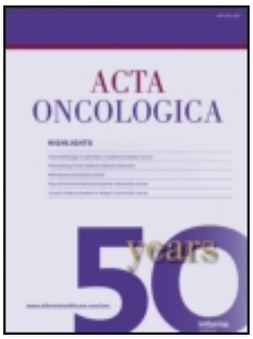

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ORIGINAL ARTICLE

Changes in body mass index and alcohol and tobacco consumption among breast cancer survivors and cancer-free women: A prospective study in the Danish Diet, Cancer and Health Cohort

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Abstract

Background. A breast cancer diagnosis has been suggested as a teachable moment when a woman is more open to making healthier lifestyle changes. Little is known about the health behaviour changes women with breast cancer initiate compared to those made by other women. *Material and methods*. We examined changes in body mass index (BMI) and tobacco and alcohol consumption among women with a diagnosis of breast cancer and among cancer-free women. We used data from 23 420 women aged 50–64 years who participated in the Diet, Cancer and Health cohort, of whom 449 were diagnosed with breast cancer between baseline (1993–1997) and follow-up (2000–2002), and 22 971 remained cancer-free. We used multiple linear regression analysis to examine differences in BMI and alcohol and tobacco consumption between the two groups and to examine whether demographic and prognostic factors were associated with behavioural changes in women with breast cancer. *Results*. There were no significant differences in changes in BMI, alcohol and tobacco consumption between the two groups. Only in sub-analyses among women who lost weight between baseline and follow-up, women with breast cancer lost more weight than cancer-free women ($\beta = 0.2$; CI 0.1; 0.4), but residual confounding from stage cannot be excluded. Among the women with breast cancer we found no significant changes in BMI, alcohol and tobacco consumption by level of education, marital status, chemotherapy, hormone therapy or radiation. *Conclusion*. Women with breast cancer did not reduce their BMI, or modify their alcohol use or tobacco consumption compared with cancer-free women. This study indicates that guidelines and interventions to change health behaviour are needed after a cancer diagnosis.

Breast cancer is the most frequent cancer and the most frequent cause of death from cancer among women worldwide [1]. In Denmark, as in many other western countries, increasing breast cancer incidence and an improved five-year survival rate of 85% [2] implies that a large proportion of women with breast cancer survive for many years beyond their initial treatment. It is therefore relevant to examine factors that could impact breast cancer survival and quality of life. Health behaviour including changes in body mass index (BMI), alcohol and tobacco consumption may be important not only for reducing breast cancer risk but also for survival [3,4] and quality of life [5], but knowledge on whether women with breast cancer do make more health behaviour changes compared to other women is limited.

Most studies on health behaviour have addressed only changes in diet and physical activity [6] and most of the studies evaluating changes in alcohol and tobacco use and BMI were retrospective [5], therefore, possibly involving recall bias. We only identified one prospective study that focused mainly on dietary change, but also included changes in BMI, alcohol and tobacco consumption following

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breast cancer diagnosis [7]. The authors found that women with breast cancer quit smoking more often than cancer-free women, while no significant changes in alcohol consumption or BMI were observed. Beyond the scope of the study by Skeie et al. (2009), further evidence is needed to identify the types of changes that women with breast cancer make compared to cancer-free women also in subgroups of women with specific characteristics and also evidence is needed on the treatment factors that characterise those women with breast cancer who makes the health behaviour changes in order to focus public health interventions.

In this prospective study, we compared changes in BMI, alcohol and tobacco consumption following a breast cancer diagnosis in women with changes in cancer-free women. We hypothesised that women with breast cancer would make significantly more behavioural changes to comply with the recommendations of the Danish National Board of Health (www.sst.dk) with regard to alcohol consumption [women should not consume more than 14 alcoholic beverages (1 drink is approximately 12 g alcohol) per week], weight control (BMI = 18–25 kg/m^2) and tobacco use (tobacco cessation) than cancer-free women. These recommendations are developed for general health promotion, but as no Danish recommendations exists targeting cancer survivors specifically the recommendations are also likely to be used in this group. Also, we examined socio-demographic and treatment factors potentially associated with health behaviour change among women with breast cancer.

Methods

Diet Cancer and Health cohort

We used data on women from the Danish Diet, Cancer and Health study, a prospective cohort study established to evaluate the aetiological role of diet and cancer risk. The cohort has been described in detail elsewhere [8]. In brief, 79 729 women who were between the ages of 50 and 64, living in the greater Copenhagen and the Aarhus area, born in Denmark, and not registered in the Danish Cancer Registry with a previous cancer diagnosis (except non-melanoma skin cancer) were invited to participate in the study and 29 875 (37.4%) accepted the invitation. In 2000–2002, a follow-up survey of all 29 036 women who were still alive, not emigrated or missing was conducted. A total of 24 036 participated with a response rate of 80.4% of those participating at baseline. Of the 29 875 women responding to the baseline questionnaire, we excluded 337 women who had cancer before the baseline questionnaire, eight for whom background information was missing, nine who had never menstruated, 5734 who did not respond to the follow-up questionnaire, 367 who according to the Danish Cancer Registry [9] were diagnosed with a cancer other than breast cancer between the two data collections, leaving 23 420 women for the analyses. Between the two data collection periods, 449 women were diagnosed with breast cancer and 22 971 women remained cancer-free.

Information on breast cancer

We obtained clinical and prognostic information on breast cancer from the nationwide Danish Breast Cancer Cooperative Group [10], including date of diagnosis, tumour size (in cm), number of positive lymph nodes, oestrogen and progesterone receptor status (negative, positive or unknown), histological type and malignancy grade (ductal grade I–III and non-ductal), chemotherapy (none, received or unknown), endocrine therapy (primarily tamoxifen; none, received or unknown), and radiotherapy (none, received or unknown).

Information on health behaviour

At both baseline and follow-up, participants were asked to indicate how much they smoked per day in terms of cigarettes (1 g tobacco/cigarette), cigars (4.5 g tobacco/cigar), cheroots (3 g tobacco/cheroot), and pipes (3 g tobacco/pipe), and these were summed as grams of tobacco per day. At baseline, participants were asked to indicate how often they drank each of the following types of alcohol: light beer (no. of bottles, 8.9 g alcohol/bottle), ordinary beer (no. of bottles, 12.2 g alcohol/bottle), strong beer (no. of bottles, 17.5 g alcohol/bottle), wine (red, white, rosé; no. of glasses, 12.2 g alcohol/glass), fortified wine, e.g. port (no. of units, 9.3 g alcohol/unit) and liquor, e.g. schnapps (no. of units, 9.9 g alcohol/unit). The following categories of frequency were used: never, $<$1/month, 1/month, 2–3/month, 1/week, 2–4/week, 5–6/week, 1/day, 2–3/day, 4–5/day, 6–7/day, $\geq$8/day and summed as grams alcohol per day. At follow-up, separate items were included to measure red wine versus white and rosé wine; and the categories were slightly different: never/rarely, 1/month, 2–3/month, 1–2/week, 3–4/week, 5–6/week, 1/day, 2–3/day, 4–5/day, 6–7/day, $\geq$8/day. The baseline alcohol consumption categories 'never' and '$<$1/month' were combined for the analyses. BMI was calculated as [weight (kg)]/[height (m)^2]. At baseline, the weight and height of each participant wearing light underwear was measured at the study centres by trained professionals. At follow-up, weight was self-reported.

Information on education, marital status and vital status

We obtained information on marital and vital status from the Central Population Register. Since 1968, all Danish residents have been registered in the Central Population Register and assigned a unique 10-digit personal identification number, which ensures accurate linkage of information among all national registries. Marital status was used as a categorical variable (never married, divorced or widowed, married or with registered partner). We obtained information on educational status from the baseline questionnaire and used this as a categorical variable (basic school/high school, vocational training and higher education).

Statistical analyses

Descriptive analyses were conducted of demographic factors, mean BMI, alcohol and tobacco consumption at baseline and follow-up for women with breast cancer and cancer-free women. We conducted multiple linear regression analyses with 95% confidence intervals (CI) to examine health behaviour changes among women with breast cancer and cancer-free women, differences in health behaviour change (BMI, alcohol and tobacco consumption as continuous variables) between women with breast cancer and cancer-free women and factors associated with health behaviour change among women with breast cancer.

When we analysed the differences in change in BMI and alcohol and tobacco consumption between women with breast cancer and those who were cancer-free, we took into account age, behaviour at baseline (BMI, alcohol and tobacco, respectively), as well as marital status and education as these factors may influence risk of cancer as well as health behaviour. Separate analyses were conducted among women who lost weight (N = 12 497) and when excluding women with breast cancer who had recurrence prior to follow-up (N = 17), respectively. Also, we conducted separate analyses using logistic regression models in women who quit smoking between baseline and follow-up (N = 1425 of 6630 smokers), went from an alcohol consumption level above recommendations to below (N = 1235 of 4127 above recommendations of 24 g/day), and went from overweight to normal weight (N = 1479 of 11 064 overweight). Finally, we conducted separate analyses comparing cancer-free women with women diagnosed within two years of the follow-up measurement (N = 23 080), and women diagnosed more than two years from the follow-up measurement (N = 23 167).

Among women with breast cancer, associations between education, marital status, chemotherapy, hormonal therapy and radiotherapy, time between breast cancer diagnosis and date of follow-up, and changes in BMI and alcohol and tobacco consumption were examined before and after adjustment for age, behaviour at baseline, tumour size, number of positive lymph nodes, receptor status, histological grade and type. The covariates were included as they are expected to influence prognosis and potentially motivate a change. In these analyses, we excluded 70 women with breast cancer who were not enrolled in a treatment protocol, or for whom information on tumour size was unavailable. We conducted separate analyses for the women with breast cancer who were overweight (BMI $\geq$ 25) at baseline (N = 170) and for women who were overweight and who lost weight between baseline and follow-up (N = 91). Women for whom values on BMI and tobacco and alcohol consumption were missing were excluded only in the relevant analyses. The GLM and GENMOD procedures in the SAS statistical software package release 9.1 (SAS Institute, Inc., Cary, NC, USA) was used for the statistical analyses.

Results

The mean age of the 22 971 participants at entry into the study was 56 years (range 50–65 years). More women with breast cancer had higher education level (55% vs. 51%) and were divorced or widowed (29% vs. 26%) compared with cancer-free women (Table I). Hormone treatment had been given to 41% of the women with breast cancer (Table II).

Behavioural changes among women with breast cancer and cancer-free women (Table I)

Of the women with breast cancer, 32% were current smokers, 22% drank more than two drinks per day (24 g alcohol) and 46% were overweight (BMI $\geq$ 25) at baseline. Small but significant changes between baseline and follow-up were seen for BMI, and alcohol and tobacco consumption in both groups. The mean tobacco consumption decreased in both groups (breast cancer: by 1.1 g/day, cancer-free: by 0.6 g/day), and the percentage of women who did not smoke increased by 7% among those with breast cancer and 5% among cancer-free women. The mean alcohol consumption increased slightly in both groups (breast cancer: by 0.6 g/day, cancer-free: by 0.8 g/day) but was higher among women with breast cancer than cancer-free women at both baseline and follow-up.

Differences in behavioural change between breast cancer and cancer-free women

No overall significant differences were seen in change of BMI between women with breast cancer and

Table I. Demographic characteristics at baseline and health behaviour at baseline and follow-up among 23 420 Danish women in the Diet, Cancer and Health cohort study.

	Women with breast cancer N = 449			Cancer-free women N = 22 971		
Health behaviour	Baseline N (%)	Follow-up N (%)	p[a]	Baseline N (%)	Follow-up N (%)	p[a]
Age at baseline (years)						
Range	50.3–65.4			50.1–65.8		
Mean (SD)	56.7 (4.1)			56.7 (4.4)		
Education						
Basic/high school	69 (16)			4043 (18)		
Vocational training	131 (29)			7242 (32)		
Higher education	246 (55)			11623 (51)		
Unknown	3 (1)			63 (0)		
Marital status						
Never married	28 (6)			1420 (6)		
Divorced or widowed	126 (29)			6007 (26)		
Married or registered partner	292 (64)			15466 (68)		
Unknown	3 (1)			78 (1)		
Tobacco (g/day)						
Mean	4.5	3.4		4.1[b]	3.5[c]	
0	306 (68)	334 (74)	<0.0001	16 144 (70)	17 210 (75)	<0.0001
1–10	53 (12)	49 (11)		2672 (12)	2357 (10)	
11–20	80 (18)	60 (13)		3527 (15)	2895 (13)	
≥ 20	10 (2)	6 (1)		609 (3)	507 (2)	
Alcohol (drinks/day)[h]						
Mean	15.0[d]	15.6		13.2[e]	14.0	
0	25 (6)	19 (4)	<0.0001	1442 (6)	1149 (5)	<0.0001
1–2	325 (73)	318 (71)		17 487 (76)	17 178 (75)	
>2	98 (22)	111 (25)		4029 (18)	4644 (20)	
BMI						
Mean	25.3	25.3[f]		25.5	25.4[g]	
<18.5	8 (2)	7 (2)	<0.0001	245 (1)	343 (1)	<0.0001
18.5–24.9	236 (53)	237 (53)		11 815 (51)	11 899 (52)	
25–29.9	151 (34)	145 (32)		7828 (34)	7621 (33)	
≥ 30	54 (12)	58 (13)		3067 (13)	3038 (13)	

All percentages do not add up to 100.
[a]Within group differences between baseline and follow-up are based on women for whom no values were missing at either time; [b]Information missing for 19; [c]Information missing for 2; [d]Information missing for 1; [e]Information missing for 13; [f]Information missing for 16; [g]Information missing for 72; [h]One drink of alcohol corresponds to 12 g.

cancer-free women (Table III). Among women who lost weight, however, those with breast cancer lost significantly more weight ($\beta = 0.2$ kg/m^2, CI 0.1; 0.4). When excluding the 17 women with breast cancer who had recurrence before follow-up, the results remained significant (results not shown). There were no significant differences in changes in alcohol or tobacco consumption between the two groups. Also, no significant differences were observed according to breast cancer status in separate analyses comparing cancer-free women with women diagnosed within two years of the follow-up measurement and women diagnosed more than two years from the follow-up measurement, respectively.

Finally, there were no significant differences between the two groups in those who quit smoking (26% of women with breast cancer vs. 21% of cancer-free women), went from overweight to normal weight (17% of women with breast cancer vs. 13% of cancer-free women), went from an alcohol consumption level above to below recommendations (31% of women with breast cancer vs. 30% of cancer-free women).

Factors associated with behavioural changes among women with breast cancer

For women with breast cancer, the changes in BMI, alcohol and tobacco consumption were not significantly associated with education, marital status, adjuvant chemo, endocrine or radiation therapy (Table IV). Only small changes were observed in unadjusted compared to mutually adjusted analyses (results not shown). Also, time between breast cancer diagnosis and date of follow-up (per half year) was not significantly associated with changes (results not shown). Among the 91 overweight (BMI >25.0) women with breast cancer who decreased their weight, those with vocational training were less likely to decrease their BMI than those with basic or high school education ($\beta = -1.5$ kg/m^2, CI -2.7; -0.3).

Table II. Clinical and prognostic characteristics of 379 women with breast cancer in the Diet, Cancer and Health cohort study.

Characteristic	N (%)
Tumour size (cm)	
≤2	260 (69)
>2–≤5	112 (29)
>5	7 (2)
No. of positive lymph nodes	
0	228 (60)
1–3	100 (26)
4–9	34 (9)
≥10	17 (4)
Histological type and malignancy grade	
Ductal grade I	127 (35)
Ductal grade II	113 (31)
Ductal grade III	46 (13)
Non-ductal	81 (22)
Receptor status	
Negative	59 (16)
Positive	313 (83)
Unknown	7 (2)
Chemotherapy	
No	342 (90)
Yes	37 (10)
Hormone therapy	
No	220 (58)
Yes	159 (42)
Radiation	
No	137 (36)
Yes	242 (64)

We excluded 70 women with breast cancer who were not enrolled in a treatment protocol, or for whom information on tumour size was unavailable. All percentages do not add up to 100. The treatments (chemotherapy, hormone therapy and radiation) are not mutually exclusive.

Discussion

Both among women with breast cancer and those who were cancer-free, we observed a decrease in the mean tobacco consumption, increased alcohol consumption, and only a small decrease in BMI. Overall, women with breast cancer did not change their BMI or alcohol or tobacco consumption any more than cancer-free women. Of those women who lost weight, the women with breast cancer lost more weight than those who were cancer-free. Among women with breast cancer, education, marital status, or any adjuvant treatment were not significantly associated with changes in BMI, alcohol and tobacco consumption.

Studies of breast cancer survivors exclusively have reported reduced smoking after a cancer diagnosis: One retrospective study of cancer survivors of various sites, e.g. found that 46% quit smoking after a cancer diagnosis [11] while one retrospective study among cancer survivors with ductal carcinoma in situ found that 35% quit smoking after their diagnosis [12]. A number of studies have reported that women increase their BMI after a breast cancer diagnosis possibly due to reductions in resting energy expenditure [13]. In a retrospective study of a broad range of positive and negative behavioural changes, cancer survivors reported relatively few changes but most of these changes were in accordance with recommended guidelines [14]. Cross-sectional studies on differences in health behaviour between cancer survivors and people who are cancer-free have been mixed: two studies of survivors of cancers at various sites found differences in smoking prevalence between people with cancer and people who are cancer-free [15,16] while one study found no differences in smoking, and obesity among people with cancer and people who are cancer-free [17].

To our knowledge, only one prospective study has examined changes in smoking and alcohol consumption in women with breast cancer compared to other women, and no studies have examined patient-related factors associated with such health behaviour changes. The results of a Norwegian prospective study on changes in BMI, alcohol and tobacco consumption were different from ours, and showed that women with breast cancer quit smoking significantly more often (33%) than cancer-free women (20%) [7]. It is possible that breast cancer patients in Norway are more actively encouraged to quit smoking than in Denmark. Both our study and the Norwegian study showed a small increase in alcohol consumption in both groups but there was no significant difference in the change in alcohol consumption between the two groups. Contrary to our results, the Norwegian study found no difference in BMI change, perhaps because their study combined both positive and negative changes in BMI, which might have diluted any difference. The change we observed among women who decreased their BMI, with a greater decrease among women with breast cancer, was small (0.2 BMI unit), and we cannot exclude that the weight loss in the women with breast cancer was driven by their poor health condition (recurrence) and thus by residual confounding from breast cancer stage.

Few investigations have been conducted in cancer patients to understand factors related to change in health behaviour [18]. A Danish study showed that having children, being married, being religious, attending church and having a high income were negatively associated with women's alcohol consumption [19]. In a nationwide, population-based study we showed social inequality in breast cancer survival: the adjusted hazard ratio for death was lower in women with higher education (0.91; 95% CI 0.85; 0.98) and higher income (0.93; 95% CI 0.87; 0.98) [20]. Social inequality in breast cancer survival skewed towards high socio-economic position could be related to differences in health behaviour and perhaps changes in health behaviour after a diagnosis. However, the results of the study reported

Table III. Regression-derived coefficients (β) and 95% confidence intervals for changes in health behaviour by breast cancer diagnosis, education and marital status among all women and women decreased their BMI, smoking or drinking in the Diet, Cancer and Health cohort study.

	All women β [95% CI]			Women who decreased behaviour β [95% CI][1]		
Characteristic	Tobacco N = 23 252	Alcohol N = 23 259	BMI N = 23 200	Tobacco N = 3420	Alcohol N = 10 630	BMI N = 12 421
Breast cancer						
No	–	–	–	–	–	–
Yes	−0.3 [−0.8; 0.1]	0.1 [−1.0; 1.3]	0.1 [−0.1; 0.3]	0.5 [−0.7; 1.8]	−0.7 [−1.6; 0.1]	**0.2 [0.1; 0.4]**
Education						
Basic/high school	–	–	–	–	–	–
Vocational training	**−0.5 [−0.6; −0.3]**	**1.0 [0.5; 1.5]**	**−0.1 [−0.2; −0.0]**	0.4 [−0.1; 0.9]	**−0.7 [−1.0; −0.3]**	0.0 [−0.1; 0.0]
Higher education	**−0.6 [−0.7; −0.4]**	**1.6 [1.2; 2.1]**	**−0.2 [−0.3; −0.1]**	**0.5 [0.0; 1.0]**	**−1.0 [−1.4; −0.7]**	−0.0 [−0.1; 0.0]
Marital status						
Never married	–	–	–	–	–	–
Divorced or widowed	−0.1 [−0.3; 0.2]	0.0 [−0.7; 0.7]	**0.2 [0.1; 0.3]**	0.6 [−0.2; 1.4]	0.0 [−0.5; 0.6]	−0.1 [−0.1; 0.0]
With partner	**−0.3 [−0.5; −0.0]**	0.6 [−0.1; 1.2]	−0.0 [−0.1; 0.1]	1.0 [0.2; 1.8]	**−0.7 [−1.2; −0.1]**	−0.1 [−0.2; 0.0]

Regression coefficients (β) reflect differences in health behaviour change for each given increment in the independent variable. Analyses are mutually adjusted and adjusted for age at baseline.
[1]A positive estimate indicates a larger decrease; a negative estimate indicates a smaller decrease.

here indicate no significant association between education and marital status and behavioural changes among women with breast cancer. Further studies are needed to examine social inequality in health behaviour changes among cancer patients, as this may be associated with social inequality in cancer survival. Also, despite diverse late effects depending on prognosis and treatment among women with breast cancer [21], we were not able to detect significant associations between treatment factors and changes in health behaviour.

This study has a number of strengths. It is one of few studies to prospectively examine differences in change in BMI, alcohol and tobacco consumption between women with breast cancer and those who are cancer-free women, thus minimising recall bias. Also, we were able to include detailed registry-based information on prognostic and treatment factors (minimising information bias) as well as detailed information on education and marital status for a randomly selected cohort. Furthermore, to our knowledge, this is the first study to include separate analyses of women who decrease their BMI, alcohol and tobacco consumption, which may be important as differences between women with breast cancer and cancer-free women may otherwise be diluted.

Tobacco and alcohol consumption were self-reported. The observed decrease in tobacco consumption between baseline and follow-up is in line with the reported adult smoking development in Denmark [22]. Recently, the Danish National Board of Health reduced the recommended maximum alcohol consumption for women from two a day to a maximum of one drink a day [23]. In our study period, however, moderate alcohol intake was considered to be protective against heart disease [24], which might partly explain the high alcohol consumption observed, a consumption level similar to that of the general Danish population [25] where self-reported alcohol consumption accounts for only 71% of sales [26]. The small mean changes in alcohol consumption are also supported by stable alcohol sales in Denmark since the 1970s [27]. Still, the alcohol consumption measurements were slightly different at baseline and follow-up, as the latter questionnaire included a combined category of 'never/rarely' as well as separate estimates of red vs. white/rosé wine, which might have increased the amount of alcohol reported. The measurement differences would not have affected any differences between women with breast cancer and cancer-free women, but the results of the within-group analyses and analyses of factors associated with changes in alcohol consumption should be interpreted with caution.

At baseline, weight and height were measured by trained professionals, whereas at follow-up, weight was self-reported, which might have resulted in underestimated weight at follow-up. This was confirmed in a validation study of 176 men and 240

Table IV. Regression-derived coefficients (β) and 95% confidence intervals for change in health behaviour between baseline and follow-up by demographic and clinical factors in women with breast cancer.

	All women β [95% CI]			Women who decrease behaviour β [95% CI][1]		
	Tobacco N = 359	Alcohol N = 358	BMI N = 357	Tobacco N = 69	Alcohol N = 181	BMI N = 169
Education						
Basic/high school	–	–	–	–	–	–
Vocational training	−0.3 [−1.7; 1.1]	−0.5 [−4.1; 3.0]	0.0 [−0.7; 0.7]	0.7 [−2.9; 4.3]	0.1 [−2.6; 2.9]	−0.6 [−1.4; 0.2]
Higher education	0.3 [−1.0; 1.6]	−0.1 [−3.4; 3.2]	−0.0 [−0.7; 0.6]	−0.7 [−4.3; 2.9]	0.1 [−2.4; 2.6]	−0.4 [−1.1; 0.4]
Marital status						
Never married	–	–	–	–	–	–
Divorced or widowed	−0.9 [−2.8; 1.0]	−3.8 [−8.9; 1.1]	0.4 [−0.5; 1.4]	5.6 [−1.2; 12.3]	0.7 [−3.1; 4.5]	0.2 [−0.9; 1.4]
With partner	−0.7 [−2.6; 1.1]	−1.4 [−6.1; 3.3]	0.4 [−0.6; 1.4]	2.8 [−3.8; 9.4]	−0.5 [−4.1; 3.1]	−0.1 [−1.1; 1.0]
Chemotherapy						
No	–	–	–	–	–	–
Yes	−0.8 [−2.9; 1.4]	1.6 [−4.0; 7.2]	0.3 [−0.8; 1.4]	5.8 [−3.4; 15.0]	−2.8 [−7.5; 1.9]	−0.7 [−2.1; 0.6]
Hormone therapy						
No	–	–	–	–	–	–
Yes	0.6 [−0.6; 1.8]	−0.3 [−3.3; 2.8]	0.0 [−0.6; 0.6]	3.5 [−1.0; 8.0]	0.1 [−2.2; 2.4]	−0.1 [−0.9; 0.6]
Radiation						
No	–	–	–	–	–	–
Yes	0.3 [−0.7; 1.4]	1.5 [−1.2; 4.2]	0.4 [−0.1; 0.9]	−0.9 [−4.1; 2.4]	−1.9 [−3.9; 0.1]	−0.2 [−0.9; 0.4]

Regression coefficients (β) reflect differences in health behaviour change for each given increment in the independent variable. Analyses are adjusted for age, time between baseline date and date of diagnosis, tumour size, number of positive lymph nodes, histological type, grade of malignancy and receptor status and are mutually adjusted.

[1]A positive estimate indicates a larger decrease; a negative estimate indicates a smaller decrease.

women in the Diet, Cancer and Health study, in which the self-reported mean weight of the 240 female participants was found to be slightly underestimated (mean difference, 1.3 kg) with respect to that measured by a technician [28]. The Danish adult female population has increased their BMI in the period between baseline and follow-up [29]. At the same time, adult women tend to gain weight until approximately age 55 years and then after a stable period lose weight [30]. This supports the stable mean BMI observed between baseline and follow-up, but an underestimation of weight at follow-up due to self-reporting could also have influenced the observed stable BMI between baseline and follow-up. We cannot exclude the possibility that underreporting of weight at follow-up was different for the women with breast cancer and the cancer-free women, and the results should be interpreted with caution.

Women who participate in this type of study might be healthier or report a healthier lifestyle than the general population. Both women with breast cancer and those without who are alive and can respond to a questionnaire might be healthier than the general population; therefore, generalisations should be made with caution. In this study, the women with breast cancer completed the follow-up questionnaire up to six years after their diagnosis (mean, 2.6 years), which might have diluted any differences from cancer-free women. Still, in analyses comparing cancer-free women with women diagnosed with breast cancer within or more than two years prior to follow-up assessment, respectively showed only small differences in results. The analyses of factors associated with decreased tobacco consumption were based on a small sample (N = 69), which might have limited our ability to detect true associations. In analyses examining factors associated with changes in health behaviour among women with breast cancer, 70 women were excluded as they were not enrolled in a treatment protocol, or for whom information on tumour size was unavailable and in 10 women we did not have data on histological type and malignancy grade. We cannot exclude that these women are somehow different and the results should be interpreted with caution. Also, as a large number of analyses were conducted, we cannot rule out the possibility that some of the findings were due to chance. Finally, our results apply mainly to breast cancer patients: There are large variations in health behaviour depending on cancer site (e.g. smoking rate of 18–99%), the impact of different cancer types on motivation to change may differ, and our previous work showed that men

with cancer other than prostate cancer were more likely to quit smoking and decrease their BMI to normal weight compared to cancer-free men [31]. Thus cancer site-specific analyses are recommended for drawing specific conclusions.

Conclusion

This study suggests that women with breast cancer did not change their BMI or their alcohol or tobacco consumption compared with cancer-free women. Only among women who lost weight, we found that those women with breast cancer were more likely to lose more weight than cancer-free women. The changes were small, and we cannot exclude that the result was driven by a sub-group of women with poor prognosis and hence probably deteriorating health. For the clinical oncology setting the results of this study are however important. The women with breast cancer may experience a number of obstacles for making health behaviour changes and the breast cancer diagnosis may not be a motivation strong enough to prevail these obstacles. The results suggest a substantial potential for changes in smoking and alcohol consumption as well as diet and physical activity among women with breast cancer, which could be encouraged by individual recommendations, taking into account pre-cancer health behaviour and the extent of disease. Rehabilitation programmes should target health behaviour changes specifically [32] and oncology care providers should encourage cancer survivors to make health behaviour changes, which might improve quality of life and long-term survival.

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