SIMD as explanatory variables

were carried out. All analyses were unweighted, conducted with STATA software, version 11 and the conventional threshold of $P < 0.05$ used to indicate statistical significance.

We compared health behaviours in cancer patients who were diagnosed relatively recently (<2 years), much earlier (≥ 2 years) before the survey and soon after the survey (<2 years) with those who were diagnosed two or more years after the survey.

RESULTS

The total sample size was 31 136 respondents. We excluded 15 077 respondents who were aged <45 years because the incidence of cancer is much less common at these ages. The final sample comprised 16 282 participants among whom 922 (5.7%) had a diagnosis of cancer before they were surveyed (cancer survivors) and 1257 (7.7%) were diagnosed with cancer following the survey. All respondents had complete data for age and sex, and missing data comprised the following: 1628 for socio-economic data; 1 for smoking status; 10 for alcohol use; 10 for fruit and vegetable consumption; 4329 for physical activity and 2250 for BMI. Cancer survivors were significantly older than those with no history of cancer (mean ages 59.7 vs 66.6 years, respectively, $P < 0.001$). There were no significant differences in proportions of females (55.8% in both, $\chi^2 = 0.002$, $P = 0.96$) or in socio-economic distributions ($\chi^2 = 5.30$, $P = 0.26$) between the two groups (Table 1).

Cancer survivors, compared with those with no history of cancer, were significantly more likely to eat at least five portions of fruit and vegetables a day (21% vs 15%, OR_{adj} 1.41, 95% CI 1.19–1.66), less likely to take at least 2 h physical activity a week (35% vs 45%, OR_{adj} 0.79, 95% CI 0.67–0.93) and more likely to have

Table 1. Demographic and behavioural characteristics of Scottish Health Survey respondents, 1995, 1998, 2003, 2008

	All respondents n (%)	Respondents with a previous cancer n (%)	Respondents without a previous cancer n (%)	
			Subsequent cancer	No subsequent cancer
Sex				
Men	7200 (44.2)	407 (44.1)	598 (47.6)	6195 (43.9)
Women	9082 (55.8)	515 (55.9)	659 (52.4)	7908 (56.1)
Median age (IQR)	59 (52–67)	67 (59–74) ^a	62 (56–69)	58 (51–66)
SIMD				
1 (most deprived)	2863 (19.5)	170 (18.4)	284 (22.7)	2409 (19.3)
2	3125 (21.3)	181 (19.6)	271 (21.6)	2673 (21.4)
3	3136 (21.4)	191(20.7)	285 (22.8)	2660 (21.3)
4	3050 (20.8)	209 (22.7)	228 (18.2)	2613 (20.9)
5 (least deprived)	2480 (16.9)	171 (18.5)	184 (14.7)	2125 (17.0)
Cancer				
All	2179 (100)	922 (100)	1257 (100)	14103 (0)
Lung	251 (11.5)	39 (4.2)	212 (16.9)	
Breast	355 (16.3)	206 (22.3)	149 (11.9)	
Prostate	171 (7.8)	71 (7.7)	100 (8.0)	
Bowel	235 (10.8)	105 (11.4)	130 (10.3)	
Behaviour				
≥ 5 -a-day	2552 (15.7)	193 (20.9) ^a	117 (9.3)	2242 (15.9)
≥ 2 h PA per week	5315 (32.6)	248 (26.9) ^a	284 (22.6)	4783 (33.9)
Current smoker	4512 (27.7)	197 (21.4)	447 (35.6)	3868 (27.4)
Former smoker	5464 (33.6)	400 (43.4) ^a	421 (33.5)	4643 (32.9)
Alcohol > recommended	2980 (18.3)	151 (16.4)	238 (18.9)	2591 (18.4)
Former drinker	1079 (6.6)	79 (8.6)	74 (5.9)	926 (6.6)
Obesity	4020 (24.7)	208 (22.6)	304 (24.2)	3508 (24.9)

Numbers of participants, percent and median ages with inter-quartile ranges (IQR); $N = 16\,282$. Scottish Health Survey participants aged >45 years (unweighted analysis).

^aDifferences with respondents without a prior cancer significant at the 0.05 level.

stopped smoking (43% vs 33%, OR_{adj} 1.25, 95% CI 1.09–1.44) compared with respondents with no history of cancer (Table 2). Within each major cancer site, breast cancer survivors were more likely to eat fruit and vegetables (OR_{adj} 1.72, 95% CI 1.25–2.37) and to be former smokers (OR_{adj} 1.45, 95% CI 1.09–1.93) and lung cancer survivors were less likely to be obese (OR_{adj} 0.32, 0.11–0.92). No other significant site-specific associations were found.

Cancer survivors compared with future cancer patients–time since/to diagnosis. Fruit and vegetable consumption and being a former drinker were highest among cancer survivors who had been diagnosed <2 years before, but the effect was smaller than ≥ 2 years after diagnosis (Table 3). Similarly, current smoking was least prevalent among those surveyed within 2 years of diagnosis and higher in those diagnosed ≥ 2 years before. Being a former drinker was only significantly raised among those within 2 years of a cancer diagnosis. Within each cancer site, women with a more recent diagnosis of breast cancer were most likely to eat five or more portions of fruit and vegetables per day (OR_{adj} 3.33, $P=0.011$ and OR_{adj} 2.55, $P=0.008$ in those diagnosed <2 years and >2 years before survey, respectively); and those with a more recent diagnosis of colorectal cancer were more likely to report being former drinkers (OR_{adj} 6.04, $P=0.005$ and OR_{adj} 0.65, $P=0.553$ in those diagnosed <2 years and >2 years before survey, respectively).

DISCUSSION

In this national survey of over 16 000 adults, we found that cancer survivors ate more fruit and vegetables and were more likely to

have stopped smoking, but took less physical activity compared with those who had not had cancer. Lower levels of physical activity among cancer survivors have been reported in the English Longitudinal Study of Ageing (Williams *et al*, 2013), while the NHANES study reported both longer durations of sedentary behaviour but also significantly higher moderate intensity and frequency of exercise (Kim *et al*, 2013). We found breast cancer survivors were more likely to eat fruit and vegetables, and to have stopped smoking, in contrast to the findings of a recent prospective Danish study (Bidstrup *et al*, 2013). Lung cancer survivors were more likely to have stopped smoking compared with those who would subsequently develop cancer. This may be a survivor bias or a true behavioural change (Evangelista *et al*, 2003). We found that recommended health behaviours were more prevalent among those who had been more recently diagnosed, but the effect size was smaller two or more years after the diagnosis.

The low levels of physical activity that we observed may be amenable to interventions. CanChange (Hawkes *et al*, 2013), the Copenhagen Physical Activity after Cancer Treatment trial (Midtgaard *et al*, 2013) and BeWEL (Anderson *et al*, 2014) have reported significant improvements in physical activity in similar patient populations, with CanChange and BeWEL also achieving reductions in BMI among overweight patients. Adherence to recommended preventative behaviours may improve quality of life (Inoue-Choi *et al*, 2013) and survival (Izano *et al*, 2013), although the association may be confounded by underlying systemic illness. A recent systematic review of randomized controlled trials of physical activity interventions among cancer survivors found evidence for a range of physiological, physical and psychological benefits but did not identify any papers that reported outcomes

Table 2. Health behaviours in cancer survivors and those with no previous cancer

Risk factor	Number (%) by cancer history						OR_{adj} All survivors
	No cancer N (%)	All survivors N (%)	Lung	Breast	bowel	prostate	
≥ 5 -a-day	2359 (15%)	193 (21%)	1 (3%)	55 (27%)	23 (22%)	12 (17%)	1.41 (1.19–1.66)
Obese	3812 (29%)	208 (27%)	4 (13%)	56 (33%)	29 (33%)	18 (28%)	0.87 (0.74–1.03)
≥ 2 h PA per week	5067 (45%)	248 (35%)	7 (25%)	59 (37%)	20 (26%)	25 (40%)	0.79 (0.67–0.93)
Current smoker	4315 (28%)	197 (21%)	15 (38%)	48 (23%)	18 (17%)	14 (20%)	0.90 (0.76–1.06)
Former smoker	5064 (33%)	400 (43%)	20 (51%)	84 (41%)	53 (50%)	38 (54%)	1.25 (1.09–1.44)
Alcohol > recommended	2829 (18%)	151 (16%)	7 (18%)	23 (11%)	14 (13%)	13 (18%)	1.03 (0.85–1.24)
Former drinker	1000(7%)	79 (9%)	5 (13%)	12 (6%)	12 (11%)	7 (9%)	1.26 (0.99–1.61)

Numbers, percent and odds Ratios (OR) adjusted for age, sex and socio-economic deprivation. Scottish Health Survey participants aged >45 years (unweighted analysis).

Table 3. Health behaviours in cancer survivors and participants who subsequently developed cancer by recent (<2 years) or less recent (≥ 2 years) cancer diagnosis

Risk factor	Diagnosed before survey OR_{adj}				Diagnosed after survey OR_{adj}		
	≥ 2 years		<2 years		<2 years		≥ 2 years
	OR (95%CI)	n (%)	OR (95%CI)	n (%)	OR (95%CI)	n (%)	n (%)
≥ 5 -a-day	2.40 (1.80–3.20)*	141 (20.2)	3.14 (2.14–4.61)*	52 (23.3)	1.23 (0.78–1.96)	26 (10.8)	91 (9.0)
Obese	0.88 (0.69–1.11)	153 (26.1)	1.07 (0.75–1.52)	55 (30.4)	0.68 (0.48–0.98)*	46 (21.8)	258 (28.5)
≥ 2 h PA/ per day	1.14 (0.89–1.46)	200 (36.7)	0.74 (0.51–1.09)	48 (28.4)	1.18 (0.82–1.70)	66 (38.2)	218 (35.6)
Current smoker	0.60 (0.47–0.76)*	145 (20.7)	0.59 (0.41–0.83)*	52 (23.3)	1.02 (0.75–1.39)	80 (33.2)	367 (36.1)
Former smoker	1.40 (1.14–1.72)*	308 (44.1)	1.30 (0.96–1.77)	92 (41.3)	1.05 (0.78–1.42)	88 (36.5)	333 (32.8)
Alcohol > recommended	1.02 (0.79–1.32)	118 (16.9)	0.81 (0.54–1.23)	33 (14.8)	1.01 (0.69–1.48)	42 (17.5)	196 (19.3)
Former drinker	1.34 (0.91–1.97)	53 (7.6)	2.07 (1.27–3.38)*	26 (11.7)	1.10 (0.62–1.96)	16 (6.7)	58 (5.71)

Scottish Health Survey participants aged >45 years. Numbers, percent and Odds Ratios (OR) and 95% CI adjusted for age, sex and socio-economic deprivation. * $P<0.05$

such as survival (Fong *et al*, 2012). Further research is needed to confirm whether cancer outcomes are improved through other interventions, such as low-fat or high-fibre diets (Meyerhardt *et al*, 2007; Davies *et al*, 2011).

The strengths of our analysis include a relatively large and representative sample size, validated methodologies, the use of cancer registry data rather than self-reported cancer diagnosis (Williams *et al*, 2013) and differentiation between site-specific cancers. Its weaknesses include lack of validity of self-reported health behaviours. However, because Scottish Health Surveys are not carried out on any specific patient or risk group, we think it is less likely that there would be systematic over- or under-reporting of particular behaviours. We were unable to track behaviour change over time so we cannot say, from these cross-sectional data, whether the observed differences are a result of survivor bias or whether behaviours do change as a result of diagnosis, symptoms or treatment. Longitudinal prospective studies are needed to collect data on symptoms, treatment and behaviour change.

AUTHOR CONTRIBUTIONS

All authors contributed to the design of the study; ZW and DSM conducted analyses of data; all authors contributed to drafting the manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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