

Health-related behaviours in the EpiPorto study: cancer survivors versus participants with no cancer history

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Cancer survivors are at an increased risk of a second primary cancer, partly due to unhealthy behaviours. In a cohort of adults (recruitment: 1999–2003; follow-up – linkage with population-based cancer registry: up to 2009) we compared the baseline exposure to smoking, alcohol and dietary intake and physical activity between: cancer survivors (CS) – cancer diagnosis before baseline ($n=53$); no cancer (NC) participants – without cancer diagnosis at baseline or during follow-up ($n=2261$); latent cancer (LC) participants – without cancer diagnosis at baseline but diagnosed during follow-up ($n=139$). Age-, sex- and education-adjusted prevalences and means were computed, as applicable.

The prevalence of current smoking was nearly 20% among CS and NC (approximately four cigarettes per day) and 30% in LC (seven cigarettes per day). LC had the highest average alcohol intake (25.5 g/day) and NC the lowest (17.0 g/day). The proportion of participants reporting sports practice was higher for CS (50%) than for NC or LC (approximately 33%). CS and NC had higher fruit/vegetable consumption than LC (4.2 and 4.4 vs. 3.8 servings per day). In a composite index on health behaviours (including smoking, physical activity and alcohol and fruit/vegetable intake) the highest and lowest

scores were 1.74 for NC and 1.52 for LC respectively, whereas CS scored 1.63.

The exposure to each risk factor appeared comparable in CS and NC, whereas LC tended to have unhealthier behaviours. This may be partially explained by the acquisition of healthier habits by CS after diagnosis, but there still remains scope for improvement, as revealed by the low scores observed for the joint exposure to the main risk factors. *European Journal of Cancer Prevention* 20:348–354 © 2011 Wolters Kluwer Health | Lippincott Williams & Wilkins.

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Introduction

Cancer survivorship has dramatically increased in the latest decades, with most recent overall 5-year relative survival estimates (age-adjusted and casemix-adjusted) of 49.6% in Europe (Berrino *et al.*, 2009) and 64.4% in the USA (Curtis *et al.*, 2006; Ries *et al.*, 2007). Worldwide, the increasing survival of oncologic patients results in approximately 22 million cancer survivors (CSs) (Stewart and Kleihues, 2003), with a myriad of medical problems, such as recurrence of first cancer, comorbid late effects of treatment and second primary cancers.

Overall, CSs have a risk of developing a new malignancy nearly 14% higher than expected for the general population (Curtis *et al.*, 2006). Second primary cancers were estimated to represent 6.3% (ranging from 0.4 to 12.9% across cancer registries according to date of registration onset) of all incident cancer cases in Europe (1995–1999; Rosso *et al.*, 2009) and 16% in the USA (2003; Travis, 2006).

Second primary cancers are determined by iatrogenic causes, genetic characteristics and persistence of exposure

and/or effects of environmental exposures (Travis, 2006) after the diagnosis of a first primary cancer. It is therefore important to characterize CSs regarding risk behaviours modifiable by health promotion activities, namely those related to smoking, alcohol consumption, diet, obesity and physical activity (Hebert *et al.*, 1998; Khuri *et al.*, 2001; Rock and Demark-Wahnefried, 2002; Do *et al.*, 2003; Holmes *et al.*, 2005; Meyerhardt *et al.*, 2006a, 2006b; World Cancer Research Fund, 2007; Sanchez *et al.*, 2008), but research conducted in these specific populations is scarce.

In a cohort study we aimed to compare the baseline frequency of environmental risk factors for chronic diseases between CSs and participants with no previous cancer diagnosis (according to their status regarding cancer diagnosis at the end of follow-up).

Methods

Study population

This study was based on the evaluation of a cohort of adults living in Porto (EPIPorto). The recruitment of the initial sample has been previously described (Lucas *et al.*,

2009). In brief, the assembling of the cohort was conducted between 1999 and 2003 and comprised the evaluation of 2485 individuals, selected by random digit dialling, having households as the sampling unit. When a household was selected, all residents were identified by age and sex, and one resident (aged 18 years or more) was randomly selected as the respondent, without replacement if there was a refusal. The participation rate was 70% (Ramos *et al.*, 2004). A visit to the Department of Hygiene and Epidemiology of Porto Medical School was scheduled by telephone according to the participant's convenience. A personal interview, using a structured questionnaire comprising data on sociodemographic, clinical and lifestyle exposures, and a physical examination was performed by trained interviewers.

Identification of cancer cases

The identification of participants with a cancer diagnosis was accomplished using the North Region Cancer Registry and death certificate information. This population-based cancer registry was set up in 1988 and covers the whole northern region of Portugal (approximately 3.3 million inhabitants; RORENO, 1988). The identification of cohort participants in the cancer registry database was performed using the name and date of birth of each participant, up to December 2009, comprising a median follow-up time of 7.6 years (percentiles 25–75: 5.5–10.7).

We identified 192 first primary cancer cases (excluding 32 nonmelanoma skin cancers), 53 diagnosed before baseline assessment and 139 after the initial cohort evaluation. For analysis, we defined three groups taking into account the existence of a first primary cancer diagnosis and its timing, if applicable: CSs (cancer diagnosis before baseline assessment); participants with no cancer (NC) (without cancer diagnosis at baseline or during the follow-up); participants with latent cancer (LC) at baseline (without cancer diagnosis at the baseline but being diagnosed during the follow-up).

Evaluation of health-related behaviours

Participants were classified as smokers (current consumers of at least one cigarette per day, on average), occasional smokers (current consumers of less than one cigarette per day, on average), ex-smokers (not smoking for more than 6 months) and never-smokers [World Health Organization (WHO), 1997]. Smokers and occasional smokers were grouped for data analysis. With regard to the consumption of alcoholic beverages, participants were classified as drinkers (current consumers of at least one drink per week, on average), occasional drinkers (current consumers of less than a drink per week, on average), ex-drinkers (not drinking for more than 6 months) and never-drinkers. For analysis, occasional drinkers were grouped with drinkers of at least one beverage per week, and a category of drinkers of less than or equal to 1 standard drink per day for women and less than or equal to 2 standard

drinks per day for men was also created, according to the cutoff proposed by the American Heart Association (Lichtenstein *et al.*, 2006).

Dietary intake during the previous year was estimated using a validated semi-quantitative food-frequency questionnaire (Lopes, 2000; Lopes *et al.*, 2007) comprising 82 food item/group and beverage categories. For each item, participants were asked to indicate the average frequency of consumption (nine possible responses, ranging from never to six or more times per day), as well as the amount consumed (using a photograph manual with three portion sizes, small, medium and large), and the number of months during which the foods had been consumed in the previous year. Any foods that were not specified in the food-frequency questionnaire but eaten regularly (once a week or more frequently) were listed in an open section.

The consumption of fruit and vegetables was estimated by adding up the frequencies of consumption of medium servings, corrected for seasonality, of the items referring to different fruits (apple or pear, orange or mandarin, banana, kiwi, strawberry, cherry, peach or plum, melon or watermelon, persimmon, fig or loquat or apricot and grapes) and vegetables (lettuce, watercress, tomato, cucumber, green and white cabbages, broccoli, cauliflower or Brussels sprout, spinach or spring greens or turnip greens, spinach, bean pod, carrot, turnip, green pepper and onion), as previously described in detail (Lunet *et al.*, 2006). For analysis, the cutoff of five servings per day recommended by the World Cancer Research Fund on 'Food, Nutrition, Physical activity and the Prevention of Cancer' was used to classify participants according to fruit and vegetable consumption (World Cancer Research Fund, 2007).

Energy and nutrient intake were obtained from consumption frequency and portion size data using the software Food Processor Plus R (ESHA Research, Salem, Oregon, USA), based on values from the US Department of Agriculture, further adapted for typical Portuguese foods using the Portuguese tables of food composition (Ferreira and Graca, 1985) and data from other studies that analysed the composition of Portuguese foods (Lopes, 2000).

To calculate energy expenditure, we used standard metabolic energy equivalent task (MET) values. The MET is defined as the rate of energy expenditure in the activity compared with the resting metabolic rate (Blair *et al.*, 1985). Participants reported the average time spent on the following types of activity: rest (sleeping/lying awake); transport (to and from work); work; household activities; sedentary and leisure-time exercise. The activities were categorized as very light, light, moderate and heavy intensity, corresponding to an average of 1.5, 2.5, 5.0 and 7.0 MET, respectively (National Research Council, 1989). Energy expenditure was estimated by

multiplying the corresponding MET value by the time spent in each activity. The sum of the energy expenditure in each activity was computed to estimate the full-day energy expenditure.

Health behaviour score

To synthesize the joint exposure to the most important health behaviours, we adopted a previously published health behaviour score (Khaw *et al.*, 2008). In brief, the participants scored one point for each of the following health behaviours: current nonsmoking, not physically inactive (considering sedentary those with less than 10% of energy expenditure at a moderate or high intensity level – four METs – during occupational activities, leisure time or throughout the day), moderate alcohol intake (1–14 units per week) and at least five servings of fruit and vegetables per day. For data analysis, we considered the score as a continuous variable and dichotomized (the median was used as cutoff).

Anthropometrics

Anthropometric measurements were obtained after a 12-h overnight fast, with the participant wearing light clothing and no footwear. Body weight was measured to the nearest 0.1 kg using a digital scale, and height was measured to the nearest centimetre in the standing position using a wall stadiometer. Body mass index (BMI) was calculated as weight (kilograms) divided by squared height (metres), and further divided into two categories: overweight or obesity ($\geq 25.0 \text{ kg/m}^2$); normal and underweight ($< 24.9 \text{ kg/m}^2$; National Institutes of Health, 1998).

Statistical analysis

The sociodemographic characteristics of the participants were compared using the χ^2 and the Kruskal–Wallis tests, respectively for categorical and continuous variables. Multiple logistic and multiple linear regression analyses were used to compute age-, sex- and education-adjusted prevalences and mean values, respectively, and to conduct hypothesis tests for the comparisons between the groups of participants, considering the differences statistically significant when the *P* value was less than 0.05. All data analyses were performed using STATA Software, version 9.2 (College Station, Texas, USA).

Results

Sample characteristics

CSs were more frequently male and older than participants with LC or not having a cancer diagnosis (percentage of men: CSs, 60.4 vs. LC, 49.6 vs. NC, 36.6; median age: CSs, 67.1 years vs. LC, 61.8 years vs. NC, 52.5 years). Their level of education was lower than the participants with NC but equal to the participants with LC (median education: CSs, 5.0 vs. LC, 5.0 vs. NC, 8.0 years; Table 1).

Most CSs had had a female reproductive system (47.6% among women), breast (42.8% among women), prostate (28.1% among men), bladder (22.0% among men) or colorectal (18.6% among men and 4.8% among women) cancer. The overall median time from diagnosis to baseline assessment was 27.4 and 55.7 months, respectively for men and women (Table 2).

With regard to participants with LC, the neoplasms that were more frequently diagnosed during the follow-up

Table 1 Sociodemographic characteristics of the cancer survivors and participants with no cancer diagnosis at baseline evaluation (according to their status regarding cancer diagnosis at the end of follow-up)

	Participants with no cancer diagnosis at baseline			<i>P</i> ^d	<i>P</i> ^e	<i>P</i> ^f
	Participants with no cancer ^a (N=2261)	Participants with latent cancer ^b (N=139)	Cancer survivors ^c (N=53)			
Age (years), median (P25–P75)	52.5 (41.9–64.5)	61.8 (54.2–69.5)	67.1 (56.9–72.9)	<0.001	<0.001	0.069
Age (years), <i>n</i> (%)						
≤ 40	478 (21.1)	5 (3.6)	2 (3.8)			
41–65	1241 (54.9)	76 (54.7)	20 (37.7)	<0.001	<0.001	0.104
> 65	542 (24.0)	58 (41.7)	31 (58.5)			
Sex, <i>n</i> (%)						
Men	828 (36.6)	69 (49.6)	32 (60.4)	0.013	<0.001	0.119
Women	1433 (63.4)	70 (50.4)	21 (39.6)			
Education (years), median (P25–P75)	8.0 (4.0–14.0)	5.0 (4.0–9.0)	5.0 (4.0–10.0)	0.001	0.102	0.829
Education (years), <i>n</i> (%)						
< 4	224 (9.9)	8 (5.8)	4 (7.6)			
4	633 (28.0)	61 (43.9)	22 (41.5)			
5–9	487 (21.5)	39 (28.1)	13 (24.5)	<0.001	0.167	0.849
10–12	296 (13.1)	15 (10.8)	5 (9.4)			
≥ 13	621 (27.5)	16 (11.5)	9 (17.0)			

P25–P75, 25th percentile–75th percentile.

^aParticipants with no cancer diagnosis at baseline or during follow-up.

^bParticipants with no cancer diagnosis at the baseline but diagnosed with a cancer during follow-up.

^cParticipants with a cancer diagnosis before baseline assessment.

^dParticipants with no cancer versus participants with latent cancer.

^eParticipants with no cancer versus cancer survivors.

^fParticipants with latent cancer versus cancer survivors.

were prostate (23.2% among men) and breast (34.3% among women) cancers. The overall median time from baseline assessment to diagnosis was 72.3 and 52.2 months, respectively for men and women.

Health-related behaviours and anthropometric characteristics

At baseline evaluation, the prevalence of smoking was nearly 20% among the CSs and participants with NC at baseline or after the follow-up, and approximately 30% among the participants with LC. The latter also reported the highest cigarette consumption, and the NC participants the lowest, although the differences were statistically significant only when comparing NC participants with those with LC. The proportion of former smokers was similar across the three groups. No meaningful or statistically significant differences in the prevalence of current or former alcohol consumption were observed. However, LC participants had the highest average alcohol consumption (25.5 g/day) and NC participants the lowest (17.0 g/day). The proportion of CSs reporting sports practice was nearly 50% higher than for NC or participants with LC. Total physical activity was lower in the participants with LC, close to statistical significance, but the magnitude of the differences was small. With regard to dietary habits, CSs had a consumption of fruit and vegetables, fibre and vitamin C similar to that observed for NC participants and higher than that reported by participants with LC.

The assessment of the joint exposure to the main risk factors using a health behaviour score revealed higher scores (higher scores reflect the exposure to a smaller number of risk factors) among the group of subjects with NC diagnosis in comparison with participants with LC or CSs (1.74 vs. 1.52 vs. 1.63, respectively).

As expected, overweight and obesity were substantially less frequent and mean BMI lower in CSs than in the remaining groups (Table 3).

The same analyses were conducted separately for women and men, reaching the same conclusions (data not shown).

Discussion

Participants with LC showed a higher frequency of unhealthy behaviours, especially regarding smoking, alcohol intake and dietary habits, contrasting with an analogous pattern of health-related behaviours between CSs and individuals with NC diagnosis.

The higher prevalence of smoking among the participants with LC is in accordance with the established causal relationship between tobacco exposure and several cancer topographies (Gandini *et al.*, 2008). There were no differences regarding smoking between CSs and participants with NC diagnosis, as in previous studies (Bellizzi *et al.*, 2005; Grimmer *et al.*, 2009). However, nearly 20% of the CSs were current smokers, showing an ample scope for benefiting from smoking cessation, which is especially important among CSs, with a higher baseline risk of tobacco-related conditions than the general population, namely second primary cancers (Khuri *et al.*, 2001; Somerville, 2003) and cardiovascular events (Demark-Wahnefried *et al.*, 2005; Oeffinger and McCabe, 2006).

The prevalence of alcohol consumption was similar across the three groups, confirming findings from previous reports (Bellizzi *et al.*, 2005), despite the amount of daily consumption being higher in participants with LC. The latter is in accordance with the known relation between alcohol drinking and cancer, namely upper aerodigestive tract and liver (Pelucchi *et al.*, 2008). Although a direct comparison is difficult due to differences in definitions and cutoffs across studies, there is still an ample scope for public health interventions, as for smoking, since almost

Table 2 Cancer topography and time for diagnosis or since diagnosis in relation to baseline evaluation, by sex, in cancer survivors and participants with latent cancer

Topography	Men				Women			
	Participants with latent cancer		Cancer survivors		Participants with latent cancer		Cancer survivors	
	<i>n</i> (%)	Time from baseline (months) ^{a,b}	<i>n</i> (%)	Time to baseline (months) ^{a,b}	<i>n</i> (%)	Time from baseline (months) ^{a,b}	<i>n</i> (%)	Time to baseline (months) ^{a,b}
Bladder	6 (8.7)	34.3 (15.5–76.3)	7 (22.0)	100.3 (41.9–117.4)	–	–	–	–
Breast	–	–	–	–	24 (34.3)	58.7 (28.8–82.6)	9 (42.8)	82.2 (29.9–107.1)
Colon and rectum	11 (15.9)	64.3 (41.0–107.6)	6 (18.6)	45.7 (30.5–76.9)	11 (15.7)	32.2 (17.0–54.2)	1 (4.8)	75.8
Female reproductive system ^c	–	–	–	–	8 (11.4)	29.1 (9.7–64.3)	10 (47.6)	49.1 (32.1–93.9)
Lung	8 (11.6)	68.5 (49.2–83.8)	–	–	3 (4.3)	20.9 (5.0–66.3)	–	–
Prostate	16 (23.2)	95.5 (62.0–111.2)	9 (28.1)	11.9 (5.1–24.4)	–	–	–	–
Stomach	7 (10.1)	86.3 (71.0–101.0)	4 (12.5)	81.2 (13.3–144.3)	2 (2.9)	14.0 (8.7–19.3)	–	–
Other	21 (30.4)	58.6 (40.8–96.3)	6 (18.8)	7.8 (4.4–13.2)	22 (31.4)	59.8 (30.6–94.5)	1 (4.8)	8.7
All cancers	69 (100.0)	72.3 (47.0–100.9)	32 (100.0)	27.4 (9.4–88.1)	70 (100.0)	52.2 (20.8–75.2)	21 (100.0)	55.7 (29.9–93.9)

^aMedian (25th percentile–75th percentile).

^bDoes not include data on date of diagnosis from 14 participants, in which cancer diagnosis information was obtained only from death certificates. In these cases, date of diagnosis was computed by subtracting an estimate of survival (based on the median survival for each topography of the other cancer cases in the sample) to the date of death.

^cIncludes cervical, corpus uteris, ovarian and vulvar cancers.

Table 3 Health-related behaviors and anthropometric measures in cancer survivors and participants with no cancer diagnosis at baseline evaluation (according to their status regarding cancer diagnosis at the end of follow-up)

	Participants with no cancer diagnosis at baseline assessment						<i>P</i> ^d	<i>P</i> ^e	<i>P</i> ^f
	Participants with no cancer (<i>N</i> =2261)		Participants with latent cancer (<i>N</i> =139)		Cancer survivors (<i>N</i> =53)				
	<i>n</i> (%)	Adjusted prevalence (95% CI) ^a	<i>n</i> (%)	Adjusted prevalence (95% CI) ^a	<i>n</i> (%)	Adjusted prevalence (95% CI) ^a			
Smoking									
Current smoker	543 (24.6)	19.2 (17.4–21.2)	34 (25.4)	31.7 (23.5–41.1)	8 (15.7)	22.5 (11.8–38.8)	0.015	0.893	0.245
Former smoker	433 (19.2)	16.2 (14.6–18.0)	35 (25.2)	19.6 (13.8–27.0)	18 (34.0)	26.6 (16.3–40.2)	0.913	0.407	0.663
Tobacco consumption (cigarettes/day) ^{b,c}		4.0 (3.6–4.4)		7.0 (5.4–8.6)		4.1 (1.6–6.7)	0.005	0.401	0.116
Alcohol consumption									
Current drinker	1628 (73.8)	75.9 (73.9–77.7)	107 (79.9)	81.9 (74.3–87.5)	42 (82.4)	84.1 (71.3–91.8)	0.468	0.632	0.884
Current drinker (≥ 1/2 drinks/day) ^g	857 (41.6)	40.5 (38.2–42.9)	70 (53.9)	43.9 (34.9–53.3)	27 (54.0)	41.0 (27.1–56.3)	0.962	0.490	0.376
Former drinker	165 (7.3)	5.9 (5.0–7.1)	10 (7.2)	4.4 (2.3–8.2)	4 (7.6)	4.3 (1.6–11.3)	0.422	0.613	0.975
Amount of alcohol consumed (g/day) ^{b,c}		17.0 (16.0–18.0)		25.5 (21.4–29.6)		20.9 (14.3–27.6)	0.022	0.466	0.207
Dietary intake									
Fruit and vegetables (servings/day) ^b		4.4 (4.3–4.5)		3.8 (3.4–4.2)		4.2 (3.6–4.8)	0.008	0.730	0.265
Fruit and vegetables (≥ 5 servings/day) ^h	752 (34.2)	34.0 (32.0–36.0)	33 (25.2)	25.5 (18.7–33.8)	14 (27.5)	27.5 (16.9–41.3)	0.069	0.464	0.835
Fibre (g/day) ^b		23.4 (23.0–23.7)		22.1 (20.7–23.5)		24.9 (22.6–27.2)	0.062	0.259	0.064
Vitamin C (μg/day) ^b		131.8 (129.1–134.4)		120.4 (109.5–131.3)		131.9 (114.4–149.4)	0.091	0.662	0.269
Total energy intake (kcal/day) ^b		2228.1 (2203.8–2252.5)		2283.5 (2183.1–2383.8)		2356.4 (2195.9–2156.9)	0.844	0.908	0.863
Physical activity									
Sports practice	764 (34.6)	34.0 (32.0–36.0)	45 (33.3)	33.4 (25.8–42.0)	26 (51.0)	49.9 (36.3–63.6)	0.737	0.039	0.112
Total physical activity (METs-hours/day) ^b		1.55 (1.53–1.56)		1.51 (1.46–1.56)		1.53 (1.45–1.61)	0.097	0.496	0.638
Health behaviour score (points)		1.74 (1.71–1.78)		1.52 (1.37–1.67)		1.63 (1.39–1.87)	0.005	0.385	0.447
Health behaviour score (> 2 points)	459 (21.0)	18.7 (17.0–20.5)	15 (11.5)	11.8 (7.2–18.8)	7 (14.0)	16.8 (8.1–31.5)	0.059	0.762	0.387
Anthropometrics									
Overweight or Obesity	1385 (62.3)	64.2 (62.1–66.3)	95 (70.9)	64.6 (55.4–72.9)	28 (54.9)	44.8 (31.3–59.1)	0.973	0.007	0.038
BMI ^b		26.9 (26.7–27.1)		26.8 (26.0–27.6)		25.4 (24.2–26.6)	0.923	0.035	0.119

95% CI, 95% confidence interval; BMI, body mass index; METS, metabolic energy equivalent task units.

^aResults are presented as prevalences adjusted simultaneously for age, education and sex and respective 95% confidence intervals, except if otherwise specified.^bResults are presented as means adjusted simultaneously for age, education and sex and respective 95% confidence intervals.^cThese results only apply to current smoker and drinker participants.^dParticipants with no cancer versus participants with latent cancer, adjusted for age, education and sex.^eParticipants with no cancer versus cancer survivors, adjusted for age, education and sex.^fParticipants with latent cancer versus cancer survivors, adjusted for age, education and sex.^gAccording to the recommendations of the American Heart Association of a maximum daily intake of one standard drink for women and two for men (Lichtenstein *et al.*, 2006).^hAccording to the recommendations of the World Cancer Research Fund on 'Food, Nutrition, Physical activity and the Prevention of Cancer' of at least five servings of fruit/vegetables per day (World Cancer Research Fund, 2007).

40% of the survivors drink more than expected from the guidelines of American Heart Association (Lichtenstein *et al.*, 2006).

Participants with LC had a lower consumption of fruit and vegetables and dietary fibre, as expected from the relation between these exposures and cancer risk (Gallus *et al.*, 2004; Lunet *et al.*, 2007). Moreover, in accordance with two population-based CSs studies (Coups and Ostroff, 2005; Eakin *et al.*, 2007), we found similar dietary behaviours between CSs and participants with NC diagnosis, regarding fruits and vegetables, fibre, vitamin C and daily total energy intake. Nevertheless, approximately 75% of the CSs eat fewer than five servings of fruit and vegetables per day.

Our results showed a lower level of total physical activity among participants with LC, near statistical significance, in accordance with the association between sedentary behaviour and cancer, namely colon, endometrium and postmenopausal cancers (Vainio *et al.*, 2002; World Cancer Research Fund, 2007). We also found a higher prevalence of sports practice in the CSs group, but previous studies yielded conflicting findings (Coups and Ostroff, 2005; Bellizzi *et al.*, 2005; Eakin *et al.*, 2007; Grimmett *et al.*, 2009), which may be explained by differences in the moment of evaluation (regarding time since diagnosis and treatment status) and in the validity of physical activity assessment across studies. Several reports confirmed an increasing proportion of CSs meeting the physical activity recommendations as the number of years since diagnosis increased, which could be explained by a progressively decreased disability motivated by the psychological impairment of cancer diagnosis and the side effects of cancer treatment (Bellizzi *et al.*, 2005; Courneya *et al.*, 2007). Nevertheless, in our study, when CSs were grouped by time since diagnosis, the higher adjusted prevalence of sports practice was observed both in CSs for less than median time from diagnosis to baseline (60.9, 95% CI: 41.0–77.7) and for a longer period (38.7, 95% CI: 21.9–59.8).

Overweight/obesity is a modifiable risk factor for cancer and other chronic conditions and is a surrogate of health-related behaviours such as physical exercise and diet. In this study, CSs had a lower BMI than the remaining participants whereas previous studies reported either similar (Bellizzi *et al.*, 2005) or higher BMI levels (Eakin *et al.*, 2007) in CSs. The short time since diagnosis, for some of the participants in our investigation, could contribute to explain our findings, as the proximity to treatment may determine a decrease in the patient weight. However, the prevalence of overweight/obesity was lower both in the participants evaluated a longer (49.2, 95% CI: 30.1–68.5) or a shorter (40.3, 95% CI: 23.0–60.5) time after the diagnosis.

Although these results are ultimately locale-specific, our sample has an expected cancer topography distribution,

since we have the most frequent topographies in the LC group (Ries *et al.*, 2007; Berrino *et al.*, 2009) and the topographies with greater survival in the CSs group (Ries *et al.*, 2007; Berrino *et al.*, 2009), which favours a good external validity. The group of NC participants may include a small number of participants with LC that could not be identified in the cancer registry because some of the cancers diagnosed more recently may have not been registered up to 2009, reflecting the dynamic nature of cancer registration and its increasing completeness with time. This, however, is not likely to have influenced our conclusions since the misclassification of participants with LC as NC is expected to have affected only a small number of participants.

As in previous studies on this subject (Coups and Ostroff, 2005; Bellizzi *et al.*, 2005; Eakin *et al.*, 2007; Grimmett *et al.*, 2009), the cross-sectional design precludes the establishment of a temporal relation between cancer diagnosis and change of behaviours. In fact, among the CSs with healthier lifestyles it is not possible to distinguish between those that quitted smoking, increased their fruit and vegetable consumption or started to practise a sport after having a cancer diagnosed, from those that survived longer because they had the latter exposures for a longer time before, since the prognosis is expectedly worse in cancer patients with unhealthy behaviours (Rock and Demark-Wahnefried, 2002; Holmes *et al.*, 2005; Meyerhardt *et al.*, 2006a, 2006b). Although we may not discard the hypothesis that our findings reflect mostly a survival effect rather than a real shift in behaviours after the cancer diagnosis, the observation of important departures from healthier lifestyles among the CSs is not compromised by the cross-sectional study design.

An additional limitation is the small sample size of the CSs group, which that precludes the achievement of robust findings from stratified analyses, namely by cancer topography.

Underestimation of smoking and alcohol consumption and overestimation of physical activity and fruit and vegetable intake are more likely to have occurred among CSs (Rock and Demark-Wahnefried, 2002; Holmes *et al.*, 2005; Meyerhardt *et al.*, 2006a, 2006b), but the magnitude of the differences between CSs and LC participants can hardly be explained by such a bias.

Despite the limitations described above, our study adds to previous reports the comparison of CSs with a healthier subset of the general population, in terms of cancer risk. Further progress in the understanding of health related behaviours of CSs requires large cohort studies powered sufficiently to allow stratification by follow-up duration and type of cancer.

In conclusion, this study shows that the distribution of the exposures to each of the most important risk factors

for cancer among CSs tends to be similar to that observed in the subgroup of the general population with healthier behaviour, despite a still high prevalence of risk factors for chronic diseases, and a joint exposure to a large number of risk factors, demanding health promotion interventions in this specific population.

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