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Weight changes and lifestyle behaviors in women after breast cancer diagnosis: a cross-sectional study

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Abstract

Background: Weight gain rather than weight loss often occurs after breast cancer diagnosis despite breast cancer survivors frequently reported making healthful lifestyle changes. This study describes the prevalence and magnitude of changes in weight before and after breast cancer diagnosis and examines lifestyle behaviors of breast cancer survivors with stable weight, weight gain or weight loss.

Methods: Respondents were 368 women with breast cancer characterized by stages I, II and III. All were recruited from hospitals or breast cancer support groups and had completed conventional treatment. Current weight and height were measured while weight at cancer diagnosis and 1 year before diagnosis were self-reported. Weight change was calculated as the difference between current weight and weight a year preceding breast cancer diagnosis. A 24-hour diet recall and Global Physical Activity Questionnaire assessed dietary intake and physical activity, respectively. Differences in lifestyle behaviors among weight change groups were examined using Analysis of Covariance (ANCOVA).

Results: Mean weight change from a year preceding diagnosis to study entry was 2.73 kg (95% CI: 1.90-3.55). Most women (63.3%) experienced weight gain rather than weight loss (36.7%) with a higher percentage (47.8%) having at least 5% weight gain (47.8%) rather than weight loss (22%), respectively. Compared to other weight change groups, women in >10% weight gain group had the lowest fruit and vegetable servings (1.58 servings/day; 95% CI: 1.36-1.82) and highest servings of dairy products (0.41 servings/day; 95% CI: 0.30-0.52).

Conclusions: Weight gain was evident in this sample of women after breast cancer diagnosis. Information on magnitude of weight change after breast cancer diagnosis and lifestyle behaviors of breast cancer survivors with varying degrees of weight change could facilitate the development and targeting of effective intervention strategies to achieve healthy weight and optimal health for better survival.

Background

Breast cancer is the second most frequent cancer in the world, with an estimated 1.05 million cases in the year 2000 [1]. Breast cancer is also the most commonly diagnosed cancer among Malaysian women. Although the incidence of breast cancer in Malaysia is much lower compared to European countries, it is increasing steadily as it comprised 30.4% of all female cancers [2]. In 2006,

3,525 new cases of breast cancer were reported to the National Cancer Registry (NCR) of Malaysia, giving an age-standardized incidence rate of 39.3 per 100,000 women [3]. The 5-year survival of European women diagnosed in the period 1990-1994 was 77% [4]. A higher figure of 90% was reported in the United States [5]. However, the overall 5-year survival from breast cancer reported for Malaysian women was 58% between 1993 and 1997 [6].

Weight change occurs in most women after breast cancer diagnosis and the amount of weight gain or loss could vary among the survivors [7]. Most cancers cause

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weight loss, changes in appetite and dietary intake, reduced physical activity and deterioration of psychological well being. However, weight gain rather than weight loss has been frequently reported in patients after diagnosis of breast cancer. Halbert et al., (2008) [8] found that 47% of women reported weight gain, 32% weight loss and 21% no weight change. Studies have reported a weight gain ranging from 1.0 to 6.0 kg during the first year after being diagnosed with breast cancer [9-11]. However, greater gains are not uncommon [12].

Lifestyle change is one of the many possible actions women may take when they have been diagnosed with breast cancer in order to improve breast cancer prognosis and reduce the probability of cancer recurrence. Several studies [13-15] have found that breast cancer survivors changed their diets with the most common dietary changes reported were decreased consumption of dietary fat and increased intake of fruits and vegetables. Lower energy and macronutrient intakes post-diagnosis have also been reported in response to breast cancer diagnosis [16]. Besides making healthful dietary changes, breast cancer survivors were also more likely to increase or maintain their moderate to vigorous physical activity post-diagnosis [17-19].

As many developing countries, including Malaysia, have disproportionately high rates of breast cancer morbidity and mortality, a comprehensive assessment of lifestyle behaviors after breast cancer is essential as these behaviors may potentially affect prognosis, cancer recurrence, long-term survival and risk of other chronic diseases such as cardiovascular, hypertension and diabetes [11]. To date, information on lifestyle behaviors after breast cancer diagnosis is mainly derived from studies in western population. As lifestyle changes in response to cancer diagnosis could be influenced by various factors within specific settings, the lifestyle behaviors observed in the developing countries may differ from those reported in western population. Cancer awareness and knowledge, motivation to change, professional and social support, access to healthy food are among factors that may vary by cultures which could potentially influence lifestyle behaviors. This study reports on the prevalence and magnitude of weight changes after breast cancer diagnosis and examines self reported dietary intake and physical activity of breast cancer survivors with various levels of weight change.

Methods

Study respondents

This cross-sectional survey was conducted in eight general hospitals and four breast cancer support groups in seven states of Peninsular Malaysia. These states represented the Northern, Central, Southern and East Coast regions of Peninsular Malaysia. Respondents were

recruited from oncology or surgical out-patient clinics of general hospitals and breast cancer support groups over a period of 10 months (February to December 2008). Lists of cancer patients attending the out-patient clinics for medical check-up as well as active members of support groups were provided by the hospitals and support groups, respectively. Out of 615 breast cancer survivors screened, 400 women met the selection criteria and were invited to participate in this study. A total of 368 women voluntarily participated in the study, giving a response rate of 92%.

This study employed purposive sampling as the selection of respondents was based on several criteria i.e. women 20-65 years old at the time of diagnosis, diagnosed with cancer of stages 0-III, completed conventional treatments (surgery, chemotherapy, radiotherapy) at least 6 months prior to recruitment, free from cancer recurrence and not currently under any medication (e.g. hormonal pills) that would affect the study outcome. All respondents were interviewed using a pre-tested questionnaire either at the hospitals or premises of breast cancer support groups. The study protocol was approved by the Medical Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia and the Medical Research Ethics Committee (MREC), Ministry of Health Malaysia. Prior to data collection, informed consent was obtained from all respondents.

Measurements

Dietary intake

A 24-hour recall was used to assess the dietary intakes of the respondents. Portion size, brand names and cooking method were recorded. Standard household measuring cups and spoons were used to assist respondents in portion size estimation. The nutritionist Pro™ software version 2.5 (First Data Bank, USA, 2005) [20] was utilized to analyse the dietary data. Several food databases such as Malaysian Food Composition Tables [21], Singapore Food Facts (1999) [22], ASEAN Food Composition Tables [23] and USDA Food Databases were utilized in addition to those available in nutritionist Pro™. For dishes that were not available in any food database, 2-3 recipes were used to calculate the energy and nutrient content, and the average values were used in dietary analysis. Total energy intake, percentage of energy from macronutrients and the number of servings for grains, meats and legumes, fruits, vegetables and dairy products were calculated.

Physical activity

The current physical activity level was measured using the Global Physical Activity Questionnaire (GPAQ) [24]. Women were requested to recall the number of days in the last seven days that they did vigorous intensity

activity or/and moderate intensity activity at three major settings (activities at work/home, travel to and from places, recreational activities), as well as the number of hours and minutes per day they did the activities, respectively. The respective total hours for physical activity were calculated and multiplied with the metabolic equivalent (MET) hours per week and the values were then categorized into low, moderate and high.

Anthropometric measurements

The weight a year preceding breast cancer diagnosis, was based on self-reported information. All respondents indicated that the reported weights were stable for at least 6 months prior to diagnosis. Current weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively using TANITA digital weighing scale (TANITA Corporation of America, Inc, United States) and SECA body meter (SECA, British Indicators Ltd, United Kingdom). Body mass index (BMI) was calculated and classified according to the World Health Organization classification [25]. Waist circumference was assessed using a SECA microtoise tape (SECA, British Indicators Ltd, United Kingdom). Waist circumference ≥ 80 cm for women was considered as at high risk for abdominal obesity [25].

Weight change was defined as the difference between the present weight and the weight a year preceding breast cancer diagnosis. Percent of weight change was calculated as = [present weight (kg) - weight a year preceding breast cancer diagnosis (kg)]/weight a year preceding breast cancer diagnosis (kg) $\times 100\%$. The changes in weight for the women were then categorized into $>10\%$ weight loss, 5-10% weight loss, no change ($<5\%$ weight loss and weight gain), 5-10% weight gain and $>10\%$ weight gain groups [26]. These weight change categories were chosen as they are commonly used for weight loss recommendation to reduce the risk of obesity and cancer. A reduction of 5-10% of body weight is likely to have a significant beneficial health effect on those who need to lose weight, even if the ideal weight was not achieved.

Other variables

Information were also collected on socio-demographic background (e.g. age, education level, employment status, marital status), reproductive and breast cancer history (e.g. time since diagnosis, menopausal status, type of treatments), family history of breast and other specific cancers.

Statistical analysis

All data were analyzed using the *Statistical Package for the Social Sciences for Windows* (SPSS version 15) (Chicago, IL, USA). One way analysis of variance (ANOVA) and Chi-square analysis were used to examine weight change according to selected socio-demographic characteristics.

The general linear model of analysis of covariance (ANCOVA) was used to test the differences in dietary intake, and physical activity by weight change groups with household income, years of education, age at diagnosis and time since diagnosis as covariates. The LSD (Least Significant Difference) test was applied to evaluate the statistically significant mean difference among the weight change groups.

Results

Table 1 shows the socio-demographic characteristics, reproductive and breast cancer history of respondents. The median age of the women was 53 years. Among the women, more than half (57.1%) were Malay, 33.2% Chinese and 9.8% Indian. More than half had completed secondary education (51.9%) and 69.3% were currently unemployed. Over 80% of the women were post-menopausal at study entry. The mean duration of time from diagnosis to study entry was 4.86 years (95% CI: 4.50-5.21). About 41.0% of the women were diagnosed with cancer stage II, 31.8% stage I and 15.7% stage III. About 69% of the women reported a family history of cancer. The type of treatments that the women received varied depending on their stage of cancer at the time of diagnosis. Most women had undergone a mastectomy (79.6%) and chemotherapy (82.9%).

Table 2 describes the weight status of respondents. The mean weight a year preceding breast cancer diagnosis, at diagnosis and current weight were 59.36 kg (95% CI: 58.17-60.55), 58.36 kg (95% CI: 57.51-59.95) and 62.09 kg (95% CI: 60.75-63.43), respectively. Nearly half of the women (49.2%) had normal BMI a year preceding breast cancer diagnosis. However, the percentage of women with normal BMI decreased to about 41% at study entry. Nearly two-thirds (65.7%) of the women were abdominally obese based on waist circumference. The mean weight change and percentage of weight change in women from a year preceding breast cancer diagnosis to study entry were 2.73 kg (95% CI: 1.90-3.55) and 5.17% (95% CI: 3.72-6.61), respectively. About 47.8% of women gained at least 5% of weight and about one-third (29.9%) had gained $>10\%$ of weight.

Dietary intake and physical activity of women after breast cancer diagnosis are described in Table 3. The mean total energy intake of women was 1,350 kcal/day (95% CI: 1307.56-1391.84). The mean percentage of energy from carbohydrate, protein and fat were 56.02% (95% CI: 54.98-57.08), 16.38% (95% CI: 15.92-16.86) and 27.47% (95% CI: 26.61-28.34), respectively. Women reported an average of 6.09 daily servings of grains and cereals, 2.18 daily servings of meats and legumes, 0.76 daily servings of fruits, 1.18 daily servings of vegetables and 0.33 daily servings of dairy products, respectively. Most of the women (92.4%) did not currently consume alcohol. About 42% of the respondents

Table 1 Socio-demographic characteristics, reproductive and breast cancer history of women

Characteristics	Total n (%)	Mean (95% CI)
Age (years) (<i>Median</i>)		53.00
Ethnicity		
Malay	210 (57.1)	
Chinese	122 (33.2)	
Indian and Punjabi	36 (9.8)	
Marital status		
Single	18 (4.9)	
Married	304 (82.6)	
Divorced/Widowed	46 (12.5)	
Education years (years)		8.96 (8.56-9.36)
Employment status		
Employed	113 (30.7)	
Unemployed	255 (69.3)	
Monthly personal income (RM)		636.84 (500.32-768.12)
Monthly household income (RM)		2022.58 (1897.89-2426.08)
Menopausal status at study entry		
Pre-menopausal	70 (19.0)	
Post-menopausal	298 (81.0)	
Age at diagnosis (years)		48.53 (47.60-49.46)
Time since diagnosis (years)		4.86 (4.50-5.21)
Stage of cancer		
Stage I	117 (31.8)	
Stage II	151 (41.0)	
Stage III	58 (15.8)	
Not known	42 (11.4)	
Treatment		
Lumpectomy	62 (16.8)	
Mastectomy	293 (79.6)	
Radiotherapy	293 (79.6)	
Chemotherapy	305 (82.9)	
Hormonal therapy	159 (43.2)	
Family history of cancer		
Yes	115 (31.2)	
No	253 (68.8)	

Table 2 Weight status of women with breast cancer

Weight information	Total	Mean (95% CI)
Weight a year preceding breast cancer diagnosis (kg)		59.36 (58.17-60.55)
Weight at time of diagnosis (kg)		58.36 (57.51-59.95)
Weight at study entry (kg)		62.09 (60.75-63.43)
Height (m)		1.55 (1.54-1.55)
Waist circumference at study entry (cm) ^b		84.81 (83.62-85.99)
Increased risk (≥ 80)	94 (25.5)	
Substantial risk (≥ 88)	148 (40.2)	
BMI a year preceding breast cancer diagnosis (kg/m^2) ^a		24.82 (24.35-25.29)
Underweight (< 18.5)	21 (5.7)	
Normal (18.5-24.9)	181 (49.2)	
Overweight (25.0-29.9)	122 (33.2)	
Obese (≥ 30.0)	44 (12.0)	
BMI at study entry (kg/m^2) ^a		25.93 (25.41-26.45)
Underweight (< 18.5)	20 (5.4)	
Normal (18.5-24.9)	151 (41.0)	
Overweight (25.0-29.9)	38 (37.5)	
Obese (≥ 30.0)	59 (16.0)	
Weight change from a year preceding diagnosis to study entry (kg)		2.73 (1.90-3.55)
>10 kg weight loss	15 (4.1)	
5-10 kg weight loss	39 (10.6)	
0-<5 kg weight loss	83 (22.6)	
0-<5 kg weight gain	105 (28.5)	
5-10 kg weight gain	71 (19.3)	
>10 kg weight gain	55 (14.9)	
Percentage of weight change from a year preceding diagnosis to study entry (%)		5.17 (3.72-6.61)
> 10% weight loss	40 (10.9)	
5-10% weight loss	41 (11.1)	
0-<5% weight loss	54 (14.7)	
0-<5% weight gain	57 (15.5)	
5-10% weight gain	66 (17.9)	
> 10% weight gain	110 (29.9)	

^a World Health Organization, (1998).

^b Increased risk of metabolic complications associated with obesity.

^c Substantial risk of metabolic complications associated with obesity.

had a high level of activity, 38.3% moderate and 19.6% low activity levels. Most respondents (86.1%) were engaged in work/domestic, transport related (61.4%) and recreational (41.0%) activities.

Table 3 Dietary intake and physical activity of women after breast cancer diagnosis

	Total	Mean (95% CI)
Dietary intake		
Total energy intake (kcal/day)		1350 (1307.56-1391.84)
Percentage of energy from carbohydrate (%)		56.02 (54.98-57.08)
Percentage of energy from protein (%)		16.38 (15.92-16.86)
Percentage of energy from fat (%)		27.47 (26.61-28.34)
Number of servings from grains and cereals ^a		6.09 (5.91-6.35)
Number of servings from meats ^b		2.18 (2.04-2.29)
Number of servings from fruits		0.76 (0.61-0.82)
Number of serving from vegetables		1.18 (1.08-1.24)
Number of serving from dairy products ^c		0.33 (0.27-0.39)
Alcohol intake		
Yes	28 (7.6)	
No	340 (92.4)	
Physical activity		
Total physical activity (MET-min/week)		3529.56
Low	72 (19.6)	(3052.64-3986.36)
Moderate	141 (38.3)	
High	155 (42.1)	
Activities at work/domestic (min/day)		
Did work activity	317 (86.1)	
No work activity	51 (13.9)	
Travel to and from places (min/day)		
Did travel activity	226 (61.4)	
No travel activity	142 (38.6)	
Recreational activities (min/day)		
Did recreational activity	151 (41.0)	
No recreational activity	169 (45.9)	
Sedentary behavior ^d (min/day)		206.62 (191.92-221.32)

^a grains and cereals-grain/cereal/tubers based on Malaysian Dietary Guidelines (2010).

^b meats-meat/fish/poultry/legumes based on Malaysian Dietary Guidelines (2010).

^c dairy products-milk/dairy products based on Malaysian Dietary Guidelines (2010).

^d Sitting or reclining at work, at home, getting to and from places including time spent on sitting at desk, travelling in car, bus or watching television but do not include time spent sleeping.

Among socio-demographic and cancer characteristics of women, only BMI a year before diagnosis was significantly different by weight change groups (Table 4). Women with weight gains have significantly lower pre-diagnosis BMI than those with weight loss or stable weight (Table 4). Dietary intake and physical activity of women by weight changes are presented in Table 5. The number of servings for fruits and vegetables and dairy products differed significantly among the weight change groups. The least number of servings for fruits and vegetables was reported for the >10% weight gain group (1.58 servings/day; 95% CI: 1.36-1.82) compared to other weight change groups. In contrast, the >10% weight gain group was found to have the greatest number of servings for dairy products compared to the >10% weight loss group ($p < 0.05$), although none of the groups achieved the recommended 2-3 servings/day of milk and dairy products. Women in all weight change groups did not differ significantly in physical activity.

Discussion

Weight gain is a common observation among women with breast cancer. This study supports the existing evidence that women tend to gain weight after breast cancer diagnosis. A significant gain in weight amounting to 2-3 kg after diagnosis of breast cancer was found in this study. Although some aspects of weight gain pattern among the breast cancer survivors in our study were similar to those observed in other studies [12,27,28], the magnitude of weight gain differed. The magnitude of weight gain observed from pre-diagnosis to study entry was somewhat similar (2.4 kg) to that reported by Caan et al., (2006) [17], but was lower (3.17 kg) than that reported in the WHEL study [29]. In both studies, the mean duration between time of diagnosis and study entry was similar (4-5 years) to our study.

Overweight and obesity were already prevalent in over 40% of the women prior to diagnosis, however more women were overweight and obese at study entry. Similar to Rock et al. (1999) [7], we also showed that women with higher weight gains had significantly lower pre-diagnosis BMI than those with lower weight gains and stable weight. A higher body mass index (BMI) in women after breast cancer diagnosis will increase the risk for recurrence and lower the survival [7,12]. Kroenke et al. (2005) [30] showed that breast cancer survivors who increased their body mass index by 0.5-2.0 kg/m² had a risk ratio of recurrence of 1.4 and those who gained more than 2.0 kg/m² had a risk ratio of 1.53, with both groups having significantly higher all-cause mortality compared to survivors with a stable weight. The clinical significance of weight gain (2.7 kg) observed in the present study is not known, however

Table 4 Socio-demographic and cancer characteristics of women by weight change groups

Characteristics	Weight changes groups since diagnosis			Mean (95% CI)		p-value
	>10% weight loss (n = 40)	5-10% weight loss (n = 41)	No change* (n = 114)	5-10% weight gain (n = 60)	>10% weight gain (n = 113)	
Age at diagnosis (years)	50.05 (47.45-52.65)	51.02 (48.17-53.87)	49.19 (47.34-51.05)	47.28 (45.11-49.46)	47.05 (45.47-48.63)	0.06
Ethnicity						
Malay	24 (58.5)	20 (48.8)	60 (52.6)	34 (56.7)	72 (19.6)	0.34
Non-Malay	17 (41.5)	21 (51.2)	54 (47.4)	26 (43.3)	40 (35.7)	
Marital status						0.43
Married	35 (85.4)	36 (87.8)	90 (78.9)	53 (88.3)	90 (80.4)	
Others**	6 (14.6)	5 (12.2)	24 (21.1)	7 (11.7)	22 (19.6)	
Education (years)	8.56 (7.26-9.86)	8.54 (7.30-9.78)	8.68 (7.93-9.44)	9.92 (8.93-10.90)	9.03 (8.34-9.71)	0.28
Secondary and lower	22 (53.7)	24 (58.5)	58 (50.9)	22 (36.7)	58 (51.8)	
Tertiary and others	19 (46.3)	17 (41.5)	56 (49.1)	38 (63.3)	54 (48.2)	
Employment status						0.86
Employed	10 (24.4)	12 (29.3)	34 (29.8)	20 (33.3)	37 (33.0)	
Unemployed	31 (75.6)	29 (70.7)	80 (70.2)	40 (66.7)	75 (67.0)	
Monthly household income (RM)	1756.10 (1246.58-2265.61)	2002.63 (1252.71-2752.56)	1967.76 (1563.28-2372.25)	2968.67 (2089.90-3847.44)	2134.45 (1620.90-2647.99)	0.10
Menopausal status at study entry						0.10
Pre-menopausal	3 (7.3)	4 (9.8)	24 (21.1)	14 (23.3)	25 (22.3)	
Post-menopausal	38 (92.7)	37 (90.2)	90 (78.9)	46 (76.7)	87 (77.7)	
Time since diagnosis (years)	4.63 (3.41-5.86)	5.20 (3.74-6.65)	4.67 (4.03-5.31)	4.48 (3.69-5.28)	5.21 (4.65-5.78)	0.59
Stage of cancer						0.89
Stage I	9 (24.3)	12 (31.6)	36 (37.5)	22 (40.7)	38 (37.6)	
Stage II	21 (56.8)	19 (50.0)	43 (44.8)	22 (40.7)	46 (45.5)	
Stage III	7 (18.9)	7 (18.4)	17 (17.7)	10 (18.5)	17 (16.8)	
BMI a year preceding diagnosis*** (kg/m ²)	26.62 (24.86-28.37)	25.96 (24.45-27.47)	25.18 (24.33-26.04)	24.50 (23.38-25.62)	23.54 (22.78-24.29)	0.001**** ^{a, b, c, d}

*0-5% weight loss or weight gain.

**Single, widowed or divorced.

***Body mass index a year preceding breast cancer diagnosis.

****p < 0.05.

^a A significant difference between >10% weight loss and 5-10% weight gain groups, at p < 0.05.

^b A significant difference between >10% weight loss and >10% weight gain groups, at p < 0.05.

^c A significant difference between 5-10% weight loss and >10% weight gain groups, at p < 0.05.

^d A significant difference between no change and >10% weight gain groups, at p < 0.05.

the calculated increase (1 year before diagnosis to study entry) in body mass index is 1.11 kg/m² which if based on previous studies could have significant effect on cancer recurrence and survival. About two-thirds of the women (65.8%) in this present study had at risk waist circumference. Having a higher BMI and waist circumference could

put these women at risk of cardiovascular diseases, diabetes and cancer recurrence [31].

We found that women who gained weight after breast cancer diagnosis had lower fruit and vegetable intakes compared to those who lost weight. Although the weight loss groups had a higher intake of fruit and

Table 5 Lifestyle behaviors of women by weight change groups

	Weight change since diagnosis		Mean (95% CI)			p-value
	>10% weight loss (n = 40)	5-10% weight loss (n = 41)	No change* (n = 114)	5-10% weight gain (n = 60)	>10% weight gain (n = 113)	
Total energy intake (kcal/day)	1344	1408	1330	1377	1335	0.82
Percentage of energy intake from carbohydrate (%)	55.76 (52.66-59.03)	55.20 (52.00-58.39)	56.79 (54.88-58.70)	55.73 (53.08-58.39)	55.81 (53.85-57.72)	0.90
Percentage of energy intake from protein (%)	16.15 (14.62-17.45)	17.41 (15.99-18.83)	15.76 (14.91-16.61)	16.66 (15.48-17.84)	16.59 (15.77-17.49)	0.30
Percentage of energy intake from fat (%)	28.10 (25.52-30.75)	27.35 (24.73-29.97)	27.50 (25.93-29.07)	27.49 (25.31-29.67)	27.27 (25.66-28.83)	0.98
Number of servings from grains and cereals	5.99 (5.40-6.70)	6.88 (6.23-7.54)	6.23 (5.84-6.62)	5.70 (5.15-6.24)	6.04 (5.62-6.41)	0.87
Number of servings from meats	2.08 (1.72-2.45)	2.49 (2.13-2.85)	2.12 (1.91-2.34)	2.13 (1.83-2.44)	2.16 (1.94-2.38)	0.49
Number of servings from fruits and vegetables	2.06 (1.66-2.41)	2.12 (1.74-2.50)	2.00 (1.77-2.22)	1.94 (1.62-2.26)	1.58 (1.36-1.82)	0.04 ^{***a, b, c}
Number of serving from dairy products	0.19 (0.01-0.36)	0.31 (0.13-0.49)	0.33 (0.22-0.44)	0.31 (0.17-0.46)	0.41 (0.30-0.52)	0.03 ^{***a}
Alcohol intake						0.12
Yes	2 (7.1)	1 (3.6)	12 (42.9)	6 (21.4)	7 (25.0)	
No	38 (11.2)	40 (11.8)	102 (30.0)	54 (15.9)	106 (31.2)	
Total physical activities (MET-min/week)	4436.71 (3112.63, 5602.65)	4246.85 (2996.98, 5494.10)	2817.77 (2071.49, 3563.63)	3753.38 (2717.08, 4790.58)	3351.85 (2616.35, 4126.77)	0.15
Low	5 (12.5)	9 (22.0)	28 (24.6)	12 (20.0)	18 (15.9)	0.16
Moderate	16 (40.0)	11 (26.8)	47 (41.2)	17 (28.3)	50 (44.2)	
High	19 (47.5)	21 (51.2)	39 (34.2)	31 (51.7)	45 (39.8)	

Adjusted for household income, years of education, age at diagnosis and time since diagnosis.

* 0-5% weight loss or weight gain.

** p < 0.05.

^a A significant difference between >10% weight loss and >10% weight gain groups, at p < 0.05.

^b A significant difference between 5-10% weight loss and >10% weight gain groups, at p < 0.05.

^c A significant difference between no change and >10% weight gain groups, at p < 0.05.

vegetables, the number of servings still did not meet the recommendation of 3-5 servings daily. Increasing the consumption of fruits and vegetables may reduce the risk of overweight/obesity as well as facilitate the slowing down of weight gain, especially among overweight and obese adults [32]. However, the Women's Healthy Eating and Living (WHEL) study, a randomized controlled dietary intervention study that examined the effect of plant-based diets without a specific energy restriction among breast cancer survivors, showed that diets high in fruits, vegetables and fiber were not significantly associated with weight change [33]. Although the mechanism underlying fruit and vegetable intake and body weight is still uncertain, it is known that fruits and vegetables are generally low in energy density, which could influence energy intake [34]. Consumption of ≥9 servings of fruit and vegetables is associated with lower energy density as well as a lower prevalence of obesity

even for diets high in fat [35]. Furthermore, fruits and vegetables have a high water and fiber content, which, in turn, promotes satiety. Therefore, women who consume more fruits and vegetables are more likely to lose weight compared to those who consume less fruit and vegetables.

Adequate consumption of dairy products is encouraged because they are rich sources of essential nutrients that are important for bone health. The present study found that women who gained > 10% of weight consumed significantly more servings of dairy products than those who lost > 10% of weight after breast cancer diagnosis; although none of the groups met the recommended intake of 1-3 servings of dairy products. A plausible explanation for the low dairy product intake among these women is that many believed milk and dairy products are high in saturated fat and cholesterol, and contain carcinogens that can cause cancer recurrence. Although we

did not examine changes in dietary intake before and after cancer diagnosis, it is possible that these women could have stopped or reduced the intake of dairy products since cancer diagnosis. Skeie et al. (2009) [36] also reported that breast cancer survivors reduced their milk consumption after breast cancer diagnosis. However, the Women's Intervention Nutrition Study (WINS) showed that breast cancer survivors had 1.6-1.8 servings per day of dairy products [37]. Several studies [38,39] have reported that low fat dairy products could prevent weight gain and promote weight loss among healthy adult population. An adequate dairy consumption in conjunction with controlled/reduced caloric intake may be associated with weight regulation [39-41] and reduced adiposity [42,43], indicating that dairy intake may be valuable for weight maintenance.

Most of the women (80.4%) in the present study had moderate and high physical activity level. This physical activity pattern is consistent with the findings of a study among United States women that showed 70% of women with breast cancer had moderate-intensity physical activity while 10% had high-intensity physical activity [19]. However, another study [44] among breast cancer survivors found that the majority (74.6%) had low intensity physical activity and only 25.4% had moderate and high intensity physical activity. In addition, cancer survivors have also been reported to be more active than non-cancer controls [45]. Perhaps, they are more likely to adopt healthier lifestyle changes [46], which could explain why most of the women in the present study had at least a moderate-intensity physical activity.

This study has several limitations. The small sample size of this study may not be representative of the population of women with breast cancer in Malaysia. Despite the recruitment of respondents from hospitals and breast cancer support groups throughout the country, there could still be differences in socio-demographic, reproductive and other characteristics. Another limitation is that study participation was voluntary which could result in selection bias in that those who are weight or health conscious would participate in the study. This study used self-reported weight a year preceding breast cancer diagnosis, which is subject to recall error and consequently could affect the calculation and classification of weight change. However, self-reported weight has been shown to be accurate [47] and most epidemiological studies have used self-reported weight and weight change data [48,49]. Self-reported measures also tend to overestimate desirable health behaviors such as physical activity and intake of fruits and vegetables. Being overweight and diagnosed with breast cancer may prompt women to over-report healthy behaviors. In contrast, undesirable health behaviors (i.e. smoking, sedentary lifestyle, high dietary fat intake) will be under-reported. This study was cross-sectional in that the

information on factors associated with weight change could not imply cause and effect relationship. A longitudinal study design is most appropriate to identify changes in lifestyle behaviors that cause weight loss or gain in cancer survivors. As we did not measure weight, dietary intake and physical activity level at other times (e.g. every year after breast cancer diagnosis), the selection of period to measure these variables could contribute to different results. For example, it is possible that although the study only measured weight status at fixed periods, i.e. a year before breast cancer diagnosis, at diagnosis and at study entry, women will initially lose or gain weight at different times. It is also possible that women make lifestyle changes from time to time and that their current diets or physical activity may be better or healthier compared to their earlier practices. Despite these limitations, this is the first study to investigate weight change before and after diagnosis in a sample of Malaysian women diagnosed with breast cancer.

Conclusion

The high proportion of breast cancer survivors experiencing weight gain in this study suggests that efforts are needed to encourage breast cancer survivors to achieve or maintain healthy body weight. Understanding lifestyle behaviors i.e. dietary intake and physical activity of women diagnosed with breast cancer and with varying degrees of weight change is essential for the development and targeting of effective strategies to improve health and survival of breast cancer survivors. As the intake of fruits, vegetables and dairy products of women in this study are still below the recommended servings per day, dietary strategies should target all breast cancer survivors, regardless of their weight status. Despite limited evidence on how lifestyle behaviors prevents cancer recurrence or prolongs life, a diagnosis of breast cancer should be a starting point for women to have healthful diets and regular physical activity.

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Authors' contributions

YHY designed the study, conducted data collection, performed and interpreted the analyses and prepared the manuscript; ZMS designed the study, supervised and assisted data collection, analysed and interpreted of study findings, assisted in the preparation of the manuscript and approved

the final manuscript; CYM, ZH, MK, RMY, ZO, NS and YHW supervised and assisted in study design and data collection. All authors read and revised the manuscript.

Competing interests

The authors declare that they have no competing interests.

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