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ORIGINAL ARTICLE

Health behavior change among breast cancer patients

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Abstract
Objectives Changes in health behavior among women with breast cancer with respect to food intake, exercise and smoking habits are considered. We aimed to analyze (1) significant modifications of these behaviors about a year after breast cancer surgery and (2) the impact of social, medical and behavioral patient characteristics on these changes.
Methods Data were derived from a longitudinal study of 229 women (age < 70) in Germany with a first manifestation of breast cancer. Food intake, physical activity and smoking were assessed by means of personal interviews immediately after surgery (T0) and 14 months later (T1).
Results The intake of fruits and vegetables and physical exercise increased significantly over the observation period. Socio-demographic and medical parameters were largely irrelevant for behavioral changes while smoking status turned out as most important for changes in daily fruit consumption.
Conclusions The results demonstrate that breast cancer patients change their lifestyle habits in a significant way even without intervention. Patients who smoke are in particular need of professional support to implement health-promoting behavior, and intervention should especially focus on this group.

Keywords Breast cancer · Food intake · Exercise · Smoking · Change in health behavior

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Introduction

Evidence suggests that lifestyle factors such as dietary patterns, physical activity, and smoking may affect overall health and relapse-free survival in breast cancer patients. The effect of diet on breast cancer had been examined with diverging results (Kwan et al. 2009; Nelson 2008). The Women's Intervention Nutrition Study (WINS) concluded that the consumption of a low fat diet may increase the length of relapse-free survival (Blackburn and Wang 2007). According to the Women's Healthy Eating and Living (WHEL) study, however, a diet very high in fruits and vegetables, and low in fat does not affect breast cancer recurrence or death rates (Pierce et al. 2007a, b). There is agreement that weight loss and physical activity may play a key role in the survival after breast cancer treatment (Hong et al. 2007; Nelson 2008; Pierce et al. 2007a, b; Holick et al. 2008; Linos et al. 2007; Blanchard et al. 2008; Pinto and Maruyama 1999). In addition a combination of multiple lifestyle factors has been found to have a more pronounced effect on the survival (Ballard-Barbash and McTiernan 2007; Pierce et al. 2007a, b).

Breast cancer patients seem highly motivated to make lifestyle changes (Demark-Wahnefried et al. 2000; McBride et al. 2000; Wayne et al. 2004), and studies on self-reported change are indicating that such changes are indeed common in this group (Patterson et al. 2003). Increased fruit and vegetable consumption and higher physical activity as well as decreased fat and meat intake were the most frequent changes named (Kostopoulou and Katsouyanni 2006; Maskarinec et al. 2001; Maunsell et al. 2002; Patterson et al. 2003; Salminen et al. 2000; Tangney et al. 2002; Thomson et al. 2002; Wayne et al. 2004). To our knowledge, only three non-interventional studies considered two or more measurements for quantifying the

amount of change. One only examined nutrition variables (Wayne et al. 2004) whereas the others focused exclusively on changes in exercise behavior (Harrison et al. 2009; Pinto et al. 2002a, b). None of these non-interventional studies, however, reported significant changes in mean dietary intake or changes in physical exercise over time.

Coming from a social epidemiologic perspective, a key question is whether socio-demographic factors may contribute to successful changes in lifestyle patterns. Some findings suggest younger breast cancer survivors to be more likely to report lifestyle changes (such as decreased meat or increased fruit and vegetable consumption or higher exercise levels) after diagnosis (Maunsell et al. 2002; Patterson et al. 2003; Pinto et al. 2002a, b; Sternfeld et al. 2009; Wayne et al. 2004) while others fail to identify such a link (Harrison et al. 2009; Hong et al. 2007). Some studies reported associations between low levels of education, lower levels of physical activity (Hong et al. 2007; Sternfeld et al. 2009), and less likelihood to make healthy dietary changes after cancer diagnosis (Patterson et al. 2003), whereas others did not (Wayne et al. 2004). It is also uncertain whether such lifestyle changes after breast cancer diagnosis are in accordance with expert recommendations. Current guidelines and preventive measures include recommendations to maintain a healthy weight, to engage in physical activity, to consume a balanced diet, and to limit alcohol consumption (Deutsche Krebshilfe e. V 2008; Doyle et al. 2006; Koula-Jenik et al. 2006). Earlier findings indicate that only few breast cancer survivors are meeting diet and exercise recommendations at different time since diagnosis (Blanchard et al. 2008; Demark-Wahnefried et al. 2000; Harrison et al. 2009; Irwin et al. 2004; Pinto et al. 2002a, b).

Our study is the first one to consider multiple lifestyle factors at two points in time using a non-interventional design and hence without intervention impact. In contrast to most research, we assessed data on intra-individual change and mean change over time.

Our study addresses the following questions:

1. To what extent do women change their dietary patterns and physical activity levels on their own initiative in the year after primary breast cancer treatment?
2. Are these changes in accordance with current lifestyle recommendations?
3. What subject characteristics (social, medical and behavioral) have effects on fruit intake and physical activity in breast cancer patients?

Methods

Study population

The analyzes are part of an ongoing prospective study on the role of social and psychosocial factors in the course of breast cancer. Women included in the study were up to 70 years of age at the time of initial diagnosis of primary breast cancer (sizes T_1–T_3; N_0–N_3; no evidence of metastases). Women with multiple cancers, recurrence of breast cancer or a history of psychiatric disorders were excluded. The baseline interview (T0) took place in 2002–2003. Three gynecological clinics from the city of Hannover in Germany are participating in the study. Out of 338 eligible patients, 256 (76 %) met the inclusion criteria and agreed to participate, and 82 (24 %) refused. The demographical and clinical status of non-participants (T0) are unknown, as well as their reasons for non-participating. A total of 27 women had to be excluded subsequently for the following reasons: women refused to continue at follow-up ($n = 9$), women could not be reached for follow-up interview ($n = 7$), missing lifestyle questionnaires at either time point (T0 or T1) ($n = 11$), women had died ($n = 1$). Finally, 229 (68 %) cases remained for this study. The basic socio-demographic and medical characteristics of the sample are provided in Table 1.

Data collection

The baseline interview (T0) was performed in the hospital shortly after surgery. For the second interview patients were contacted again and visited by an interviewer approximately 14 months after surgery (T1). All interviews were conducted by means of an interviewer-administered lifestyle questionnaire asking for socio-demographic data, dietary, exercise and smoking habits. Medical information was collected from medical records (categories of variables see Table 1).

Food intake was assessed by respondents' consumption of 19 different food items or food groups (e.g. "How many servings of the following fruits do you usually eat per day?").

According to the guidelines for a balanced and wholesome diet issued by the German Nutrition Society (DGE), nutrition was classified into six different food groups: bread, dairy products, fruits, vegetables, meat, and snacks (Koula-Jenik et al. 2006). Therefore, summarized variables were used to assess food intake.

Physical activity was assessed by asking whether participants routinely exercised during their leisure time, and if so, how many hours they usually engaged in moderate (e.g. walking, bowling, cycling, etc.), and how many hours in vigorous (e.g. tennis, running, swimming, etc.) exercise during a 'usual' week. Literature recommends 30 min of moderate-to-vigorous exercise on at least 5 days per week; this equals 150 min of weekly physical activity (Doyle et al. 2006). Hence, hours of moderate and vigorous exercise were summarised into a new variable indicating overall exercise. When the study was planned in 2000,

Table 1 Basic characteristics of the study sample ($n = 229$), Hanover, Germany, 2002/2003

Characteristics		Characteristics	
Age in years (Mean/SD)	53.2/ ± 9.5	Smoking at baseline	
0–49 years	82 (32.0 %)	Yes	37 (16.2 %)
50–59 years	86 (33.6 %)	No	192 (83.8 %)
≥60 years	83 (32.4 %)	Missing	0
Missing	5	Tumor size[2]	
Time since surgery[1]	14/ ± 3.6	T_1	149 (67.4 %)
School education		T_2	66 (29.9 %)
Second. general school	83 (38.4 %)	T_3	6 (2.7 %)
Intermediate	80 (37.0 %)	Missing	8
Upper secondary school	53 (24.5 %)	Grading[3]	
Missing	13	I	17 (7.9 %)
Occupational position[4]		II	134 (62.3 %)
Low	56 (25.5 %)	III	64 (29.8 %)
Intermediate	92 (41.8 %)	Missing	14
High	72 (32.7 %)	Treatment	
Missing	9	Only surgery	11 (4.8 %)
Employment status		Surgery + radiotherapy	90 (39.6 %)
Full time	33 (18.0 %)	Surgery + chemotherapy	20 (10.1 %)
Part time	43 (23.5 %)	Surgery + radio + chemo	103 (45.4 %)
Not employed	107 (58.5 %)	Missing	2
Missing	46	Inpatient rehabilitation	
Marital status		Yes	141 (65.9 %)
Married/living with a partner	170 (74.2 %)	No	73 (34.1 %)
Solitary	59 (25.8 %)	Missing	40
Missing	0		
Minor children at home			
Yes	82 (36.0 %)		
No	146 (64.0 %)		
Missing	1		

Displayed are valid percents

[1] Time since surgery at the second assessment in months (mean/SD)

[2] Tumor size *T1* up to 2 cm, *T2* >2 cm up to 5 cm, *T3* >5 cm

[3] The tumor is placed in one of three grades of malignancy: *grade I* low, *grade II* intermediate and *grade III* high

[4] Occupational position: low = unskilled and semi-skilled workers; simple blue- and white-collar workers/employees, such as shop assistant, amanuensis; intermediate = middle grade workers and employees, such as accountant; high = executive workers and employees, such as department manager

there was no established German questionnaire for measuring nutrition and exercise, thus the questions were extracted from different instruments.

Smoking was assessed by asking: "Do you currently smoke cigarettes?" rated on a yes/no scale, and if so, how many cigarettes per day.

In order to avoid bias due to patient's hospitalization at baseline, we explicitly asked about women's behavior at the time before surgery.

Table 2 provides current recommendations and cut points used to categorise the women into two groups. Finally variables were generated for each item (0 = did not meet the recommendation; 1 = met the recommendation).

Statistical analysis

In order to compare means of nutrition and exercise levels, paired-sample *t* tests were performed at baseline and 1 year following diagnosis. As meat consumption was rated on an ordinal scale, no mean values were calculated for this variable. In this case, level of significance was calculated by means of the Wilcoxon rank-sum test.

Table 2 Current nutritional and exercise recommendations and cut points for grouping patients, Hanover, Germany, 2002/2003

	DGE and AID (Koula-Jenik et al. 2006; Stehle 2007)	Cut point
Bread	3–6 slices (200–300 g)/d = 2–3 s/d	2–3 s/d
Dairy products	3 s/d	2–3 s/d
Fruit	At least 250 g = 2–3 s/d (fruit juice not included)	day: ≥2 s/d week: ≥7 occasions/w
Vegetable	At least 400 g = 3–4 s/d	≥7 occasions/w
Meat	2–3 dishes/w = 300–600 g/w	Warm dish: ≤ 2 dishes/w cold cuts: 1 s/d
Snacks	1 s/d acceptable	≤7 occasions/w
	American Cancer Society (Doyle et al. 2006)	Cut point
Exercise	At least 30 min of moderate-to-vigorous physical activity, above the usual activities, on ≥5 d/w = 150 min = 2.5 h	≥3 h/w = 180 min
Smoking	Do not smoke	Non-smoker = 0 cigarettes

s/d Servings per day, *h/w* hours per week, *w* week, *d* day

One-year changes were obtained by subtracting values at baseline from those from the second interview. Frequency distributions were used to evaluate how many women 'increased', 'decreased', or did 'not change' their lifestyle behavior concerning diet, physical activity and smoking. 'Not change' means that a participant was within the same category at both time points (e.g. the same amount of hours per week), while 'increased' and 'decreased' indicate a positive or negative change of response category. The nonparametric McNemar tests for correlated dichotomous variables were performed in order to detect changes of health-related behaviors as compared with expert recommendations. Finally, repeated measures analyzes of variance (ANOVA) with a two factor mixed design were performed in order to estimate the effects of predictors that may influence changes in health behavior. 'Moderate physical activity' and 'daily fruit intake' at T0 and T1 were used as the within-subject factors as they showed the greatest improvement over time reflecting two different lifestyle habits. In order to focus our analysis we did not consider vegetable intake as another within-subject factor because it is an element of the lifestyle habit 'nutrition' that had already been represented by fruit intake. Social, medical and behavioral variables (see Table 5) were used as between-subject factors, whereby each of these variables is analyzed separately. We preferred this solution because a multivariate model with all predictors would reduce the statistical power due to decreasing sample size. For all analyzes $p \leq 0.05$ was taken as level of statistical significance. SPSS version 19.0 was used for statistical analyses.

Results

Individual changes between baseline (T0) and follow-up (T1)

With regard to dietary intake about 50 % of the patients reported higher fruit consumption at follow-up (T1) (Table 3). The mean daily intake significantly increased from 3.0 to 3.4 servings per day ($p = 0.001$). In addition, 43 % of the study sample increased their daily vegetable consumption; the corresponding mean increased by almost one occasion per week ($p < 0.05$). A reduction occurred in dairy products where 43 % reduced their consumption in the year after breast cancer diagnosis. The mean daily consumption significantly decreased from 3.0 to 2.7 servings per day ($p = 0.001$). Mean snack consumption did not notably change over time, but an analysis at individual level revealed that 39 % of the women were consuming fewer and 45 % were consuming more snacks than prior to diagnosis. Minor changes occurred in meat and bread.

At follow-up nearly 50 % of the study population reported higher levels of physical exercise. Mean levels of physical activity significantly increased from 2.2 to 2.9 h per week ($p < 0.0001$), which is equivalent to an additional average of 46 min per week. This effect was mainly due to increased engagement in moderate exercise. However, one quarter of the study population reduced their levels of physical activity from baseline to follow-up.

The majority of smokers (73 %) did not reduce their daily nicotine consumption, and only five women (17 %) reported a reduction or cessation.

Table 3 Individual changes of diet, physical activity, and smoking, the corresponding means of change between T0 and T1, Hanover, Germany, 2002/2003

	Individual behavioral change number of women (%)			Mean ± SD[a]			Sig.	*N*
	No change (%)	Increased (%)	Decreased (%)	Baseline T0	Follow-up T1	Change over time		
Dietary intake								
Bread (s/d)	151 (67.7)	32 (14.3)	40 (17.9)	1.5 ± 0.6	1.5 ± 0.6	0.0 ± 0.6	0.122	223
Dairy products (s/d)	69 (30.5)	61 (27.0)	96 (42.5)	3.0 ± 1.5	2.7 ± 1.4	−0.3 ± 1.4	0.001	226
Fruit (s/d)	59 (26.6)	106 (47.7)	57 (25.7)	3.0 ± 1.7	3.4 ± 1.8	0.4 ± 1.8	0.001	222
Fruit[b]	30 (13.4)	113 (50.4)	81 (36.2)	10.5 ± 5.8	11.4 ± 5.5	0.9 ± 5.8	0.026	224
Vegetable[c]	59 (26.0)	97 (42.7)	71 (31.3)	8.3 ± 3.2	9.0 ± 3.2	0.7 ± 3.5	0.004	227
Meat/warm dish[d]	114 (50.0)	53 (23.2)	61 (26.8)				0.918	229
Meat/cold cuts (s/d)	163 (72.4)	23 (10.2)	39 (17.3)	0.7 ± 1.4	0.6 ± 1.3	−0.1 ± 0.5	0.029	225
Snacks[b]	38 (16.8)	101 (44.7)	87 (38.5)	4.3 ± 3.9	4.5 ± 3.7	0.2 ± 4.2	0.490	226
Physical activity								
Moderate exercise (h/w)	79 (34.5)	107 (46,7)	43 (18.8)	1.5 ± 2.0	2.3 ± 2.1	0.8 ± 2.3	0.000	229
Vigorous exercise (h/w)	155 (68.0)	36 (15.8)	37 (16.2)	0.7 ± 1.4	0.6 ± 1.3	−0.01 ± 1.3	0.883	228
Overall exercise (h/w)	65 (28.5)	105 (46.1)	58 (25.4)	2.2 ± 2.7	2.9 ± 2.5	0.8 ± 2.7	0.000	228

	Individual behavioral change number of women (%)			Mean ± SD[a]	Sig.	*N*
	No change	Quitting	Starting			
Smoking						
Current smokers	22 (73.3)	3 (10.0)	5 (16.7)			30

s/d Servings per day, *h/w* Hours per week, *T0* Baseline interview, *T1* Follow-up Interview

[a] SD standard deviation

[b] Occasions per week (range: 0–21)

[c] Occasions per week (range 0–14)

[d] Mean/SD was not calculated due to ordinal scale format. Level of significance was calculated by means of the Wilcoxon rank-sum test

Changes in accordance with current recommendation

With respect to dietary intake a large proportion of women already met the recommended levels at baseline and mostly maintained over the observation period (Table 4). With the exception of bread, dairy products and snacks, the number of women meeting the recommendations generally increased from baseline to follow-up. However, statistical significant increases were only seen in meeting fruit recommendations ($p < 0.01$).

With respect to *physical activity*, the percentage of women meeting the recommendations significantly increased between baseline and follow-up by 12 % ($p < 0.01$). At follow-up, half of the study sample was practising exercise in accordance with recommendations. Most patients already reporting sufficient exercise at baseline had maintained it and 38 % of the women not reaching the recommended levels at baseline increased their physical activity.

Regarding smoking, *t*he majority of women met the recommendation at both assessments, ten started (again) to smoke while seven stopped after their breast cancer diagnosis.

Predictors of change

At baseline, moderate physical activity increased significantly with women's age whereas no impact of age on fruit intake was found (Table 5). Overall women's age had no significant effect on changes in health behavior

Table 4 Changes of diet, physical activity and smoking over the time with respect to current recommendations, Hanover, Germany, 2002/2003

	Women not meeting the recommendation at baseline, number of women (%)		Women meeting the recommendation at baseline, number of women (%)		Meeting the recommendation at follow-up (%)	Women meeting the recommendation at baseline (T0) in comparison to follow-up (T1) (%)	Sig.	*N*
	Baseline T0 (%)	Improvement over the time (%)	Baseline T0 (%)	Stable over the time (%)				
Dietary intake								
Bread	113 (50.7)	25 (22.1)	110 (49.3)	72 (65.5)	97 (43.5)	−13 (−5.8)	0.130	223
Dairy products	91 (40.3)	47 (51.6)	135 (59.7)	87 (64.4)	134 (59.3)	−1 (−0.4)	1.000	226
Fruit/day	42 (19.4)	32 (74.4)	179 (80.6)	166 (92.7)	198 (89.2)	19 (+8,6)	0.007	222
Fruit[a]	74 (33.0)	46 (62.2)	150 (67.0)	135 (90.0)	181 (80.8)	31 (+13,8)	0.000	224
Vegetable[a]	50 (22.0)	26 (52.0)	177 (78.0)	161 (91.0)	187 (82.4)	10 (+4,4)	0.164	227
Meat/warm	104 (45.6)	37 (35.6)	124 (54.4)	99 (79.8)	136 (59.6)	12 (+5.3)	0.162	228
Meat/cold	11 (4.9)	7 (63.6)	214 (95.1)	210 (98.1)	217 (96.4)	3 (+1,3)	0.549	225
Snacks	35 (15.5)	22 (62.9)	191 (84.5)	166 (86.9)	188 (83.2)	−3 (−1.3)	0.711	226
Physical activity								
Overall exercise	142 (62.3)	54 (38.0)	86 (37.7)	60 (69.8)	114 (50.0)	28 (+12.3)	0.002	228
Smoking								
Current smokers	37 (16.2)	7 (19.0)	191 (83.8)	181 (94.8)	188 (82.5)	−3 (−1.3)	0.629	228

T0 baseline interview, *T1* follow-up Interview

[a] Occasions per week

over the time. Women with a high school education (upper secondary school degree) report lower levels in daily fruit intake and moderate exercise at baseline compared to women with secondary general school certificate, however, this difference did not meet statistical significance. Women in higher occupational positions showed significantly less improvement over time and had lowest absolute levels in fruit intake and moderate exercise at follow-up. Woman having under-age children initially reported significantly lower levels of moderate exercise. At follow up differences were smaller and failed to reach statistical significance. Women working fulltime had the highest levels of daily fruit intake and the lowest levels in moderate exercise at baseline and follow-up compared to not-working women, but differences were not statistically significant. Tumor size, grading, kind of breast cancer treatment and participation in rehabilitation had no consistent effect on daily fruit intake and moderate exercise neither at baseline nor at follow-up. Smoking status was most important for changes in daily fruit consumption. Non-smokers reported increases, whereas smokers even decreased their daily fruit intake. In addition, smokers tended to reported lower exercise levels at baseline and showed less improvement over time. Vegetable intake not meeting the recommendation at baseline turned out as a significant predictor of lower levels of daily fruit intake at T0. Not meeting the exercise recommendation was also associated with less fruit intake, however, this finding failed to reach statistical significance.

Discussion

Prevalence of health-related behavioral change

As assumed, the majority of patients showed some behavioral changes in the year after breast cancer surgery. A large proportion consumed more fruits and vegetables, fewer dairy products and engaged in higher levels of physical activity. Mean daily fruit intake and mean levels of exercise significantly increased over the observation period. In a sub-cohort of the WHEL study women's daily fruit intake increased by almost a serving at 12 months follow-up (Newman et al. 2005). Based on similar mean fruit intakes at baseline, the greater improvement in the WHEL study may be explained by the fact that the women received dietary intervention. Our findings, in contrast, are demonstrating changes in lifestyle habits without any intervention.

Table 5 Predictors of changes in daily fruit intake and engagement in moderate exercise from T0 to T1 ($n = 183$–229), Hanover, Germany 2002/2003

	Fruit[a]					Moderate exercise[b]				
	T0 (Mean)	Sig.[c]	T1 (Mean) Follow-up	Diff. T0–T1	Sig.[d]	T0 (Mean)	Sig.[c]	T1 (Mean)	Diff. T0–T1	Sig.[d]
Age										
0–49 years	3.06	0.404	3.52	0.46	0.589	1.03	**0.020**	2.01	0.98	0.556
50–59 years	2.75		3.26	0.51		1.53		2.11	0.58	
≥60 years	3.07		3.29	0.22		1.93		2.74	0.81	
School education										
Second. general school	3.19	0.209	3.57	0.38	0.938	1.45	0.598	2.39	0.94	0.505
Intermediate	2.80		3.19	0.39		1.62		2.14	0.52	
Upper secondary school	2.80		3.29	0.49		1.38		2.19	0.81	
Job position										
Low	2.84	0.765	3.42	0.58	0.586	1.43	0.091	2.29	0.86	**0.036**
Intermediate	3.01		3.42	0.41		1.23		2.41	1.18	
High	2.98		3.21	0.23		1.85		2.10	0.25	
Employment status										
Full time	3.35	0.159	3.65	0.30	0.731	1.19	0.929	1.72	0.53	0.663
Part time	3.11		3.34	0.23		1.28		2.30	1.02	
Not employed	2.74		3.22	0.48		1.63		2.44	0.81	
Marital status										
Marriage/partnership	3.01	0.360	3.38	0.37	0.718	1.45	0.672	2.27	0.82	0.754
Single	2.80		3.27	0.47		1.62		2.33	0.71	
Minor children										
Yes	3.02	0.784	3.54	0.52	0.467	1.01	0.**046**	1.91	0.90	0.594
No	2.93		3.26	0.33		1.76		2.49	0.73	
Tumor size										
T_1	3.07	0.058	3.47	0.40	0.299	1.68	0.234	2.39	0.71	0.313
T_2	2.51		3.15	0.64		1.23		2.06	0.83	
T_3	3.33		2.83	−0.50		0.67		2.83	2.16	
Grading										
I	2.84	0.969	2.84	0.00	0.692	1.00	0.143	1.31	0.21	0.443
II	3.01		3.42	0.41		1.68		2.43	0.75	
III	2.92		3.34	0.42		1.14		2.22	1.08	
Treatment										
Only surgery	2.45	0.145	2.68	0.23	0.387	1.36	0.980	2.00	0.64	0.922
Surgery + radiotherapie	3.17		3.72	0.55		1.59		2.50	0.91	
Surgery + chemotherapy	3.29		3.07	−0.22		1.52		2.13	0.61	
Surgery + radio + chemo	2.77		3.17	0.40		1.45		2.19	0.74	
Inpatient rehabilitation										
Yes	2.88	0.970	3.31	0.43	0.579	1.73	0.051	2.44	0.71	0.659
No	2.92		3.22	0.30		1.22		2.08	0.86	
Smoking T0										
Yes	2.90	0.783	2.58	−0.32	**0.010**	0.94	0.119	1.58	0.64	0.672
No	2.96		3.50	0.54		1.60		2.42	0.82	
Vegetable intake T0										
Not meeting recommend	2.47	**0.016**	3.06	0.59	0.402	1.33	0.655	2.02	0.69	0.770
Meeting recommend	3.09		3.43	0.34		1.55		2.35	0.80	
Snack intake T0										
Not meeting recommend	3.09	0.665	3.67	0.58	0.509	1.50	0.933	2.39	0.89	0.759

Table 5 continued

	Fruit[a]					Moderate exercise[b]				
	T0 (Mean)	Sig.[c]	T1 (Mean) Follow-up	Diff. T0–T1	Sig.[d]	T0 (Mean)	Sig.[c]	T1 (Mean)	Diff. T0–T1	Sig.[d]
Meeting recommend	2.93		3.29	0.36		1.50		2.26	0.76	
Exercise/fruit intake T0[e]										
Not meeting recommend	2.80	0.075	3.26	0.46	0.467	1.26	0.509	2.33	1.07	0.428
Meeting recommend	3.23		3.50	0.27		1.54		2.30	0.76	

T0 baseline interview, *T1* follow-up Interview

Bold values indicate significant effects ($p \leq 0.05$)

[a] Servings/day

[b] Hours/week

[c] Significant differences between factor levels of predictors at baseline T0

[d] Significant interactions between time T0–T1 and predictors

[e] Exercise overall physical activity at baseline as a predictor for change in fruit intake from T0 to T1 and fruit intake at baseline as a predictor for change in moderate exercise from T0 to T1

Only one non-interventional prospective study on dietary changes with breast cancer patients was available (Wayne et al. 2004). In contrast to our findings, no changes in mean fruit or vegetable consumption over time were reported and mean fruit intake was lower. These differences may be explained by the fact that the second measurement took place more than 2 years after diagnosis. Hence, it is possible that dietary changes in our study may not be stable over time. Data from a non-interventional comparison group from the WHEL Study revealed that behavioral changes after breast cancer diagnosis were not long lasting (Thomson et al. 2005). However, other methodological issues or subject characteristics of the study samples may also be contributors to the differences. The average age of our study sample, for example, was younger and therefore possibly more likely to adjust a healthier lifestyle.

So far, few studies have quantified change in diet after breast cancer diagnosis. There is, however, earlier research presenting data on self-reported change (Maunsell et al. 2002; Patterson et al. 2003; Pinto et al. 2002a, b; Salminen et al. 2002; Salminen et al. 2000). In general, a substantial proportion of women (30–69 %) reported some dietary changes after breast cancer diagnosis. This included increased fruit and vegetable consumption and decreased meat and fat consumption. Our results confirm most of these earlier findings. Contrary to our expectation, we found a large proportion of women reporting higher intakes of sweets and snacks at follow-up. Furthermore, the reduction of meat intake in our study was lower than expected.

Apart from nutrition, we considered physical activity as another lifestyle pattern. A recently published study found no mean changes in the amount of weekly exercise between 6 and 18 months after cancer diagnosis (Harrison et al. 2009), some studies reported decreased levels of physical exercise (Irwin et al. 2003). The patients in our study significantly increased their physical activity, thus supporting findings on self-reported changes (Patterson et al. 2003; Pinto et al. 2002a, b; Wayne et al. 2004).

Relevance of behavioral changes according to recommendations

Some findings suggest that only a minority of breast cancer patients are meeting the 5-A-Day recommendation (Blanchard et al. 2008; Demark-Wahnefried et al. 2000). In our study, however, the mean fruit consumption at baseline was already above the recommended levels and increased to follow-up. Unlike in earlier studies where most breast cancer patients reported insufficient levels of physical activity (Bellizzi et al. 2005; Blanchard et al. 2008; Irwin et al. 2004; Pinto et al. 2002a, b), we found 50 % of the sample reached recommended levels at follow-up. These findings are of relevance given that healthier nutrition and engagement in physical activity may play a role in reducing breast cancer recurrence (Holmes et al. 2005) and overall mortality (Blackburn and Wang 2007; Holick et al. 2008; Kroenke et al. 2005; Kwan et al. 2009; Pierce et al. 2007a, b; Sternfeld et al. 2009). It is important to point out that the cut off point applied in our analysis is above the current recommendation issued by the ACS (Doyle et al. 2006). With a lower cut off point even more women would have met the recommendation. Increased levels of total physical activity in our study were mainly due to moderate exercise. This, however, may be sufficient for having a beneficial impact on breast cancer survival (Holick et al. 2008).

A finding that needs to be discussed is the fact that there are 26 women in this study who met the physical activity recommendation at baseline but did not maintain their levels of exercise at follow-up. As previously mentioned, this may be due to persistent treatment-related symptoms such as fatigue, depression or pain (Hong et al. 2007).

Women consuming a healthy diet prior to diagnosis mostly maintained it. Thus, we may conclude that not all breast cancer patients have to change their diet after diagnosis. For some it might be sufficient to maintain their lifestyle habits in order to improve their individual outcome. Yet, a notable number of women did not meet the recommendations at baseline, but improved their behavior upon follow-up. Taken into account that these changes were made without any intervention it is remarkable that behavioral changes were in accordance with current recommendations (Doyle et al. 2006). It is conceivable that some women may have knowledge about relationships between nutrition and the course of cancer (Salminen et al. 2000). A reduction of dairy products, snacks and sweets may be motivated by their high fat content, unfavorable effects on body weight and subsequently, the risk of breast cancer occurrence and possible recurrence (Blackburn and Wang 2007; Kwan et al. 2009). Nevertheless, there are also opposing trends with some women increasing the intake of potentially unhealthy food. A recent study had shown that depressive symptoms are positively associated with sweet food consumption (Jeffery et al. 2009). Depressive state as a common side effect of treatment may be one reason for this finding (Maunsell et al. 2002).

Predictors of behavioral change

In a final step we analyzed subject characteristics that may have effects on behavioral changes. Coming from a social epidemiologic perspective, our analysis was focused on socio-economic variables. Within the framework of psychological constructs explaining behavioral change such as the Health Action Process Approach (HAPA) (Schwarzer et al. 2011) these factors reflect possible barriers and resources of successful behavioural modification. In addition, we also investigated the impact of clinical parameters and behavioral factors on changes in daily fruit intake and engagement in moderate exercise. Contrary to earlier reports (Kostopoulou and Katsouyanni 2006; Sternfeld et al. 2009), younger age was not associated with increased but with decreased moderate physical activity. However, as detailed analyzes have shown, vigourous exercise was increased in younger patients while decreased in older patients. This refers to the importance of the way in which physical activity is defined and underlines the need of assessing changes in moderate as well as vigourous physical activity. As distinguished from previous studies (Kostopoulou and Katsouyanni 2006; Hong et al. 2007), a higher education and higher job positions were not associated with higher fruit consumption or increased physical activity. This largely holds also for vegetable intake that was not in the focus of the present analysis. It was particularly remarkable that women in higher occupational positions showed significant less improvement in moderate physical activity over time and had lowest levels at follow-up. As further investigations on our dataset have shown, women in higher occupational positions were more likely to work full time which was associated with lower levels of moderate exercise. It can be assumed that employment status affects leisure time resources and thus opportunities for engaging in physical exercise. However, further analyzes are warranted in order to obtain more information about the mediating role of employment status. Overall, our findings suggest that associations between social status and health-related behavior among breast cancer patients are different from those in the general population where health-enhancing behavior mainly increased with social status (for example Hanson and Chen 2007).

In accordance with previous studies, cancer-related factors such as tumor size, grading and treatment, were of minor importance for inducing lifestyle changes (Harrison et al. 2009; Hong et al. 2007; Wayne et al. 2004). Women who attended inpatient rehabilitation tended to have higher levels of moderate exercise at baseline compared to women not participating in rehabilitation. Although failing statistical significance, this finding supports the assumption that women with particular needs are underrepresented in rehabilitation centres. Smoking status appears to be the most important factor in predicting unfavorable behavior patterns. Smokers significantly reduced their daily fruit consumption in the year following diagnosis. In accordance with earlier studies (Holick et al. 2008), they had lower exercise levels to both timepoints (T0 and T1). Our findings also suggest that other health-related behaviors are interrelated: higher vegetable intake as well as higher rates in moderate exercise was found to be correlated with higher daily fruit intake. This indicates that effective tertiary prevention among breast cancer patients requires to take different lifestyle factors into account.

Limitations

Despite the strength of the study (i.e., two time points, prospective assessments of health-related behaviors to determine variation over time, assessment of different lifestyle behaviors, measurement of mean and individual changes), there are also limitations to mention. First, due to lack of data for non-participants we did not know whether they differ significantly from the participants with respect to psychosocial and clinical factors. This may limit the

generalizability of our findings. In addition, we have contacted only women with tumor stages T_{1-3}, N_{0-2}, i.e., patients with a rather favorable prognosis. Furthermore, self-reports are inferior to objective indicators due to problems with memory. Since there is no control group, lifestyle changes seen in our study population may not be typical for breast cancer patients. Finally it has to be mentioned that due to relatively small sample size our study might have limited statistical power to detect socio-demographic and clinical factors that may have an influence on lifestyle pattern at baseline as well as follow-up. This may lead to an underestimation of the effects of these predictors.

Practical implications

The results demonstrate that breast cancer patients change their lifestyle habits in a significant way even without intervention. These changes seem to be largely independent of socio-demographic factors, and it appears that the breast cancer diagnosis may be responsible for the observed changes. This implies that intervention studies have to take this effect into account. As an exception, holding a high job position was associated with a significant smaller increase of moderate physical exercise after breast cancer diagnosis. From this it may follow that occupational commitment acts as a barrier for physical activity. Our analysis has also shown that data at individual level are superior to aggregated data and should therefore be preferred in future studies. Patients who smoke are in particular need of professional support to implement health-promoting behavior, and intervention should especially focus on this group. Given that single health-related behaviors revealed to be intercorrelated, support should be offered as part of multi behavioral interventions.

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References

Ballard-Barbash R, McTiernan A (2007) Is the whole larger than the sum of the parts? The promise of combining physical activity and diet to improve cancer outcomes. J Clin Oncol 25:2335–2337

Bellizzi KM, Rowland JH, Jeffery DD, McNeel T (2005) Health behaviors of cancer survivors: examining opportunities for cancer control intervention. J Clin Oncol 23:8884–8893

Blackburn GL, Wang KA (2007) Dietary fat reduction and breast cancer outcome: results from the women's intervention nutrition study (WINS). Am J Clin Nutr 86:878–881

Blanchard CM, Courneya KS, Stein K, American Cancer Society's SCS-II (2008) Cancer survivors' adherence to lifestyle behavior recommendations and associations with health-related quality of life: results from the american cancer society's SCS-II. J Clin Oncol 26:2198–2204

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

Deutsche Krebshilfe e.V (Ed.) (2008) Gesund bleiben. Präventionsratgeber 1 Gesunde Lebensweise

Doyle C, Kushi LH, Byers T, Courneya KS, Demark-Wahnefried W, Grant B et al (2006) Nutrition and physical activity during and after cancer treatment: an American cancer society guide for informed choices. CA Cancer J Clin 56:323–353

Hanson MD, Chen E (2007) Socioeconomic status and health behaviors in adolescence: a review of the literature. J Behav Med 30:263–285

Harrison S, Hayes SC, Newman B (2009) Level of physical activity and characteristics associated with change following breast cancer diagnosis and treatment. Psycho-Oncol 18:387–394

Holick CN, Newcomb PA, Trentham-Dietz A, Titus-Ernstoff L, Bersch AJ, Stampfer MJ et al (2008) Physical activity and survival after diagnosis of invasive breast cancer. Cancer Epidemiol Biomarkers Prev 17:379–386

Holmes MD, Chen WY, Feskanich D, Kroenke CH, Colditz GA (2005) Physical activity and survival after breast cancer diagnosis. JAMA 293:2479–2486

Hong S, Bardwell WA, Natarajan L, Flatt SW, Rock CL, Newman VA et al (2007) Correlates of physical activity level in breast cancer survivors participating in the women's healthy eating and living (WHEL) study. Breast Cancer Res Treat 101:225–232

Irwin ML, Crumley D, McTiernan A, Bernstein L, Baumgartner R, Gilliland FD et al (2003) Physical activity levels before and after a diagnosis of breast carcinoma: the health, eating, activity, and lifestyle (HEAL) study. Cancer 97:1746–1757

Irwin ML, McTiernan A, Bernstein L, Gilliland FD, Baumgartner R, Baumgartner K et al (2004) Physical activity levels among breast cancer survivors. Med Sci Sports Exerc 36:1484–1491

Jeffery RW, Linde JA, Simon GE, Ludman EJ, Rohde P, Ichikawa LE et al (2009) Reported food choices in older women in relation to body mass index and depressive symptoms. Appetite 52: 238–240

Kostopoulou V, Katsouyanni K (2006) The truth-telling issue and changes in lifestyle in patients with cancer. J Med Ethics 32:693–697

Koula-Jenik H, Kraft M, Miko M, Schulz R (eds) (2006) Leitfaden Ernährungsmedizin, 1st edn. Urban and Fischer, München

Kroenke CH, Fung TT, Hu FB, Holmes MD (2005) Dietary patterns and survival after breast cancer diagnosis. J Clin Oncol 23: 9295–9303

Kwan ML, Ambrosone CB, Lee MM, Barlow J, Krathwohl SE, Ergas IJ et al (2008) The pathways study: a prospective study of breast cancer survivorship within Kaiser Permanente Northern California. Cancer Causes Control. doi:10.1007/s10552-008-9170-5

Kwan ML, Weltzien E, Kushi LH, Castillo A, Slattery ML, Caan BJ (2009) Dietary patterns and breast cancer recurrence and survival among women with early-stage breast cancer. J Clin Oncol 27:919–926

Linos E, Holmes MD, Willett WC (2007) Diet and breast cancer. Current Oncol Rep 9:31–41

Maskarinec G, Murphy S, Shumay DM, Kakai H (2001) Dietary changes among cancer survivors. Eur J Canc Care 10:12–20

Maunsell E, Drolet M, Brisson J, Robert J, Deschenes L (2002) Dietary change after breast cancer: extent, predictors, and relation with psychological distress. J Clin Oncol 20:1017–1025

McBride CM, Clipp E, Peterson BL, Lipkus IM, Demark-Wahnefried W (2000) Psychological impact of diagnosis and risk reduction among cancer survivors. Psycho-Oncol 9:418–427

Nelson N (2008) Dietary intervention trial reports no effect on survival after breast cancer. J Nat Cancer Inst 100:386–387

Newman VA, Thomson CA, Rock CL, Flatt SW, Kealey S, Bardwell WA et al (2005) Achieving substantial changes in eating behavior among women previously treated for breast cancer—an overview of the intervention. J Am Diet Assoc 105:382–391

Patterson RE, Neuhouser ML, Hedderson MM, Schwartz SM, Standish LJ, Bowen DJ (2003) Changes in diet, physical activity, and supplement use among adults diagnosed with cancer. J Am Diet Assoc 103:323–328

Pierce JP, Natarajan L, Caan BJ, Parker BA, Greenberg ER, Flatt SW et al (2007a) Influence of a diet very high in vegetables, fruit, and fiber and low in fat on prognosis following treatment for breast cancer: the women's healthy eating and living (WHEL) randomized trial. J Am Med Assoc 298:289–298

Pierce JP, Stefanick ML, Flatt SW, Natarajan L, Sternfeld B, Madlensky L et al (2007b) Greater survival after breast cancer in physically active women with high vegetable-fruit intake regardless of obesity. J Clin Oncol 25:2345–2351

Pinto BM, Maruyama NC (1999) Exercise in the rehabilitation of breast cancer survivors. Psycho-Oncol 8:191–206

Pinto BM, Maruyama NC, Clark MM, Cruess DG, Park E, Roberts M (2002a) Motivation to modify lifestyle risk behaviors in women treated for breast cancer. Mayo Clin Proc 77:122–129

Pinto BM, Trunzo JJ, Reiss P, Shiu SY (2002b) Exercise participation after diagnosis of breast cancer: trends and effects on mood and quality of life. Psycho-Oncol 11:389–400

Salminen EK, Lagstrom HK, Heikkila S, Salminen S (2000) Does breast cancer change patients' dietary habits? Eur J Clin Nutr 54:844–848

Salminen E, Heikkila S, Poussa T, Lagstrom H, Saario R, Salminen S (2002) Female patients tend to alter their diet following the diagnosis of rheumatoid arthritis and breast cancer. Prev Med 34:529–535

Schwarzer R, Lippke S, Luszczynska A (2011) Mechanisms of health behavior change in persons with chronic illness or disability: the Health Action Process Approach (HAPA). Rehabil Psychol 56:161–170

Stehle P (2007) Dissemination of nutritional knowledge in Germany—nutrition circle, 3D food pyramid and 10 nutrition guidelines. Ann Nutr Metab (Suppl 51):21–25

Sternfeld B, Weltzien E, Quesenberry CP Jr, Castillo AL, Kwan M, Slattery ML et al (2009) Physical activity and risk of recurrence and mortality in breast cancer survivors: findings from the LACE study. Cancer Epidemiol Biomarkers Prev 18:87–95

Tangney CC, Young JA, Murtaugh MA, Cobleigh MA, Oleske DM (2002) Self-reported dietary habits, overall dietary quality and symptomatology of breast cancer survivors: a cross-sectional examination. Breast Cancer Res Treat 71:113–123

Thomson CA, Flatt SW, Rock CL, Ritenbaugh C, Newman V, Pierce JP (2002) Increased fruit, vegetable and fiber intake and lower fat intake reported among women previously treated for invasive breast cancer. J Am Med Assoc 102:801–808

Thomson CA, Rock CL, Giuliano AR, Newton TR, Cui H, Reid PM et al (2005) Longitudinal changes in body weight and body composition among women previously treated for breast cancer consuming a high-vegetable, fruit and fiber, low-fat diet. Eur J Nutr 44:18–25

Wayne SJ, Lopez ST, Butler LM, Baumgartner KB, Baumgartner RN, Ballard-Barbash R (2004) Changes in dietary intake after diagnosis of breast cancer. J Am Diet Assoc 104:1561–1568