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

Z Wang¹, P McLoone¹ and D S Morrison*¹

¹West of Scotland Cancer Surveillance Unit, Institute of Health and Wellbeing, University of Glasgow, 1 Lilybank Gardens, Glasgow, G12 8RZ, UK

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 (Courneyea, 2003; Coups and Ostroff, 2005; Courneyea 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...
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 ≥30 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 dependant variable and age, sex and SIMD as explanatory variables analyses with each dichotomous behaviour variable as the dependent variable).

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 \(\chi^2\)-tests, independent sample \(t\)-tests and binary logistic regressions were carried out. Adjusted, multivariable analyses with each dichotomous behaviour variable as the dependent 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

| Behaviour | Respondents without a previous cancer n (%) | Respondents with a previous cancer n (%) | Subsequent cancer | No subsequent cancer |
|-----------|-----------------------------------------------|------------------------------------------|------------------|---------------------|
| Sex       |                                               |                                          |                  |                     |
| Men       | 7200 (44.2)                                   | 407 (44.1)                               | 596 (47.6)       | 6195 (43.7)         |
| Women     | 9082 (55.8)                                   | 515 (55.9)                               | 659 (52.4)       | 7908 (56.1)         |
| Median age (IQR) | 59 (52–67)                               | 67 (59–74)*                              | 62 (54–69)       | 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)       | 216 (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)*                              | 177 (9.3)        | 2242 (15.9)         |
| ≥2 h PA per week | 5315 (32.6)                              | 248 (26.9)*                              | 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)                       | 404 (43.4)*                              | 421 (33.5)       | 4643 (32.9)         |
| Alcohol > recommended | 2980 (18.3)                       | 151 (16.4)                               | 238 (18.9)       | 2591 (18.4)         |
| Former drinker | 1079 (6.4)                            | 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).

*Differences with respondents without a prior cancer significant at the 0.05 level.
stopped smoking (43% vs 33%, ORadj 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 (ORadj 1.72, 95% CI 1.25–2.37) and to be former smokers (ORadj 1.45, 95% CI 1.09–1.93) and lung cancer survivors were less likely to be obese (ORadj 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 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 (Evanista 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 (Midtgård 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.

**DISCUSSION**

In this national survey of over 16000 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 (Evanista 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.

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

| Risk factor | No cancer | All survivors | Lung | Breast | bowel | prostate | All survivors |
|-------------|-----------|---------------|------|--------|-------|---------|---------------|
|             | N (%)     | N (%)         | N (%) | N (%)  | N (%) | N (%)   | N (%)         |
| ≥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%)| 20 (26%)| 35 (50%)| 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 | ORadj | Diagnosed after survey | ORadj |
|---------------------------|-------------------------|-------|------------------------|-------|
|                          | ≥2 years | <2 years | ≥2 years | <2 years |
|                          | OR (95%CI) | n (%) | OR (95%CI) | n (%) | OR (95%CI) | n (%) | OR (95%CI) | 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 (35.6) | 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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