ACTA ONCOLOGICA
2019, VOL. 58, NO. 5, 673–681
https://doi.org/10.1080/0284186X.2018.1563712

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ORIGINAL ARTICLE

Physical activity levels of women with breast cancer during and after treatment, a comparison with the Dutch female population

R. Gal[a], E. M. Monninkhof[a], P. H. M. Peeters[a], C. H. van Gils[a], D. H. J. G. van den Bongard[b], G. C. W. Wendel-Vos[c], N. P. A. Zuithoff[a], H. M. Verkooijen[d] and A. M. May[a]

[a]Department of Clinical Epidemiology, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, Utrecht University, Utrecht, The Netherlands; [b]Department of Radiation Oncology, University Medical Center Utrecht, Utrecht University, Utrecht, The Netherlands; [c]Centre for Nutrition, Prevention and Health Services, National Institute for Public Health and the Environment, Bilthoven, The Netherlands; [d]Imaging Division, University Medical Center Utrecht, Utrecht University, Utrecht, The Netherlands

ABSTRACT

Background: Physical activity has been shown to reduce side-effects of breast cancer and its treatment. As physical activity levels of patients with breast cancer are largely unknown, we investigated these levels and compared them to women from the general population.

Methods: In this prospective cohort study, physical activity levels of women with breast cancer participating in the UMBRELLA cohort were assessed at radiotherapy intake and thereafter every 6 months up to 3 years with the SQUASH questionnaire, which was also used in a random sample of the Dutch population. We compared physical activity levels (no activity, low, moderate or high levels of sports, leisure time or total activity) between patients and the Dutch female population using multinomial logistic regression. Standardized Prevalence Ratios (SPR) were calculated to compare adherence to Dutch physical activity guidelines.

Results: Women with breast cancer ($n_{baseline} = 1655$, $n_{6\ months} = 1414$, $n_{12\ months} = 1186$, $n_{18\ months} = 957$, $n_{24\ months} = 744$, $n_{30\ months} = 555$, and $n_{36\ months} = 377$) were less likely to spend time in physical activity compared to the general population ($n = 11{,}710$) until 3 years post-diagnosis, especially after 6 months ($OR_{high\text{-}vs.\text{-}no\ activity} = 0.34$, 95% CI: 0.28–0.41). From 12 months onwards, patients were more likely to perform sports compared to the general population, especially patients who underwent systemic therapy. Guideline adherence was significantly lower in patients at baseline and 6 months ($SPR_{baseline} = 89$, 95% CI: 82–97; $SPR_{6\ months} = 88$, 95% CI: 81–96), and comparable to the general population at 12–36 months, especially in older women.

Conclusions: Physical activity levels in women with breast cancer during and after treatment were lower compared to the Dutch female population. Three years post-treatment, they were still less physically active, although they spend more time in sport activities. As about half of the patients did not perform any sports, physical activity needs to be stimulated during and after treatment.

ARTICLE HISTORY
Received 14 August 2018
Accepted 19 December 2018

Introduction

Since the incidence of breast cancer is high and still rising, a growing number of women will live with the possible side-effects of breast cancer and its treatment, including fatigue, impaired exercise tolerance, anxiety, depression, and arm symptoms (e.g., lymphedema, pain) [1–4]. Physical activity reduces several treatment-related side-effects and is associated with improved breast cancer outcomes, e.g., less recurrence of breast cancer, lower risk of premature death, and new breast cancer primaries [5–8]. Since evidence on beneficial effects of physical activity for patients with breast cancer is substantial, guidelines for cancer patients have been developed [9], for example by the American College of Sports Medicine (ACSM) [10].

Few studies have focused on the actual physical activity levels of women with breast cancer. Three studies showed that the proportion of women with breast cancer that do not meet the general guidelines of performing at least 150 min per week of moderate-to-vigorous physical activity after treatment was high, varying from 60% to nearly 85% [11–13]. Another study found a decrease in adherence from 29% within 20 weeks after primary treatment to 22% one year later [14]. In addition, three studies showed mixed results when comparing physical activity levels of women with breast cancer 2 or more years after diagnosis to levels of the general female population [15,16]. To the best of our knowledge, only one European study assessed activity levels among patients with breast cancer [17]. This Belgian study

CONTACT R. Gal R.Gal@umcutrecht.nl University Medical Center Utrecht, Julius Center for Health Sciences and Primary Care, STR 6.131, PO Box 85500, 3508 GA Utrecht, The Netherlands

Supplemental data for this article can be accessed here.

showed that the physical activity levels of survivors of breast cancer decreased in the first year after surgery and were still lower than pre-operative levels 2 years post-surgery.

In this study, we aim to get insight into physical activity levels of women with breast cancer during and up to 3 years after treatment by comparing them to women of similar age in the Dutch female population.

Methods

Data of the present study were obtained from the Utrecht cohort for Multiple BReast cancer intErvention studies and Long-term evaLuAtion (UMBRELLA cohort), which is an ongoing cohort study and inclusion is running since September 2013 in the University Medical Center Utrecht (UMC Utrecht), The Netherlands [18]. In UMBRELLA, all patients with invasive breast cancer or ductal carcinoma in situ (DCIS) who are referred for radiotherapy at the UMC Utrecht and understand the Dutch language are invited to participate. Approximately, 575 patients are referred each year [Young-Afat, 2017]. Patients give consent to the prospective collection of patient reported outcome measures through questionnaires. Of those invited between October 2013 and July 2016, 88% gave consent [18].

Patient-reported outcomes (including physical activity levels) are captured at baseline (before the start of radiotherapy) and at regular intervals of 6 months. Return rates of the regular questionnaires ranged from 80% at baseline to 67% after 24 months [18]. Clinical data about pathological tumor status and breast cancer treatment was obtained from the nationwide Netherlands Cancer Registry (NCR), maintained by Netherlands Comprehensive Cancer Organization (IKNL) [19]. For this study, we included women who agreed to participate in the UMBRELLA cohort between September 2013 and June 2018.

Data from the Dutch female population were obtained from the Health Surveys of 2012–2015 (Gezondheidsenquête) conducted by Statistics Netherlands (CBS) [20–23]. Note that the results are based on own calculations. This annual survey collects information about lifestyle and health-related aspects and is completed by random samples of the general population of approximately 14,000 men and women of all ages each year. We combined the results of the years 2012–2015 and we selected women aged 30 years and older, reflecting the age-range in the UMBRELLA cohort.

Outcome measures

In the UMBRELLA cohort, physical activity levels of patients with breast cancer were measured at baseline and then every 6 months until three years follow-up by the validated Dutch version of the Short QUestionnaire to ASsess Health-enhancing physical activity (SQUASH) questionnaire [24]. Since we used repeated measurements in a dynamic cohort, not all patients were scheduled for all six follow-up measurements yet. In the Dutch reference population, the same questionnaire was used in the Health Survey of the years 2012–2015.

The SQUASH assesses the amount of habitual physical activity during an average week in the past months using questions referring to frequency, duration and intensity of the activity items [24]. Questions are structured in commuting activities (walking and cycling separate), sports (four open questions), leisure time activities (walking, cycling, gardening and odd jobs), household activities (light and moderate-vigorous), and activities at work and school (light and moderate/vigorous; referred to as activities at work). We excluded household activities and light activities at work from further calculations since we considered these as low intensive. For sports and leisure time activities, minutes per week performing the activity was calculated. Also, total minutes per week physical activity was calculated by summing up the minutes spent in commuting activities, sports, leisure time activities and moderate/vigorous activities at work.

The physical activity outcome had a large number of zero scores (for women not engaging in this activity item), while those who did engage in physical activities showed values that were skewed to the right. Therefore, each activity variable was divided into four categories: no activity, low, moderate, and high level, based on tertiles in the Dutch female reference population (Table 1). In addition, we assessed whether women met the 2017 Dutch physical activity guidelines, i.e., at least 150 min per week of moderately intensive physical activity, and at least twice a week physical activities that strengthen muscles and bones [25]. Activities with moderate and vigorous intensity ($\geq$3.5 Metabolic Equivalent of Task (MET) intensity value) were taken into account [26].

Statistical analysis

Descriptive statistics were presented. To compare physical activity levels of women with breast cancer to the Dutch female poulation, we performed multinomial logistic regression analyses for each follow-up measurement separately (i.e., at baseline, and 6, 12, 18, 24, 30, and 36 months), with the Dutch female population as the reference group. Analyses were performed for sports, leisure time activities, and total activity, with 'no activity' as the reference category.

Table 1. Categories of physical activity in minutes per week, categorized in tertiles based on the distribution in the Dutch female population.

	No activity (min/week)	Low activity[a] (min/week)	Moderate activity[a] (min/week)	High activity[a] (min/week)
Sports	0	0.1–119	120–224	$\geq$225
Leisure time activities (sports excluded)	0	0.1–239	240–539	$\geq$540
Total activity[b] (household activities and light work excluded)	0	0.1–419	420–899	$\geq$900

[a]The categories low, moderate and high activity are defined by tertile cutoffs in the general Dutch female population, above age 30, that filled out to be engaged in the defined activity items (sports, leisure time, and total).
[b]Total activity was calculated by summing up the minutes spent in commuting activities, sports, leisure time activities and moderate/vigorous activities at work.

Table 2. Characteristics of the women with breast cancer and the reference population.

		Women with breast cancer						
	Dutch population	Baseline	6 months	12 months	18 months	24 months	30 months	36 months
N	11,710	1655	1414	1186	957	744	555	377
Age in years, mean (SD)	55.0 (14.3)	58.0 (10.6)	58.7 (10.7)	59.3 (10.4)	59.4 (10.2)	60.1 (10.2)	60.5 (10.2)	61.0 (10.2)
Available data from cancer registry		1262 (76)	1176 (83)	1074 (91)	887 (93)	688 (93)	510 (92)	349 (93)
Pathological tumor stage, %								
No evidence[a]		63 (5)	62 (5)	48 (5)	45 (5)	34 (5)	25 (5)	13 (4)
In situ		138 (11)	125 (11)	125 (12)	98 (11)	74 (11)	58 (11)	44 (13)
T1 (≤20 mm)		750 (60)	693 (59)	631 (59)	526 (59)	401 (58)	294 (58)	200 (57)
T2 (20-50 mm)		235 (19)	221 (19)	206 (19)	162 (18)	137 (20)	102 (20)	72 (21)
T3 (≥50 mm)		35 (3)	34 (3)	30 (3)	22 (3)	15 (2)	9 (2)	8 (2)
T4[b]		3 (0.2)	3 (0.3)	3 (0.3)	2 (0.2)	1 (0.1)	2 (0.4)	
Cannot be assessed		37 (3)	37 (3)	30 (3)	31 (4)	25 (4)	20 (4)	12 (3)
Patients who started specific treatments before completion of SQUASH questionnaire, *N* (%)								
Radiotherapy		287 (223)	1128 (96)	1067 (100)	884 (100)	685 (100)	509 (100)	348 (100)
Surgery		1199 (95)	1160 (99)	1071 (100)	886 (100)	687 (100)	510 (100)	349 (100)
Neoadjuvant chemotherapy		177(14)	176 (15)	145 (14)	117 (13)	87 (13)	59 (12)	37 (11)
Adjuvant chemotherapy		50 (4)	302 (26)	292 (27)	250 (28)	211 (31)	161 (32)	115 (33)
Hormonal therapy		186 (15)	434 (37)	496 (47)	413 (47)	320 (47)	237 (47)	161 (47)
Immunotherapy		56 (4)	119 (10)	113 (11)	100 (11)	82 (12)	56 (11)	39 (11)

SD: standard deviation.
[a]In approximately 5% of the breast cancer cases, there was no pathological evidence because lesions were completely biopsied.
[b]Tumor of any size growing into the chest wall or skin.

Results were expressed as odds ratios with 95% confidence intervals. Cases with a missing observation at a measurement in follow-up were excluded from that particular analysis because most missings were completely at random since not all patients had sufficient follow-up time. The odds ratios of these analyses were interpreted as the combined effect of having breast cancer (compared to the Dutch female population) and being physically active (compared to no activity). Analyses were repeated for patients treated with or without systemic therapy (i.e., (neo)adjuvant chemotherapy, immunotherapy and/or hormonal therapy, either Tamoxifen or aromatase inhibitors).

To compare the prevalence of meeting the physical activity guidelines in women with breast cancer to the Dutch female population, we calculated Standardized Prevalence Ratios (SPR) as the ratio of the observed number of women with breast cancer who meet the guidelines to the expected number of meeting the guidelines based on the Dutch female population (reference population). SPRs were calculated at baseline and during follow-up, and for different age groups (30–39, 40–49, 50–54, 55–64, 65–74, and ≥75 years). In addition, 95% confidence intervals were calculated based on Poisson's distribution (if the number of observed women with breast cancer who meet the guidelines was <100) and on Byar's distribution (if the number of observed women with breast cancer who meet the guidelines was ≥100) [27].

Analyses for descriptive statistics and multinomial logistic regression analyses were performed using Statistical Package for Social Sciences (SPSS) software (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.).

Results

Participants

Information about physical activity was available from 1655 (baseline), 1414 (6 months), 1186 (12 months), 957 (18 months), 744 (24 months), 555 (30 months), and 377 (36 months) women with breast cancer. Of these patients, information on pathological tumor stage and breast cancer treatment were available from 1262 (76%), 1176 (83%), 1074 (91%), 887 (93%), 688 (93%), 510 (92%), and 349 (93%) women. Information about treatment was not available for all patients since retrieving data from the Netherlands Cancer Registry (NCR) is performed only once a year. From the reference population, data on physical activity levels from 11,710 women were available. Women with breast cancer who completed follow-up questionnaires did not differ from women who did not respond to questionnaires, except at 6-months where non-responders were on average older and more often diagnosed with stage II or III breast cancer (data not shown).

The average age of women with breast cancer was 58 years (at baseline; Table 2) and 55 years for the Dutch female population. Most of the women with breast cancer had a pathological tumor stage 1 (approximately 60%) and approximately 11% had in situ breast cancer. At baseline, almost all women with breast cancer underwent surgery and 23% had started radiotherapy. At 6 months, almost all women had finished radiotherapy. Overall, 61% of the women with breast cancer underwent systemic therapy (i.e., (neo)adjuvant chemotherapy, immunotherapy, and/or hormonal therapy). Women with breast cancer who underwent systemic therapy were significantly younger than women without systemic therapy (56 versus 61 years, $p < .01$).

Physical activity levels of women with breast cancer compared to the Dutch female population

Women with breast cancer were less likely to have high levels of leisure time activities (≥540 min per week; e.g., baseline OR = 0.60, 95% CI = 0.50–0.71; 36 months OR = 0.51, 95% CI = 0.36–0.72) and total physical activity (≥900 min per week; e.g., baseline OR = 0.49, 95% CI = 0.40–0.60; 36 months

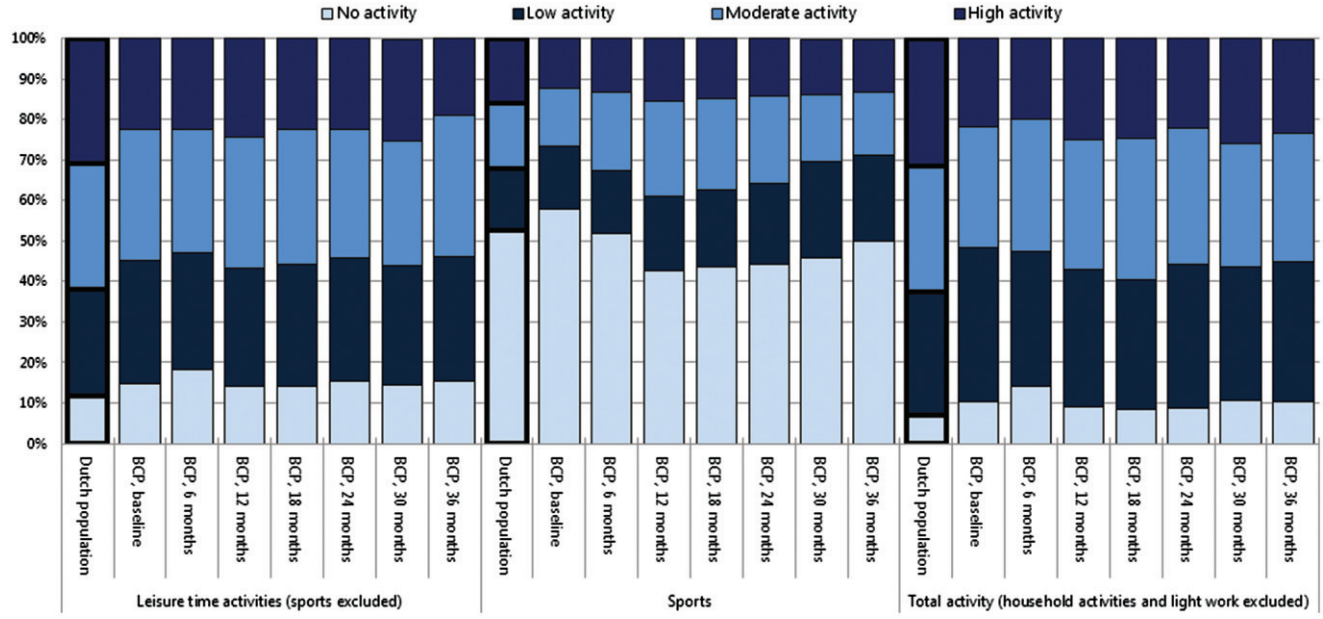

Figure 1. Physical activity levels of women with breast cancer and the Dutch female population. BCP: women/patients with breast cancer.

OR = 0.62, 95% CI = 0.42–0.92) compared to the Dutch female population (Figures 1 and 2; Supplementary Table S1). At 6 months, age-adjusted odds ratios of women with breast cancer compared to the Dutch female population were the lowest (leisure time: $OR_{high} = 0.49$, 95% CI = 0.41–0.58; total activity: $OR_{high} = 0.34$, 95% CI = 0.28–0.41). Women with breast cancer spent less time on sports at baseline compared to the Dutch female population ($OR_{high} = 0.75$, 95% CI = 0.64–0.88), but they were more likely to spent time on sports activities from 6 months onwards (e.g., 12 months $OR_{moderate} = 2.10$, 95% CI = 1.79–2.45).

Physical activity levels in women with breast cancer with and without systemic therapy

From baseline until 36 months (except at 12 months), all women with breast cancer (with and without systemic treatment) spent less time on leisure time activities compared to the Dutch female population (Figure 3; Supplementary Table S2). For women with breast cancer who underwent systemic therapy, age-adjusted odds ratios were lower at baseline and 6 months for leisure time activities (e.g., baseline $OR_{high} = 0.50$, 95% CI = 0.39–0.63) and total physical activity (e.g., baseline $OR_{high} = 0.35$, 95% CI = 0.26–0.46), but at 12 months, odds ratios were higher for leisure time activities ($OR_{low} = 1.39$, 95% CI = 1.05–1.82). Women with breast cancer who did not undergo systemic therapy were less likely to spent time on leisure time activities compared to the Dutch female population (e.g., 6 months $OR_{high} = 0.67$, 95% CI = 0.50–0.90). From 18 months onwards, women with and without systemic therapy had comparable levels of leisure time activity.

At baseline, women with breast cancer who underwent systemic therapy were less likely to spent time on sports activities compared to the Dutch female population ($OR_{moderate} = 0.77$, 95% CI = 0.62–0.96). From 6 months onwards, all women with breast cancer were more likely to spent time on sports activities compared to the Dutch female population, but at 12, 18, and 24 months women with systemic therapy were more likely to sport compared to women without systemic treatment (e.g., 24 months $OR_{moderate,\ localtherapy} = 1.53$, 95% CI = 1.08–2.16; $OR_{moderate\ systemictherapy} = 2.12$, 95% CI = 1.65–2.72).

Guideline adherence in women with breast cancer compared to the Dutch female population

Forty-three percent of the Dutch female population met the physical activity guidelines (Table 3). At baseline and 6 months, the prevalence of meeting the guidelines in women with breast cancer was statistically significant lower compared to the prevalence in the Dutch female population (baseline $SPR_{overall} = 89$, 95% CI = 82–97; 6 months $SPR_{overall} = 88$, 95% CI = 81–96). From 12 months onwards, guideline adherence was comparable between women with breast cancer and the Dutch female population (e.g., 12 months $SPR_{overall} = 104$, 95% CI = 95–113).

At baseline and 6 months, the prevalence of meeting the guidelines in older women with breast cancer was statistically significant lower compared to the same age groups in the Dutch female population (e.g., baseline $SPR_{65\text{-}74years} = 74$, 95% CI = 91–89; 6 months $SPR_{65\text{-}74years} = 81$, 95% CI = 67–97). From 12 months onwards, guideline adherence in older women (i.e., ≥55 years) was lower than expected but not statistically significant (e.g., 24 months $SPR_{75+years} = 94$, 95% CI = 45–173). In contrast, women aged 30–34 years were more likely to meet the guidelines compared to the general population at each follow-up measurement. From 12 months onwards, the prevalence of meeting the guidelines in younger women with breast cancer (i.e., <55 years) was higher than expected but not statistically significant (e.g., 24 months $SPR_{40-49\ years} = 108$, 95% CI = 80–142).

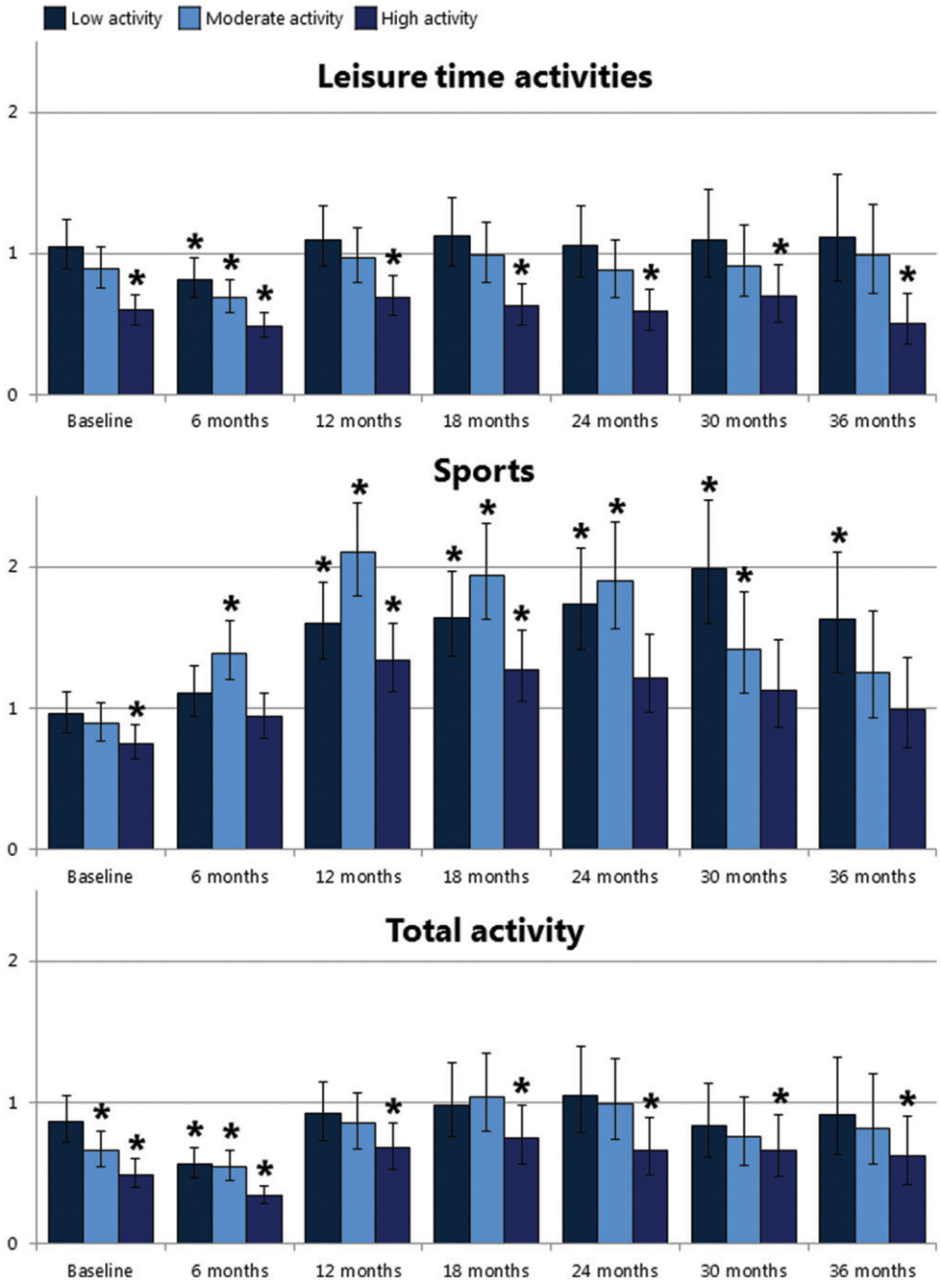

Figure 2. Results of multinomial logistic regression analyses of physical activity levels of women with breast cancer, compared to the Dutch female population. Adjusted for age. Data were presented as odds ratios and whiskers refer to the 95% confidence interval. An asterik denotes a statistically significant difference (i.e., the 95% confidence intervals does not contain 1). For example, when OR $<$ 1.00, women with breast cancer were less likely to be active compared to the Dutch female population.

Discussion

In the first months after diagnosis, women with breast cancer were less likely to be physically active and less likely to meet the physical activity guidelines compared to the Dutch female population, especially women who underwent systemic therapy. Between one and three years follow-up, women with breast cancer spend less time in physical activities (total and leisure time activities) compared to the reference population. In this period, older women with breast cancer also were less likely to meet the physical activity guidelines. However, from 6 months onwards, women with breast cancer were more likely to spend time on sports activities and this was particularly observed in women who underwent systemic therapy.

Previous studies comparing physical activity levels of women with and without breast cancer showed mixed results [15,16,28]. Kwon et al. [15] found no difference in physical activity levels between female breast cancer survivors and non-cancer females, whereas Shi et al. [16] showed a higher physical activity level in breast cancer survivors. Philips et al. [28] reported higher moderate-to-vigorous physical activity in breast cancer survivors, but they were more sedentary. Also, guideline adherence, i.e., performing at least 150 min per week of moderate-to-vigorous physical activity, varied between studies from 15% to nearly 68% in women

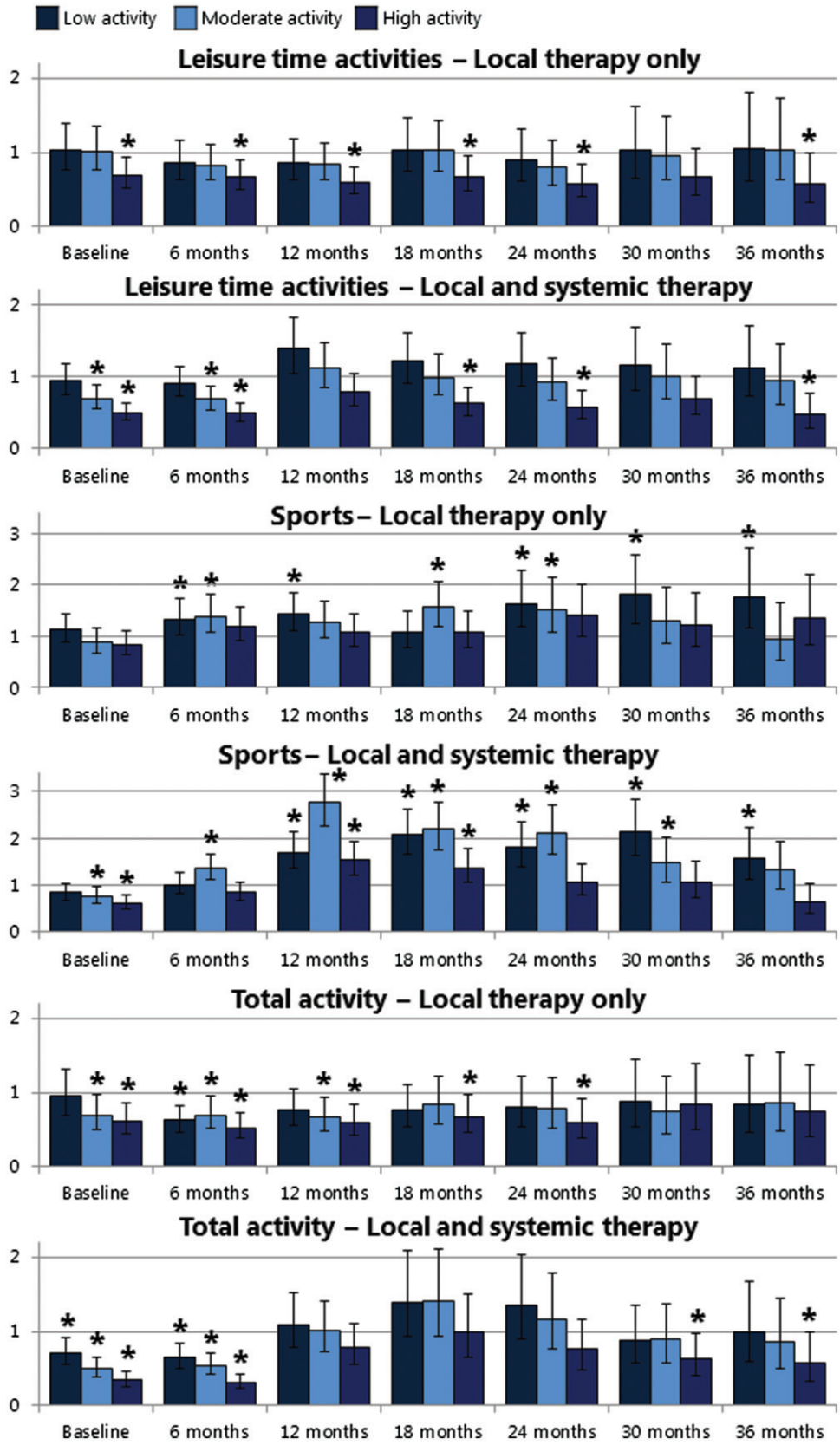

Figure 3. Results of multinomial logistic regression analyses of physical activity levels of women with breast cancer with or without adjuvant systemic therapy, compared to the Dutch female population. Adjusted for age. Data were presented as odds ratios and whiskers refer to the 95% confidence interval. An asterik denotes a statistically significant difference (i.e., the 95% confidence intervals does not contain 1). For example, when OR $<$ 1.00, women with breast cancer were less likely to be active compared to the Dutch female population.

Table 3. Standardized prevalence ratios for adherence to the 2017 Dutch physical activity guidelines in women with breast cancer, with the general Dutch female population as the reference population[a].

Age group (years)	Dutch population		Women with breast cancer																			
			Baseline			6 month			12 months			18 months			24 months			30 months			36 months		
	N	% met GL	*N*	% met GL	SPR (95% CI)	*N*	% met GL	SPR (95% CI)	*N*	% met GL	SPR (95% CI)	*N*	% met GL	SPR (95% CI)	*N*	% met GL	SPR (95% CI)	*N*	% met GL	SPR (95% CI)	*N*	% met GL	SPR (95% CI)
30–39	1959	45	69	54	118 (83–163)	49	51	112 (73–166)	29	72	159 (99–244)	22	68	150 (84–248)	16	50	110 (47–217)	16	56	124 (57–235)	10	60	132 (48–288)
40–49	2532	49	281	47	94 (79–112)	216	44	90 (73–111)	164	57	115 (93–142)	129	56	113 (89–143)	92	53	108 (80–142)	56	59	119 (82–168)	36	53	107 (64–167)
50–54	1407	49	329	40	**83 (70–98)**	284	47	96 (81–114)	241	61	**124 (105–146)**	189	53	110 (89–133)	129	49	100 (78–129)	95	51	104 (76–136)	58	45	92 (60–135)
55–64	2576	47	479	43	92 (80–106)	395	39	**84 (72–99)**	356	44	94 (80–110)	298	45	97 (81–115)	249	44	94 (77–113)	190	45	96 (77–120)	126	48	103 (80–135)
65–74	1996	37	412	27	**74 (61–89)**	381	30	**81 (67–97)**	316	30	82 (67–101)	254	30	82 (65–103)	197	26	**72 (54–95)**	150	29	80 (58–107)	114	26	72 (49–103)
75+	1237	18	85	11	60 (27–114)	89	9	51 (22–100)	80	15	85 (44–148)	65	11	61 (24–125)	60	17	94 (45–173)	47	6	36 (7–105)	33	9	51 (11–150)
Overall	11,707	43	1,655	38	**89 (82–97)**	1,414	38	**88 (81–96)**	1,186	44	104 (95–113)	957	42	100 (90–110)	743	39	92 (82–103)	554	40	94 (82–107)	377	38	90 (76–106)

CI: confidence interval; GL: guidelines; SPR: standardized prevalence ratio (×100%).
[a]In bold if statistically significant (the 95% confidence intervals does not contain 100).

with breast cancer who where 2–10 years post-diagnosis [11,12,15]. As time since diagnosis differed between studies, a direct comparison between studies is difficult. In the present study, data were available from shortly after diagnosis to 3 years follow-up, which makes it possible to gain insight into the time-trend of physical activity levels. We found that women with breast cancer were less physically active compared to the Dutch female population up to 3 years follow-up. Treatment-related side-effects, e.g., fatigue, lymphedema and a reduced energy level, may be possible barriers to exercise and hence a reason for the decreased physical activity levels during and shortly after treatment [29,30].

Another explanation for the inconsistent findings across studies may be cultural differences [31]. Physical activity levels differ across countries due to different health behaviors, lifestyles, policies to promote physical activity and measures of physical activity. For example, in the Dutch population, we see high levels of cycling because it is stimulated in the Netherlands by a good infrastructure, a mild climate and absence of hills [32].

In addition, in the Netherlands, the guideline 'Cancer rehabilitation' recommends exercise programs consisting of aerobic and resistance training with at least moderate intensive physical activity during and/or after breast cancer treatment [33]. Costs of cancer rehabilitation programs are in most cases covered by basic health insurance companies, especially for women with breast cancer undergoing systemic therapy. This may explain that women with breast cancer who underwent systemic therapy were more likely to perform sports activities. The 2-weekly contact with a physiotherapist is an opportunity to encourage patients to develop an active lifestyle outside the program, for example by setting activity goals in order to adhere to the Dutch physical activity guidelines. Also, our experience was that women are keen to find ways to improve their cancer outcomes themselves, which has also been suggested by Sander et al [34], and, therefore, welcome exercise programs. In addition, in 2017, the updated Dutch physical activity guidelines were presented. New to the recommendation of at least 150 min of physical activity per week at moderate intensity, is the recommendation to perform bone- and muscle strengthening activities at least twice a week and to avoid long periods of being sedentary. The presentation of the updated guidelines and emphasis on a greater health benefit with more physical activity ('the more, the better') may promote physical activity [25].

Despite the above, around half of the women with breast canceer did not perform any sports activities at any of the follow-up measurements. Therefore, physical activity and cancer rehabilitation during and after treatment still needs to be encouraged [35,36], especially older women need to be stimulated since they were less likely to meet the physical activity guidelines. Probably older patients still believe previous advices saying that you should rest during serious diseases [37].

Strengths of this study are the large sample size, the availability of individual data from the Dutch female population and repeated measurements up to 3 years to study time-

trends. In addition, the same questionnaire was used in both the reference population and breast cancer patients.

There are also limitations. First, physical activity levels were self-reported and, therefore, prone to measurement error and overestimation of physical activity levels [31,38,39]. Recall bias would be present when women with breast cancer were more or less likely to overestimate their physical activity level compared to healty controls. We assume, however, that the tendency to overestimate physical activity levels is comparable between patients and healthy adults [40–42], and therefore, recall bias is presumably limited.

Second, comorbidities and physical activity levels prior to diagnosis might correlate with physical activity levels after treatment, but this information was not available. However, as physical activity is advised during and after treatment for its beneficial effects on treatment-related side-effects and risk of recurrence [43], it is important to get insight into the actual physical activity level of women with breast cancer during and after treatment. Information about treatment was not available for all women with breast cancer, but women with breast cancer with and without information on treatment did not differ in age and physical activity level (data not shown).

Third, the Health Survey was sent to a random sample of 15,000 people from the Dutch population of 12 years and older every year. With a response rate of 60–65%, assumably women with a more healthy lifestyle more often responded, which might imply an overestimation of the physical activity level in our reference population.

In conclusion, physical activity levels of women with breast cancer during and shortly after treatment were lower compared to the Dutch female population, especially in women who underwent systemic treatment and in older women. One to 3 years after diagnosis, women with breast cancer still had lower physical activity levels. However, from 6 months onwards, women with breast cancer were more likely to perform sports activities. Given the positive results on treatment-related side-effects and that around half of the patients did not perform any sports activities, physical activity needs to be stimulated during and after treatment.

Acknowledgments

The authors thank the study team of the UMBRELLA cohort at the department of Radiotherapy, Imaging Division and Julius Center for Health Sciences and Primary Care of the University Medical Center Utrecht (UMCU) for running the cohort and collecting the data. The authors also want to thank G.C.W. Wendel-Vos for assistance with the statistical analysis (SQUASH syntax).

Ethics approval

This study was conducted according to the principles of the Declaration of Helsinki (Forteleza, October 2013: http://www.wma.net/en/30publications/10policies/b3/).

Availability of data and material

The datasets generated and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request. Under certain conditions, microdata from the Health Surveys are accessible for statistical and scientific research. For further information: cvb@cbs.nl.

Disclosure statement

The authors report no conflicts of interest.

Funding

This work was supported by a Veni grant from The Netherlands Organization for Health Research and Development (ZonMw 016.156.050). In addition, funding was provided by the department of Radiotherapy, Imaging Division of the UMCU, and the Department of Clinical Epidemiology, Julius Center for Health Sciences and Primary Care, UMCU.

ORCID

R. Gal http://orcid.org/0000-0001-7340-4581
E. M. Monninkhof http://orcid.org/0000-0002-6641-7605
P. H. M. Peeters http://orcid.org/0000-0003-2296-6458
C. H. van Gils http://orcid.org/0000-0003-0817-7567
D. H. J. G. van den Bongard http://orcid.org/0000-0002-5549-324X
G. C. W. Wendel-Vos http://orcid.org/0000-0002-0653-3620
N. P. A. Zuithoff http://orcid.org/0000-0002-4441-1448
H. M. Verkooijen http://orcid.org/0000-0001-9480-1623
A. M. May http://orcid.org/0000-0003-4857-8189

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