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Weight change patterns among breast cancer survivors: results from the Shanghai Breast Cancer Survival Study

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Abstract

In a population-based cohort study of 5014 women with stage 0–III breast cancer, we evaluated weight change patterns from diagnosis to 6, 18, and 36 months post-diagnosis. Patients were recruited to the study approximately 6 months after cancer diagnosis between 2002 and 2006 and followed through 36 months post-diagnosis. The medians of weight change from diagnosis to 6, 18, and 36 months post-diagnosis were 1.0 kg, 2.0 kg, and 1.0 kg, respectively. Approximately 26% of survivors gained ≥5% of their at-diagnosis body weight during the first 6 months after diagnosis, while 37% and 33% of women gained the same percentage of weight at 18 and 36 months post-diagnosis. More weight gain was observed among women who had a more advanced disease stage, were younger, had lower body mass index at diagnosis, were premenopausal, or received chemotherapy or radiotherapy during the first 6 months after cancer diagnosis. Multivariate analyses indicated that age at diagnosis, body size, comorbidity, and disease stage independently predicted weight gain from diagnosis to 36 months post-diagnosis. In summary, weight gain is common over the first 3 years after breast cancer diagnosis among Chinese women. More research is needed to investigate measures to prevent weight gain in breast cancer survivors.

Keywords

weight change pattern; breast cancer; survivor; Chinese population

Introduction

Weight gain is common among women diagnosed with breast cancer in Western countries,[1–4] and usually ranges between 1 and 6 kg during the first year after a diagnosis of breast cancer.[1, 2, 5–8] Several studies have reported that weight gain is associated with negative effects on health outcomes, such as lower quality of life (QOL) and poor breast cancer prognosis.[2, 3, 8–10] Sociodemographic characteristics including age[7, 11] and menopausal status[1, 4, 7, 11] have been found to be related to weight gain after cancer diagnosis. Although clinical factors such as disease stage and adjuvant treatment have been suggested to increase the risk for weight gain,[1, 2, 4, 7, 11] the existing evidence is inconsistent.

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To date, most studies on weight change after breast cancer diagnosis have had small sample sizes and have focused on the first year after cancer diagnosis.[1, 4, 6, 7, 11–15] Few prospective cohort studies have examined weight change at different time points, such as during the second and the third year after cancer diagnosis, when most women have completed cancer-related treatments. Furthermore, most existing research on weight change has been conducted in Western countries where the prevalence of obesity is relatively high.[1, 4, 6, 7, 11–14] Differences in the prevalence of obesity may reflect differences in dietary intake and other lifestyle behaviors between Asian and Western populations, which may translate into different weight change patterns after breast cancer diagnosis. However, to our knowledge, only one report from a small retrospective study of Asian women conducted in Korea has been published. That study found no weight gain after adjuvant treatment among women diagnosed with early stage breast cancer,[15] which is inconsistent with previous findings from Western countries.[1–4] Characterizing weight change patterns and potential risk factors based on large, population-based, cohort studies would be useful in the development of strategies for weight control among Asian women after breast cancer diagnosis.

In this report, we investigated the patterns of weight change from diagnosis to 6, 18, and 36 months after cancer diagnosis and the potential sociodemographic and clinical risk factors for weight change in a population-based cohort study of Chinese women diagnosed with breast cancer.

Methods

Study setting, subjects, and design

The Shanghai Breast Cancer Survival Study (SBCSS) is a population-based cohort study.[16, 17] Through the population-based Shanghai Cancer Registry, 6299 women aged 20–75 years who were newly diagnosed with incident breast cancer between April 1, 2002 and December 31, 2006 were identified and invited to participate in the study approximately 6 months after cancer diagnosis. Overall, 5042 women (80.0%) provided written, informed consent and participated in the first 6 months post-diagnosis in-person interview. The vast majority of study participants (>94%) are Han Chinese. Participants are being followed through additional in-person interviews administered at approximately 18 months, 36 months, and 60 months after cancer diagnosis. Since women diagnosed with stage IV cancer may undergo very different cancer-related treatments compared to women with earlier stage disease, we excluded from the analysis 28 women with TNM stage IV cancer at diagnosis. Therefore, a total of 5014 cases with stage 0–III cancer were included in the current study of weight change. All of study participants were contacted for the 18-month post-diagnosis interview. Of these women, 4554 women completed the 18-month post-diagnosis interview and 100 died before the 18-month post-diagnosis interview. The remaining 360 cases did not participate in the 18-month post-diagnosis interview either because they refused or because they were unavailable during the interview period. After further excluding 10 participants with missing information on weight at the 18-month postdiagnosis interview, 4544 participants remained for the analysis of weight change between diagnosis and 18 months post-diagnosis. The 36-month post-diagnosis interview was completed by 4140 SBCSS participants, and 196 deaths were identified before the interview. After excluding 678 women who refused to be interviewed or were unavailable during the interview period and 3 cases with missing weight information, 4137 cases remained for the analysis of weight gain from 18- to 36-months post-diagnosis. Study participation was volunteer based, and no incentives were used. The SBCSS was approved by the institutional review boards of all institutions involved in this study.

Data collection

Structured questionnaires were administered by trained interviewers through in-person interviews to collect information on sociodemographic and clinical characteristics. Age at diagnosis, education, monthly household income, marital status, menopausal status, menopausal symptoms, lifestyles, and QOL were assessed. Disease- and treatment-related information was collected, including stage of tumor-node metastasis (TNM) at diagnosis, estrogen receptor (ER) and progesterone receptor (PR) status, type of surgery, chemotherapy, radiotherapy, immunotherapy, and tamoxifen use. In addition, medical charts were reviewed to verify diagnosis, treatment, and disease stage information. ER and PR status were included in the analyses in the following joint categories: ER+/PR+ (receptor-positive), ER−/PR− (receptor-negative), and ER−/PR+ or ER+/PR− (mixed). A Charlson comorbidity index was created based on the validated comorbidity scoring system[18] and the diagnostic codes from the International Classification of Disease, 9th revision (ICD-9).[19]

Anthropometric measurements

Trained staff measured weight at approximately 6, 18, and 36 months after breast cancer diagnosis and height at approximately 6 months after cancer diagnosis. All measurements were taken twice according to a standard protocol. Participants were also asked to report their weight one year before diagnosis and at diagnosis. BMI (weight in kilograms divided by the square of height in meters) at 6, 18, and 36 months post-diagnosis and weight change from diagnosis to 6, 18, and 36 months post-diagnosis were calculated. Weight at cancer diagnosis was also collected through review of medical charts for 95% of study participants. Overweight and obesity from 1 year pre-diagnosis to 36 months post-diagnosis were categorized according to the World Health Organization (WHO) guidelines for international use[20] and for Chinese populations.[21]

Statistical analysis

The primary outcome variable was weight change from cancer diagnosis to 6, 18, and 36 months after diagnosis. Descriptive statistics of weight change were calculated across sociodemographic and clinical factors, including age at diagnosis, education, income, BMI at diagnosis, marital status, menopausal status, menopausal symptoms, comorbidity, relapse/metastasis, cancer-related treatments, ER/PR status, TNM stage, and BMI. Pearson correlation analysis was conducted to estimate the correlation between medical chart-derived and self-reported weight information. Percentage (%) of weight change during the 6, 18, and 36 months after diagnosis was calculated as (100*(weight at specific study time point − weight at diagnosis)/weight at diagnosis).

The t-test or one-way analysis of variance (ANOVA) was applied to compare differences in weight change by sociodemographic and clinical factors. Multivariate linear analysis was conducted to examine the associations of weight gain with sociodemographic and clinical factors. All factors that were significantly associated with weight change in the univariate analysis were further evaluated in the multivariate models. We adjusted for age at diagnosis, education, and income in the multivariate models to control for age related weight change and the influence of socioeconomic status on weight change. We also conducted additional analyses restricted to women for whom we had weight information abstracted from medical charts and found similar results. All tests were performed by using Statistical Analysis Software (SAS, version 9.1; SAS Institute, Inc., Cary, North Carolina). The significance levels were set at $P< 0.05$ for two-sided analyses.

Results

Of the 5014 participants, the mean age at diagnosis was 53.5 years (SD: 10.0). Fifty-one percent of women were postmenopausal and 72% reported menopausal symptoms after breast cancer diagnosis. Overall, 20% of participants had serious comorbidities. Approximately 50% of women had ER/PR positive tumors, 28% had ER/PR negative tumors, and 20% had mixed (ER+/PR−, or ER−/PR+) tumors. In total, 37% of women were diagnosed with stage 0-I breast cancer, 49% with stage II, and 9% with stage III. The correlation coefficient between weights obtained from medical chart review and self-reported weight at diagnosis was 0.92. There were no significant differences in sociodemographic or clinical characteristics between women who were included in the current study and those who were not (data not shown).

Figure 1 shows the prevalence of overweight and obesity between 1 year pre-diagnosis and 36 months post-diagnosis. Based on WHO criteria, 27% of women were overweight (BMI: 25.0–29.9) and 5% were obese (BMI≥30) at diagnosis (Figure 1a). The prevalence of overweight and obesity at 18 months post-diagnosis was 34% and 6%, respectively. Based on Chinese criteria for overweight and obesity, the rates of overweight (BMI: 24–27.9) and obesity (BMI≥28) were 31% and 12% at diagnosis, 36% and 13% at 6 months post-diagnosis, and 38% and 14% at 18 months post-diagnosis, respectively (Figure 1b). Overall, the number of overweight and obese women increased over the 36 months after diagnosis. Figure 2 summarizes weight change (Figure 2a) and percent of weight change (Figure 2b) from diagnosis to 6, 18, and 36 months after diagnosis for women who had complete weight information during the follow-up surveys. Of these women, 39%, 51%, and 46% gained ≥2kg and 15%, 24%, and 21% gained ≥5kg between diagnosis and 6, 18, and 36 months post-diagnosis, respectively. Overall, 10%, 16%, and 15% of women gained ≥10% of their body weight between diagnosis and the three follow-up surveys, respectively. During the first 6 months post-diagnosis, 14% of women had lost >2kg; this figure changed to 13% at 18 months and 17% at 36 months post-diagnosis (Figure 2a). At 6 months post-diagnosis, 11% of women had lost >5% of their at-diagnosis body weight; this figure changed to 10% at 18 months and 14% at 36 months post-diagnosis, respectively (Figure 2b).

Table 1 presents the mean weight change from diagnosis to 6 months post-diagnosis stratified by sociodemographic and clinical characteristics. During the 6-month post-diagnosis period, the median weight gain was 0.9 kg. Greater weight gain was observed among breast cancer patients who were younger at diagnosis and who were premenopausal, had a lower comorbidity index, received chemotherapy or radiotherapy, had a more advanced stage of disease, and were underweight at cancer diagnosis. Analyses based on weight information obtained through medical chart review yielded similar results (data not shown).

Table 2 shows weight change from diagnosis to 18 months after diagnosis. During the 18-month post-diagnosis period, the median weight change was 2.0 kg. Similar to the weight gain pattern for the first 6 months after cancer diagnosis, younger women and premenopausal women gained more weight than older women and postmenopausal women. Women with menopausal symptoms gained more weight than women without menopausal symptoms, while women with more serious comorbidities were more likely to lose weight. Chemotherapy, radiotherapy, and advanced cancer stage were significantly associated with more weight gain. No significant differences in weight change were observed by tamoxifen use or immunotherapy. The percentage of women who used aromatase inhibitors was very low in this study population (<1%), which prevented a detailed analysis.

Weight change from diagnosis to 36 months after diagnosis is summarized in Table 3. Women who were younger at diagnosis, had higher income, were premenopausal, received chemotherapy or radiotherapy, or had advanced disease stage were more likely to gain weight. Higher comorbidity index and higher BMI were both significantly related to weight loss.

Table 4 shows the results of multivariate analysis for weight gain in association with variables which were significantly related to weight gain in univariate analysis. Age at diagnosis, education level, BMI at diagnosis, comorbidity index, and disease stage were significantly and independently associated with weight gain between diagnosis and 36 months post-diagnosis. We did not find that cancer-related treatments were independent predictors for weight gain among breast cancer survivors (data not shown).

Discussion

Our population-based cohort study shows that weight gain is common among Chinese women within 18 months of breast cancer diagnosis and weight gain is sustained afterwards. During the first 6 months after cancer diagnosis, the median weight change was a gain of 1 kg. From diagnosis to 18 months post-diagnosis weight gain was 2.0 kg and from diagnosis to 36 months post-diagnosis was 1.0 kg. Based on Chinese criteria, the prevalence of overweight and obesity were 31% and 12% at diagnosis. It is encouraging to find that women with a higher BMI at diagnosis are more likely to lose weight rather than gain weight after cancer diagnosis, as was observed by Rock *et al.*[11]

Weight gain is a big concern for many women after breast cancer diagnosis in Western countries.[1, 2, 4–7, 11] McInnes *et al.*[4] found that 63% of US women with early-stage (I–II) breast cancer experienced weight gain at 1 year after adjuvant chemotherapy, and 68% and 40%, respectively, maintained significant weight gain after 2 and 3 years.[4] In a study of 535 women with newly diagnosed breast cancer in Canada, Goodwin *et al.* observed that 84% of women gained weight during the year after adjuvant treatment; the mean weight gain was 1.6 kg in women who received chemotherapy, 1.3 kg in women who received tamoxifen only, and 0.6 kg in women who did not receive adjuvant treatment.[1] The Women's Healthy Eating and Living (WHEL) Study examined 1116 US women with stage I–IIIA breast cancer and found that the mean weight change was a gain of 2.7kg; 60% of women reported weight gain, 26% reported weight loss, and 14% reported no weight change within the 4-year post-diagnosis period.[11] These findings are comparable with what we observed in our Chinese population, although the prevalence of obesity (BMI≥32.2) in the WHEL study was much higher (13.2%) than our study.

To date among Asian populations, only one small retrospective study of weight change after breast cancer diagnosis has been conducted. That study evaluated 260 patients in Korea with stage I–III breast cancer and reported no weight gain after adjuvant treatment.[15] The mean weight change in the Korean study was −0.3 kg at 1 year and −0.4 kg at 2 years after cancer treatment, and only 10% of women gained more than 5% of baseline body weight at 1 year,[15] which is inconsistent with the findings of studies conducted in Western countries.[1, 4, 6, 7, 13, 14] In contrast, our study indicated that 37% of women gained ≥5% of baseline body weight between diagnosis and 18 months post-diagnosis, which is remarkably different from the findings in the Korean population, but consistent with the results of Western studies. Differences in study design, cancer stage, or characteristics of the study populations may account for the discrepancy between our study and the Korean study. Our large, population-based, cohort study suggests that among Chinese breast cancer survivors, despite the relatively low prevalence of obesity, the weight change pattern is similar to that observed in Western populations.

Previous studies have investigated the association of sociodemographic factors with weight change after cancer diagnosis and results have been inconsistent.[1, 2, 4, 7, 8, 11, 14, 22, 23] Age has been previously reported as a risk factor for weight change among women with breast cancer.[7, 11] In our study, we found that women who were younger at diagnosis were more likely to gain weight than older women. Education was also independently and significantly related to weight gain in our study, consistent with the findings by Rock *et al.*[11]

Several biological mechanisms have been proposed for the weight gain observed among breast cancer survivors, including change in menopausal status, chemotherapy, hormone therapy, and metabolic rate.[1, 2, 11] We observed that premenopausal status was significantly related to more weight gain, which was consistent with previous studies,[4, 8, 22] but contradictory to findings from the Health, Eating, Activity, and Lifestyle (HEAL) study.[7] In that study, 514 white women diagnosed with 0-IIIA breast cancer in the US were evaluated; more weight gain was observed only among younger postmenopausal women.[7] It has been proposed that premenopausal women may be more likely to develop amenorrhea over the course of cancer-related treatments and tend to gain more weight than postmenopausal women.[22] However, the menopausal association was attenuated after adjustment for other risk factors in our study.

The association between cancer-related treatments and weight change has been examined with mixed results.[1, 7, 8, 11, 15, 22, 23] Tamoxifen use has been linked to more weight gain in some clinical trials[24, 25] but not in others.[26] In our study, tamoxifen use was not significantly related to weight gain. Some studies conducted in Western countries have shown that chemotherapy is related to weight change.[1, 7, 11] For example, in a cohort of 535 women with newly diagnosed breast cancer, Goodwin *et al.* observed that adjuvant chemotherapy was a strong and independent clinical predictor of weight gain.[1] The HEAL study reported that receiving chemotherapy was associated with greater weight gain.[7] The Korean study found that women with early stage breast cancer did not gain weight after adjuvant treatment.[15] In our study, women who had received chemotherapy or radiotherapy were more likely to gain weight than women who did not. However, the association was no longer significant after adjustment for other factors.

Consistent with the results of the HEAL study,[7] we found more weight gain among women with an advanced stage of breast cancer. Earlier research has reported that comorbidities such as diabetes and cardiovascular disease may not be related to weight change.[7] However, we found that the existence of serious comorbidity was inversely associated with weight change. Women with more severe comorbidity were more likely to lose weight.

When interpreting our findings, some limitations should be noted. First, weight at one year before diagnosis and at diagnosis were based on self-reports, and misclassification can occur when self-reported weight is used. However, previous validation studies have shown that self-reported weight is accurate,[27] and most epidemiological studies have used self-reported weight and weight change.[10, 28–30] We observed a high correlation coefficient between self-reported weight at diagnosis and weight from review of medical charts (r=0.92), indicating that self-reported weight is reliable in our study population. Second, no data on body composition change was available, therefore it is difficult to determine whether weight change observed in our study reflects any change in body composition among these breast cancer patients and survivors. The relatively short follow-up period is another limitation. Our ongoing follow-up study will allow us to examine the long-term patterns of weight change after breast cancer diagnosis and the impact of these patterns on breast cancer outcomes.

In summary, our large population-based cohort study indicates that weight gain after a diagnosis of breast cancer is common over the 36-month post-diagnosis period in Chinese population. Age at diagnosis, comorbidity, disease stage, and being underweight at cancer diagnosis are independent predictors for weight gain. Further research is warranted about the effect of modifiable lifestyle factors and genetic variations on weight gain. Appropriate weight control strategies should be developed for women with breast cancer.

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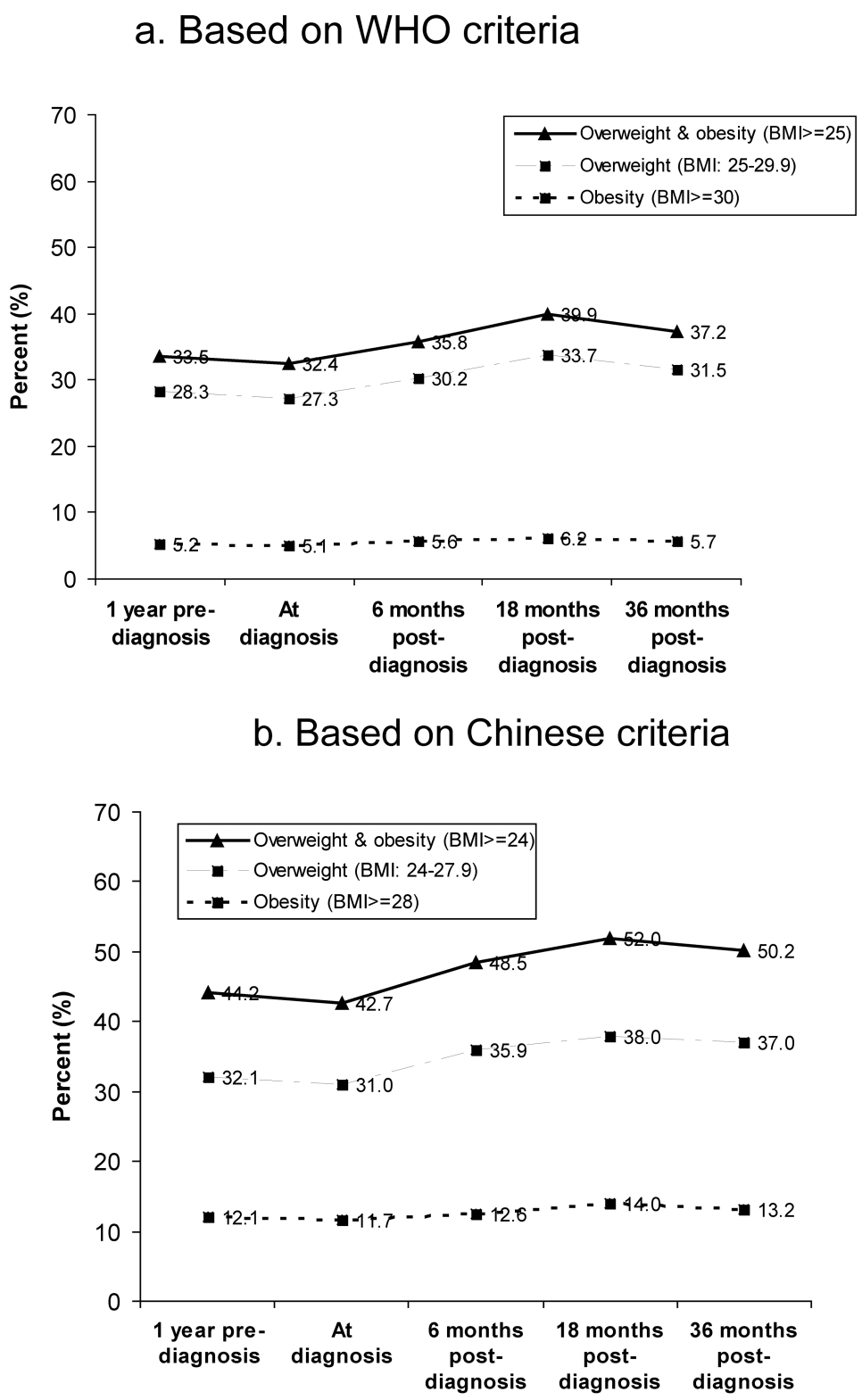

Figure 1.
Prevalence of overweight and obesity between 1 year before diagnosis and 36 months post-diagnosis

a) Based on WHO criteria for overweight and obesity
b) Based on Chinese criteria for overweight and obesity

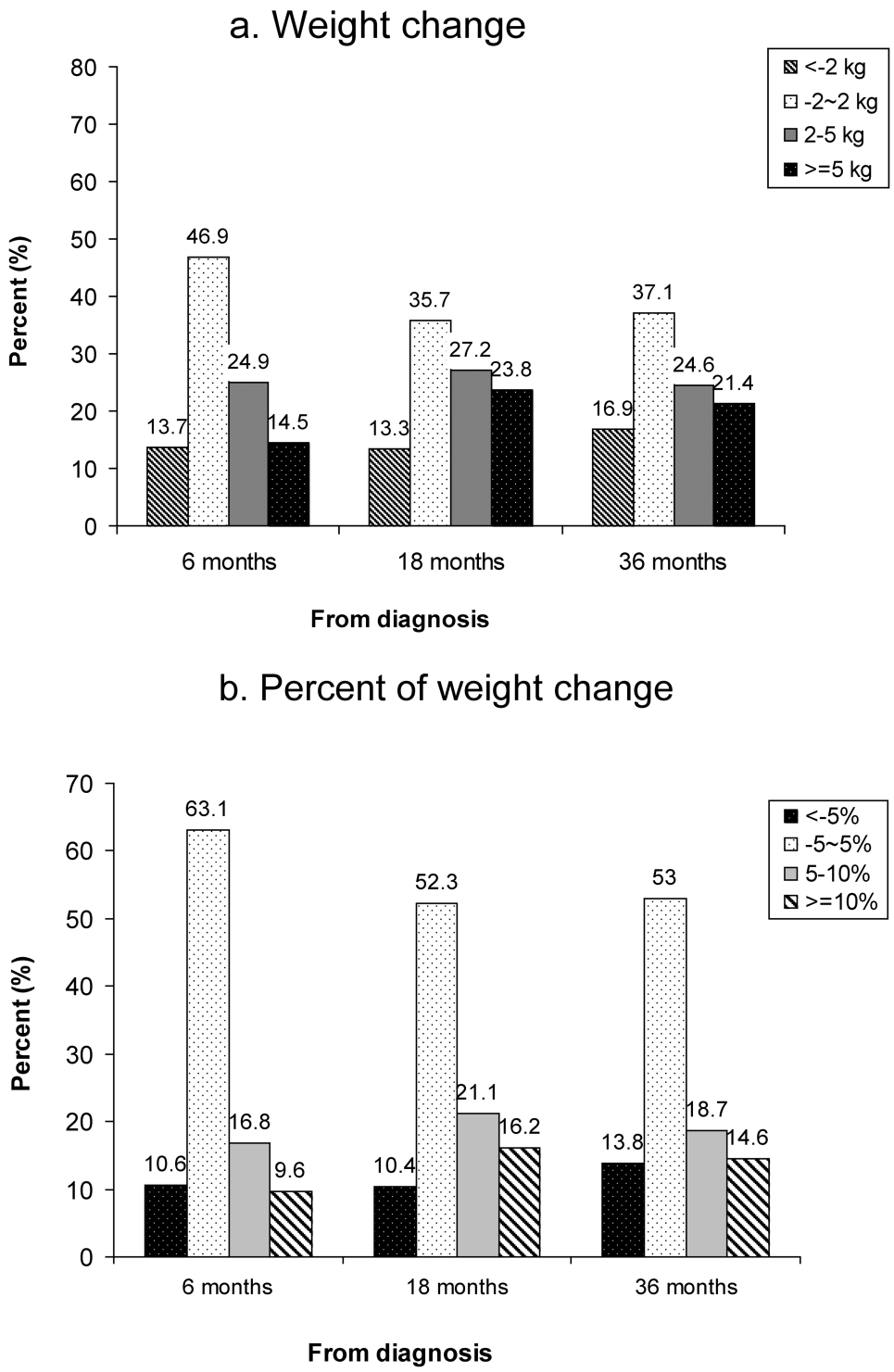

Figure 2.
Weight change from diagnosis to 6, 18, and 36 months post-diagnosis
a) Weight change
b) Percent of weight change (%)

Table 1

Weight change from diagnosis to 6 months after breast cancer diagnosis

Characteristics	N	%	Median (range)	P value
Total	5014	100.0	1.0 (−25.0, 20.0)	
Age at diagnosis (year)				<0.001
<40	241	4.8	2.0 (−7.5, 13.0)	
40–49	1999	39.9	1.5 (−12.5, 18.0)	
50–59	1477	29.5	1.0 (−12.0, 17.0)	
≥60	1297	25.9	0.0 (−25.0, 20.0)	
Education				<0.001
<High school	2320	46.3	1.0 (−25.0, 20.0)	
High school	1889	37.7	1.0 (−12.5, 18.0)	
>High school	805	16.1	1.0 (−10.0, 17.0)	
Income (yuan/month/capita)				0.307
<1000	2874	57.3	1.0 (−25.0, 20.0)	
1000–1999	1540	30.7	1.0 (−12.0, 15.0)	
≥2000	600	12.0	1.0 (−12.5, 17.0)	
Marital status				0.001
Married	4405	87.9	1.0 (−25.0, 20.0)	
Other	609	12.1	0.0 (−12.5, 15.0)	
Menopausal status				<0.001
Pre-menopausal	2455	49.0	1.5 (−12.5, 18.0)	
Post-menopausal	2559	51.0	0.0 (−25.0, 20.0)	
Menopausal symptoms				0.500
No	1431	28.5	1.0 (−11.0, 20.0)	
Yes	3583	71.5	1.0 (−25.0, 18.0)	
Charlson comorbidity index				<0.001
0	4013	80.0	1.0 (−25.0, 20.0)	
1	509	10.2	0.0 (−11.0, 14.0)	
≥2	492	9.8	−0.8 (−12.0, 12.0)	
Chemotherapy				<0.001
Yes	4570	91.1	1.0 (−12.5, 20.0)	
No	444	8.9	0.0 (−25.0, 10.0)	
Radiotherapy				<0.001
Yes	1605	32.0	1.0 (−12.0, 20.0)	
No	3409	68.0	1.0 (−25.0, 16.0)	
Immunotherapy				0.618 *
Yes	737	14.7	0.5 (−12.0, 17.0)	
No	4266	85.1	1.0 (−25.0, 20.0)	
Unknown	11	0.2	1.0 (−2.0, 8.0)	
Tamoxifen use				0.189 *
Yes	2610	52.1	1.0 (−12.0, 20.0)	

Characteristics	N	%	Median (range)	P value
No	2401	47.9	1.0 (−25.0, 17.0)	
Unknown	3	0.1	1.0 (−1.0, 3.0)	
ER/PR status				0.383 *
ER/PR positive	2510	50.1	1.0 (−12.5, 20.0)	
ER/PR negative	1385	27.6	1.0 (−25.0, 17.0)	
ER/PR mixed	1020	20.3	1.0 (−12.0, 16.0)	
ER/PR unknown	99	2.0	1.0 (−6.0, 12.0)	
TNM stage				0.073 *
0-I	1836	36.6	1.0 (−12.0, 16.0)	
IIA	1645	32.8	1.0 (−25.0, 17.0)	
IIB	837	16.7	1.0 (−12.0, 15.0)	
III	466	9.3	1.0 (−12.0, 20.0)	
Unknown	230	4.6	0.0 (−9.0, 12.0)	
BMI at diagnosis **				<0.001
Underweight (BMI<18.5)	205	4.1	2.0 (−5.0, 12.0)	
Normal (BMI: 18.5−23.9)	2709	54.0	1.0 (−12.0, 18.0)	
Overweight (BMI: 24–27.9)	1525	30.4	0.0 (−12.5, 20.0)	
Obese (BMI≥28)	575	11.5	−0.5 (−25.0, 14.5)	

* `Unknown' group was excluded from P value test

** Based on Chinese criteria for overweight and obesity (ref 21)

Table 2

Weight change from diagnosis to 18 months after breast cancer diagnosis

Characteristics	N	%	Median (range)	P value
Total	4544	100.0	2.0 (−22.0, 22.0)	
Age at diagnosis (year)				<0.001
<40	214	4.7	3.0 (−11.0, 17.0)	
40–49	1792	39.4	3.0 (−15.0, 22.0)	
50–59	1342	29.5	2.0 (−20.0, 21.0)	
≥60	1196	26.3	0.0 (−22.0, 22.0)	
Education				<0.001
<High school	2131	46.9	1.0 (−22.0, 22.0)	
High school	1708	37.6	2.0 (−20.0, 22.0)	
>High school	705	15.5	1.0 (−12.0, 20.0)	
Income (yuan/month/capita)				0.101
<1000	2612	57.5	2.0 (−22.0, 22.0)	
1000–1999	1404	30.9	1.0 (−20.0, 22.0)	
≥2000	528	11.6	2.0 (−12.0, 21.0)	
Marital status				<0.001
Married	3994	87.9	2.0 (−20.0, 22.0)	
Other	550	12.1	1.0 (−22.0, 22.0)	
Menopausal status *				0.002
Pre-menopausal	1214	26.7	3.0 (−15.0, 22.0)	
Post-menopausal	3330	73.3	1.0 (−22.0, 22.0)	
Menopausal symptoms				0.032
No	1290	28.4	1.0 (−19.0, 21.0)	
Yes	3254	71.6	2.0 (−22.0, 22.0)	
Charlson comorbidity index				<0.001
0	3616	79.6	2.0 (−20.0, 22.0)	
1	477	10.5	1.0 (−22.0, 22.0)	
≥2	451	9.9	0.0 (−18.0, 16.0)	
Relapse/metastasis *				0.285 **
No	4370	96.2	2.0 (−20.0, 22.0)	
Yes	126	2.8	1.0 (−22.0, 22.0)	
Unknown	48	1.1	1.0 (−11.0, 18.0)	
Chemotherapy				<0.001
Yes	4137	91.0	2.0 (−20.0, 22.0)	
No	407	9.0	0.0 (−22.0, 15.0)	
Radiotherapy				<0.001
Yes	1416	31.2	2.0 (−20.0, 22.0)	
No	3128	68.8	1.0 (−22.0, 22.0)	
Immunotherapy				0.396 **
Yes	677	14.9	2.0 (−16.0, 22.0)	

Characteristics	N	%	Median (range)	P value
No	3856	84.9	2.0 (−22.0, 22.0)	
Unknown	11	0.2	5.0 (−4.0, 9.0)	
Tamoxifen use*				0.434
Yes	3011	66.3	2.0 (−20.0, 22.0)	
No	1533	33.7	2.0 (−22.0, 22.0)	
ER/PR status				0.063**
ER/PR positive	2328	51.2	1.0 (−20.0, 20.0)	
ER/PR negative	1219	26.8	2.0 (−19.0, 22.0)	
ER/PR mixed	917	20.2	2.0 (−22.0, 22.0)	
ER/PR unknown	80	1.8	2.0 (−12.0, 14.0)	
TNM stage				0.001**
0-I	1695	37.3	1.0 (−22.0, 21.0)	
IIA	1510	33.2	2.0 (−19.0, 22.0)	
IIB	756	16.6	2.0 (−20.0, 22.0)	
III	381	8.4	2.0 (−12.0, 18.0)	
Unknown	202	4.5	2.0 (−13.0, 15.0)	
BMI at diagnosis$^{\xi}$				<0.001
Underweight (BMK<18.5)	179	3.9	3.0 (−10.0, 16.0)	
Normal (BMI: 18.5–23.9)	2444	53.8	2.0 (−18.0, 22.0)	
Overweight (BMI: 24.0–27.9)	1388	30.6	1.0 (−20.0, 20.0)	
Obese (BMI≥28)	533	11.7	−1.0 (−22.0, 22.0)	

*Based on information at follow-up interviews.

**`Unknown' group was excluded from P value test

$^{\xi}$Based on Chinese criteria for overweight and obesity (ref 21)

Table 3

Weight change from diagnosis to 36 months after breast cancer diagnosis

Characteristics	N	%	Median (range)	P value
Total	4137	100.0	1.0 (−20.0, 27.0)	
Age at diagnosis (year)				<0.001
<40	189	4.6	3.0 (−19.0, 27.0)	
40–49	1619	39.1	2.0 (−17.0, 23.0)	
50–59	1219	29.5	1.0 (−16.0, 19.0)	
≥60	1110	26.8	0.0 (−20.0, 24.0)	
Education				<0.001
<High school	1952	47.2	1.0 (−20.0, 27.0)	
High school	1545	37.4	1.0 (−19.0, 23.0)	
>High school	640	15.5	1.0 (−15.0, 24.0)	
Income (yuan/month/capita)				0.003
<1000	2373	57.4	1.0 (−20.0, 27.0)	
1000–1999	1284	31.0	1.0 (−19.0, 18.0)	
≥2000	480	11.6	1.0 (−15.0, 24.0)	
Marital status				0.166
Married	3624	87.6	1.0 (−19.0, 27.0)	
Other	513	12.4	1.0 (−20.0, 21.0)	
Menopausal status *				<0.001
Pre-menopausal	837	20.2	2.0 (−19.0, 27.0)	
Post-menopausal	3300	79.8	1.0 (−20.0, 24.0)	
Menopausal symptoms *				<0.001
No	1040	25.1	1.0 (−20.0, 27.0)	
Yes	3097	74.9	1.0 (−19.0, 24.0)	
Charlson comorbidity index *				<0.001
0	3336	80.6	1.5 (−19.0, 27.0)	
1	309	7.5	0.0 (−20.0, 21.0)	
≥2	492	11.9	−1.0 (−18.0, 12.0)	
Relapse/metastasis *				0.599 **
No	3851	93.1	1.0 (−20.0, 27.0)	
Yes	160	3.9	1.0 (−19.0, 19.0)	
Unknown	126	3.0	1.0 (−15.0, 16.0)	
Chemotherapy				<0.001
Yes	3764	91.0	1.0 (−20.0, 27.0)	
No	373	9.0	0.0 (−18.0, 24.0)	
Radiotherapy				<0.001
Yes	1262	30.5	2.0 (−19.0, 22.0)	
No	2875	69.5	1.0 (−20.0, 27.0)	
Immunotherapy				0.816 **

Characteristics	N	%	Median (range)	P value
Yes	609	14.7	1.0 (−15.0, 18.0)	
No	3518	85.0	1.0 (−20.0, 27.0)	
Unknown	10	0.2	2.5 (−7.0, 8.0)	
Tamoxifen use *				0.827
Yes	2706	67.1	1.0 (−19.0, 27.0)	
No	1325	32.9	1.0 (−20.0, 20.0)	
ER/PR status				0.281 **
ER/PR positive	2149	52.0	1.0 (−19.0, 27.0)	
ER/PR negative	1082	26.2	1.0 (−20.0, 21.0)	
ER/PR mixed	839	20.3	1.0 (−17.0, 22.0)	
ER/PR unknown	67	1.6	1.0 (−17.0, 16.0)	
TNM stage				0.009 **
0-I	1587	38.4	1.0 (−18.0, 24.0)	
IIA	1379	33.3	1.0 (−20.0, 23.0)	
IIB	661	16.0	1.0 (−16.0, 20.0)	
III	323	7.8	2.0 (−19.0, 27.0)	
Unknown	187	4.5	2.0 (−19.0, 13.0)	
BMI at diagnosis ξ				<0.001
Underweight (BMK<18.5)	163	3.9	3.0 (−4.0, 19.0)	
Normal (BMI: 18.5–23.9)	2209	53.4	2.0 (−13.0, 27.0)	
Overweight (BMI: 24.0–27.9)	1289	31.2	0.0 (−19.0, 23.0)	
Obese (BMI≥28)	476	11.5	−1.0 (−20.0, 20.0)	

* Based on information from the 18 months post-diagnosis interview.

** `Unknown' group was excluded from P value test

ξ Based on Chinese criteria for overweight and obesity (ref 21)

Table 4

Linear regression model: weight gain from breast cancer diagnosis to 36 months post-diagnosis and related factors

Characteristic	β	SE	P value
Age at diagnosis	−0.06	0.01	<0.001
Education (ref: <High school)			
High school	−0.04	0.15	0.782
>High school	−0.63	0.22	0.004
BMI at diagnosis	−0.32	0.02	<0.001
Charlson comorbidity index (ref: 0)			
1	−0.27	0.26	0.305
≥2	−1.67	0.22	<0.001
TNM stage (ref: 0-I)			
IIA	0.07	0.16	0.640
IIB	0.42	0.21	0.041
III	0.92	0.28	<0.001