# Physical activity levels among breast cancer survivors

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## Abstract

**Introduction—**Obesity and weight gain are negative prognostic factors for breast cancer survival. Physical activity (PA) prevents weight gain and may decrease obesity. Little information exists on PA levels among cancer survivors. We assessed PA, including the proportion of breast cancer survivors engaging in recommended levels, by categories of adiposity, age, disease stage, and ethnicity in 806 women with Stage 0–IIIA breast cancer participating in the Health, Eating, Activity, and Lifestyle Study.

**Methods—**Black, non-Hispanic White, and Hispanic breast cancer survivors were recruited into the study through Surveillance Epidemiology End Results registries in New Mexico, Western Washington, and Los Angeles County, California. Types of sports and household activities and their frequency and duration within the third year after diagnosis were assessed during an in-person interview.

**Results—**Thirty-two percent of breast cancer survivors participated in recommended levels of PA defined as 150 min/week of moderate- to vigorous-intensity sports/recreational PA. When moderate-intensity household and gardening activities were included in the definition, 73% met the recommended level of PA. Fewer obese breast cancer survivors met the recommendation than overweight and lean breast cancer survivors (p < .05). Fewer Black breast cancer survivors met the recommendation compared to non-Hispanic White and Hispanic breast cancer survivors (p < .05).

**Conclusions—**Most of the breast cancer survivors were not meeting the PA recommendations proposed for the general adult population. Efforts to encourage and facilitate PA among these women would be an important tool to decrease obesity, prevent post-diagnosis weight gain, and improve breast cancer prognosis.

## Keywords

exercise; fitness; patient; treatment; weight; race

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# INTRODUCTION

Epidemiologic studies have linked obesity and low levels of physical activity with an increased risk of breast cancer (4,21). Clinical and epidemiologic studies have also identified obesity and weight gain as important negative prognostic factors for survival among women with this disease (7). Physical activity has been associated with weight loss and weight maintenance among healthy individuals (14,23), and recent studies have shown a favorable effect of exercise on body weight among breast cancer survivors (12,20). Despite the evidence suggesting that regular physical activity can protect against weight gain, decrease breast cancer risk, and potentially improve breast cancer prognosis, efforts to encourage physical activity are not a routine part of the cancer treatment or rehabilitation process.

Recently, we reported that women diagnosed with breast cancer, who participated in the Health, Eating, Activity, and Lifestyle (HEAL) Study, were significantly less physically active within their first year after diagnosis than they were one year before diagnosis (13). Obese women reported the most significant declines in physical activity after diagnosis compared to lean women. In designing physical activity programs and interventions for cancer survivors, information on types and intensities of physical activity preferred by cancer survivors is needed.

This analysis examines physical activity levels within the third year after diagnosis in 806 breast cancer survivors enrolled in the HEAL Study, a population-based prospective cohort study. We also examined the influence of obesity, age, stage of disease, and ethnicity on various types and intensities of physical activity, and the proportion of breast cancer survivors participating in physical activity levels recommended by the Surgeon General (22) for the general adult population. To our knowledge, this paper provides the most in depth examination of physical activity levels among cancer survivors to date.

# METHODS

## Study Setting, Subjects, and Recruitment

The HEAL study is a population-based, multi-center, multi-ethnic prospective cohort study that has enrolled 1223 breast cancer survivors who are being followed to determine whether weight, physical activity, diet, sex hormones, and other exposures affect breast cancer prognosis. Women were recruited into the HEAL study through Surveillance, Epidemiology, End Results (SEER) registries in New Mexico, Los Angeles County (CA), and Western Washington. Names and contact information were retrieved from the SEER registries. Participants were randomly contacted to determine interest and eligibility (approximately 41% of women with breast cancer who were eligible by age, stage, and county of residence were enrolled into the study). Details of the aims, study design, and recruitment procedures have been published previously (13,17).

Briefly, in New Mexico, 654 women, aged 18 years or older, diagnosed with *in situ* to Stage IIIA breast cancer between July 1996 and March 1999, and living in Bernalillo, Sante Fe, Sandoval, Valencia, or Taos Counties were recruited for the HEAL Study. In Western Washington, 202 women, between the ages of 40 and 64 years, diagnosed with *in situ* to Stage IIIA breast cancer between September 1997 and September 1998, and living in King, Pierce, or Snohomish Counties were recruited for the HEAL Study. Due to other ongoing studies at the Fred Hutchinson Cancer Research Center in Seattle, Washington, a limited number of women treated for Stage I to III-A breast cancer were eligible for the HEAL Study. Thus, a higher proportion of the women from Washington had *in situ* breast cancer than at the other two sites. In Los Angeles County, 367 Black women with stage 0 to IIIA

breast cancer, who had participated in the Los Angeles portion of the Women's Contraceptive and Reproductive Experiences (CARE) Study, a case-control study of invasive breast cancer, or who had participated in a parallel case-control study of *in situ* breast cancer were recruited for the HEAL Study. Eligible participants from these two studies were a subset of the women who were diagnosed with breast cancer between May, 1995 and May, 1998. Both studies restricted eligibility to women aged 35 to 64 years at diagnosis who were English speaking and born in the U.S.

Participants in the HEAL Study completed in-person interviews at baseline (within their first year after diagnosis, mean number of months from diagnosis to interview = 6 ± 5 months) and two-years after the baseline visit (within their third year after diagnosis, mean number of months from diagnosis to follow-up visit = 31 ± 6 months) at the Fred Hutchinson Cancer Research Center in Seattle, WA, the University of New Mexico Aging and Genetic Epidemiology Center in Albuquerque, New Mexico, and at the participant's home, workplace or at place of work (if living in Los Angeles). Among the 1223 women enrolled at baseline, 38 women were later found to have a prior diagnosis of breast cancer, three women were diagnosed as having Stage IV breast cancer, and three women were diagnosed as having an undefined disease stage. A total of 243 women did not return for a follow-up visit within three years after diagnosis. Reasons for non-participation were death (n=19), too ill (n=2), refused to participate (n=102), spouse would not permit contact (n=1), moved from the study area (n=23), unable to interview (n=47), data lost (n=1), or lost to follow-up (n=48). A total of 109 women did not have complete weight (n=106) or height (n=3) data at the baseline or follow-up visits. Due to small numbers of American Indian women (n=4), Asian/Pacific women (n=12) or women defining their race as "other" (n=5), we restricted the analyses to only Black women (n=259), non-Hispanic White women (n=456), and Hispanic (n=93) women. The remaining analyses include 806 women. Written informed consent was obtained from each subject. The study was performed after approval of the Institutional Review Boards of participating centers, in accord with an assurance filed with and approved by the U.S. Department of Health and Human Services.

## Data Collection

In order to increase the validity and reliability of data collected across sites and over time, ongoing monthly conference calls were scheduled to discuss the operations of the study. A manual of operations was also developed detailing instructions on how to collect study data. Interviewers at each site followed the detailed methods included in the manual of operations.

## Physical Activity Assessment

We collected information on physical activity using an interview-administered physical activity questionnaire at an in-person visit scheduled within the third year after diagnosis. The questionnaire was based on the Modifiable Activity Questionnaire developed by Kriska and colleagues, which was designed to be easily modified for use with different populations, and which has been shown to be reliable and valid (16). The type, duration, and frequency of activities performed in the past year were assessed. The sports/recreation and household activity section of the questionnaire addressed 29 popular activities, such as fast walking, *moderate/slow walking*, jogging, aerobics, tennis, household cleaning, and yard work. The interviewer first read the list of activities to the participant and the participant identified all activities that she performed on at least ten different occasions over the past five years. For each activity performed, participants were further asked how *many months in the past year they participated in the activity, the frequency during each month, and the duration of each activity.*

We then estimated hours per week for each activity by multiplying frequency and duration together. Two mutually exclusive groups were created based on type of activity (sports/recreation including walking or household/gardening). Each activity was also categorized as light-, moderate-, or vigorous-intensity based on Ainsworth et al's Compendium of Physical Activities (1). Light-intensity physical activity was defined as less than 3 METs, moderate-intensity physical activity as 3–6 METs, and vigorous-intensity physical activity as greater than 6 METs (22). A MET is defined as the ratio of the associated metabolic rate for a specific activity divided by the resting metabolic rate (e.g., a 2-MET activity requires two times the resting metabolic energy expenditure of sitting quietly). One MET is also defined as the energy expenditure for sitting quietly, which for the average adult is approximately 3.5 ml of oxygen per kg body weight per minute or 1 kcal per kg body weight per hour (1).

### Anthropometrics

Trained staff measured weight in a standard manner at the clinic visit. Weight was measured to the nearest 0.1 kg *using a balance-beam laboratory scale. The scale was calibrated and checked for accuracy before each weighing*. Heigh was self-reported by participants at all three sites. Body mass index was computed as weight in kg divided by self-reported height in $m^2$. Three mutually exclusive BMI groups were created: lean weight (BMI < 25 kg/$m^2$), overweight (25 kg/$m^2$ ≤ BMI < 30.0 kg/$m^2$), and obese (BMI ≥ 30.0 kg/$m^2$) (19). In a subsample (n = 569), both self-reported and measured height was collected. Measured height was collected without shoes to the nearest 0.1 cm using a stadiometer. All measurements were performed and recorded twice in succession. The two measurements were averaged for a final value for analyses. Among women who had data on both measured height and self-reported height, self-reported height was 1.3 ± 2.9 cm higher than measured height; and only three women (out of 569) had a change in BMI classification from overweight to normal weight when using the self-reported height rather than measured height.

### Stage of Disease and Cancer Treatment

We obtained data on stage of disease from the respective local SEER registries (the New Mexico Tumor Registry, the Cancer Surveillance System of Western Washington, and the Cancer Surveillance Program of Los Angeles County) prior to recruitment of women into the HEAL Study. Participants were classified as having *in situ*, Stage I or Stage II-IIIA breast cancer using the SEER stage of disease classification (18).

### Other Variables

Standardized questionnaire information was collected on medical history, health habits, history of benign breast disease, age at menopause, type of menopause, hysterectomy status, family history of breast and other specific cancers, self-reported physician-diagnosed type 2 diabetes, smoking status, tamoxifen use, selected demographic data (e.g., age, education, and marital status), and self-reported race/ethnicity (Black, non-Hispanic White, or Hispanic).

### Statistical Analyses

Means and standard deviations of physiological and demographic characteristics of the study sample were calculated for all participants and by BMI group. Differences in means by BMI group were compared using analysis of variance for continuous variables and chi-square analyses for categorical variables.

We used analysis of covariance methods to estimate least squares means and test for differences or trends in physical activity levels across categories of BMI, age, stage of

disease, ethnicity/race. Each analysis adjusted for the other factors; for example, in comparing physical activity levels across BMI, we adjusted for age, disease stage, adjuvant treatment, ethnicity/race, study site, education, season, and interviewer. We used Tukey's Honestly Significant Difference (HSD) test to identify statistically significant differences between groups with the overall level of statistical significance constrained to 5%.

We examined the proportion of breast cancer survivors meeting current physical activity recommendations by categories of BMI, age, stage of disease, and ethnicity/race. The physical activity recommendation we evaluated was the Surgeon General's Physical Activity Recommendation of 30 min of moderate- to vigorous-intensity physical activity five days per week or 150 min/week (22). Some surveillance studies that report the proportion of U.S. adults engaging in recommended levels of physical activity only include sports or recreational activities (5,15, http://www.cdc.gov/nchs/nhanes.htm). Thus, to be consistent with the literature we reported the proportion of breast cancer survivors meeting current physical activity recommendations including all types of moderate- to vigorous-intensity physical activity and including only moderate- to vigorous-intensity sports/ recreational physical activity.

We also examined the percent of breast cancer survivors reporting participation in 29 different types of physical activities and the mean duration of each activity by categories of BMI.

## RESULTS

The mean age and BMI of participants were $54.9 \pm 10.5$ years and $27.8 \pm 6.4$ kg/m$^2$, respectively (Table 1). Fifty-seven percent were postmenopausal. Ninety-five percent of the participating breast cancer patients completed 12 years of high school. Twenty-three percent, 53%, and 24% of the patients were diagnosed with *in situ*, Stage I, and Stage II to III-A breast cancer, respectively. Thirty-two percent, 56%, and 12% of the participating women were Black, non-Hispanic White, and Hispanic, respectively.

We observed a statistically significant trend of decreasing time spent in moderate-intensity, vigorous-intensity and sports/recreational activity with increasing category of BMI (p for trend < .0002) (Table 2a). Obese breast cancer survivors spent 28%, 64%, and 49% less time in moderate-intensity, vigorous-intensity, and sports/recreational activity compared to lean breast cancer survivors, respectively. When examining physical activity levels by age categories, we observed a statistically significant trend for decreasing time spent in vigorous-intensity physical activity with increasing category of age (trend p = .047) (Table 2a). Women 60 years or older spent 44% less time in vigorous-intensity physical activity than women under age 50 years.

Women diagnosed with a higher stage of disease reported 15% more time spent in total physical activity compared to women diagnosed with *in situ* breast cancer (p = .031) (Table 2b). This higher total physical activity appears to come from differences in household activity. Black breast cancer survivors reported spending significantly less time in moderate-intensity, vigorous-intensity, and sports/recreational physical activity compared to non-Hispanic White and Hispanic breast cancer survivors ( p < .05) (Table 2b). When we limited the race/ethnic comparisons to women younger than 65 years (Black women recruited into the study were all younger than 65 years), the observation of Black breast cancer survivors reporting less time spent in physical activity compared to non-Hispanic White and Hispanic breast cancer survivors remained.

Seventy-three percent of the sample met the current Surgeon General's physical activity recommendation of 150 min/week of any type of moderate- to vigorous-intensity physical

activity (i.e., household, yardwork, and sports/recreational activities), (Table 3a). When we defined the Surgeon General's recommendation as 150 min/week of only moderate- to vigorous-intensity sports/recreational physical activity (excluding household and yardwork), only 32% of the sample met the recommendation. Even fewer participants met the Institute of Medicine's physical activity recommendation of 300 min/week of moderate- to vigorous-intensity physical activity. Fewer obese breast cancer survivors met the physical activity recommendations than overweight and lean breast cancer survivors (p < .0001). Fewer Black breast cancer survivors met the physical activity recommendations than non-Hispanic White and Hispanic breast cancer survivors (p < .0001) (Table 3b). No differences were observed in the proportion of women meeting the physical activity recommendations by age group (p > .05).

Walking was the most common sports/recreational activity performed by breast cancer survivors (Table 4). We observed a statistically significant trend of decreasing time spent in moderate and fast walking with increasing BMI after adjusting for age, disease stage, ethnicity, and study site (p < .05). Lean breast cancer survivors reported spending 24% and 40% more time in moderate and fast walking, respectively, than obese breast cancer survivors (p < .05).

When we compared physical activity levels during the first year after diagnosis to those during the third year after diagnosis (limited to two of the three sites – Western Washington and New Mexico – since the third site, Los Angeles County, did not collect physical activity data during the first year after diagnosis), we observed an increase in moderate- to vigorous-intensity physical activity and sports/recreational physical activity among women with a BMI < 30, p < .05 (see Figures 1 and 2). However, while the trend appears to be v-shaped, only 52% of breast cancer survivors actually increased their moderate-to vigorous-intensity physical activity from the first to the third year following diagnosis; 41% and 7% of breast cancer survivors decreased or maintained (within ± 10% levels during the year before diagnosis) their moderate- to vigorous-intensity physical activity levels during the first year and during the third year after diagnosis, respectively (data not shown). While a similar proportion of lean (52%), overweight (51%), and obese (55%) breast cancer survivors increased their moderate- to vigorous-intensity physical activity from the first year to the third year after diagnosis, the mean hours per week increase differed across BMI groups, with lean breast cancer survivors increasing their time by 1.2 ± 7.6 hours/week compared to 1.4 ± 7.6 hours/week and 0.2 ± 6.9 hours/week among overweight and obese breast cancer survivors, respectively (p for trend = .041).

## DISCUSSION

Despite strong evidence suggesting that regular physical activity can protect against breast cancer (21), only 32% of breast cancer survivors engage in the recommended level of physical activity defined as 150 min per week of moderate- to vigorous-intensity sports/ recreational physical activity. This percentage is similar to the proportion of healthy U.S. women (27%) meeting the current physical activity recommendation (5,11,15). When moderate-intensity household and gardening activities were included in the definition, 73% of breast cancer survivors met the current recommended level of physical activity. This percentage is somewhat higher than the proportion of healthy U.S. women (45%) (6) and may simply be due to different physical activity assessment methods. In our study, physical activity was assessed via a 29-item questionnaire whereas data for healthy U.S. women was assessed via the Behavioral Risk Factor Surveillance Survey (BRFSS). The BRFSS asks participants to recall the amount of time they spend in moderate-intensity activities, such as brisk walking, bicycling, vacuuming, and gardening), and vigorous-intensity activities, such as running, aerobics, and heavy yard work). Thus, the questionnaire used in the HEAL

Study may overestimate time spent in different types and intensities of activities simply because of the list-format used; conversely the BRFSS may underestimate time spent in different types and intensities of activities because of only asking about the total time spent in moderate- and vigorous-intensities activities. To our knowledge, no other studies have calculated prevalence rates of physical activity in breast cancer survivors or survivors of any type of cancer.

Of more importance, though, is our observance of fewer obese breast cancer survivors reporting participation in recommended levels of physical activity than overweight and lean breast cancer survivors. Obesity is associated with an increased risk of breast cancer, poorer survival among women with this disease, and a more advanced stage at diagnosis (7). Lower levels of physical activity among obese breast cancer survivors may also contribute to subsequent weight gain.

In our study, Black breast cancer survivors reported significantly less time spent in moderate-intensity, vigorous-intensity, and sports/recreational physical activities than non-Hispanic White and Hispanic breast cancer survivors even after adjusting for BMI, age, and study site (p < .05). Similar findings of lower levels of physical activity reported among healthy Black women compared to healthy White women have been reported (2). Black women have a lower breast cancer survival rate than White women even after adjusting for differences in age, socio-economic status, tumor characteristics, and treatment factors (3). Black women are more likely to be overweight or obese than White women,[7] and as previously mentioned, obesity is significantly associated with a higher risk of breast cancer and poorer survival (7). Cui et al (9) assessed, in 585 White women and 381 Black women newly diagnosed with breast cancer, the extent to which racial differences in stage at diagnosis could be explained by racial differences in obesity. Adjustment for the higher prevalence of obesity in Black women attenuated the risk estimate of more advanced stage of breast cancer at diagnosis in Black women compared with White women by 30%; however, a racial difference in stage of breast cancer at diagnosis still persisted after adjustment for obesity. Very little is known about whether differences in physical activity levels contribute to the disparities in breast cancer risk and prognosis between Black and White women. Differences in physical activity level may contribute to the poorer survival experienced by Black breast cancer survivors, although research on this issue is limited and needed. More longitudinal data and randomized controlled exercise trials examining associations between physical activity and body weight, fat, and breast cancer prognosis in Black breast cancer survivors are needed.

Recently, we reported that breast cancer survivors participating in the HEAL Study were significantly less physically active within their first year after diagnosis than they were one year before diagnosis (13). Obese women reported greater declines in physical activity after diagnosis than lean women. While physical activity levels reported three years after diagnosis returned to pre-diagnosis levels for approximately 50% of the sample, this sample consisted mainly of lean and overweight breast cancer survivors. The majority of obese breast cancer survivors did not increase their physical activity levels. Exercise interventions and physical activity programs focused on increasing physical activity levels among obese breast cancer survivors with the ultimate goal of improving prognosis are needed.

The HEAL Study has several strengths. The HEAL Study, a population-based study, is one of a handful that has examined physical activity levels after a diagnosis of cancer, and the only study reporting detailed physical activity by type and intensity stratified by adiposity, age, race/ethnicity, and stage of disease. However, a limitation of our study is that we cannot be sure that these findings pertain to all breast cancer survivors because our sample only included women with Stages 0 – IIIA breast cancer living in Los Angeles, Western

Washington, and New Mexico. Another limitation of the study is that pre-diagnosis physical activity levels were recalled (approximately 1 to 2 years ago) whereas during the post-diagnosis time points, participants simply reported their current physical activity levels within the first year and third year after diagnosis.

Exercise interventions among healthy overweight to obese, previously sedentary women have shown a favorable effect of exercise on body weight and fat (14). Randomized controlled trials examining the effect of exercise on body weight and fat, breast cancer recurrence and survival, and intermediate markers of recurrence and survival in overweight and obese breast cancer survivors are needed. Exercise interventions should determine approaches to help overweight and obese breast cancer survivors make behavioral changes to improve their prognosis. Such interventions should also focus on maintenance of physical activity levels among previously active breast cancer survivors and increasing physical activity levels among inactive breast cancer survivors.

In order to improve the cancer treatment and survival process, maintenance of or increases in physical activity levels is necessary. Although treatment may have a negative impact on physical activity levels, studies show that even women undergoing intensive therapy for breast cancer are able to be physically active during and following treatment (8). In an effort to decrease obesity, prevent post-diagnosis weight gain, and improve breast cancer prognosis, participation in physical activity after a diagnosis of breast cancer should be recommended by clinicians and health care providers. Special attention should be given to Black breast cancer survivors and overweight to obese breast cancer survivors.

## Acknowledgments

## References

1. Ainsworth B, Haskell W, Whitt M, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exer 2000;32:S498–516.

2. Ainsworth BE, Irwin ML, Addy C. Moderate physical activity patterns of minority women: the Cross-Cultural Activity Participation Study. J Womens Health Gend Based Med Jul-Aug;1999 8(6): 805–13. [PubMed: 10495261]

3. Bradley CJ, Given CW, Roberts C. Race, socioeconomic status, and breast cancer treatment and sruvival. J Natl Cancer Inst 2002;94(7):490–6. [PubMed: 11929949]

4. Brown J, Byers T, Doyle C, et al. Nutrition and physical activity during and after cancer treatment: an American Cancer Society guide for informed choices. CA Cancer J Clin 2003;53(5):268–91. [PubMed: 14570227]

5. Browson R, Jones D, Pratt M, Blanton C, Heath G. Measuring physical activity with the behavioral risk factor surveillance system. Med Sci Sports Exer 2000;32(11):1913–18.

6. CDC. Prevalence of physical activity, including lifestyle activities among adults – United States, 2000–20001. MMWR 2003;52(32):764–69. [PubMed: 12917582]

7. Chlebowski R, Aiello E, McTiernan A. Weight loss in breast cancer patient management. J Clin Oncol 2002;20:1128–43. [PubMed: 11844838]

8. Courneya K. Exercise interventions during cancer treatment: Biopsychosocial outcomes. Exerc Sport Sci Rev Apr;2001 29(2):60–4. [PubMed: 11337824]

9. Cui Y, Whiteman MK, Langenberg P, et al. Can obesity explain the racial difference in stage of breast cancer diagnosis between black and white women? J Womens Health Gend Based Med 2002;11(6):527–36. [PubMed: 12225626]

10. Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and Trends in Obesity Among US Adults, 1999–2000. JAMA 2002;288:1723–1727. [PubMed: 12365955]

11. Hootman JM, Macera CA, Helmick CG, Blair SN. Physical activity levels among the general US adult population and in adults with and without arthritis. Arthritis Rheum Feb 15;2003 49(1):129–35. [PubMed: 12579604]

12. Irwin ML, Ainsworth BE. Physical Activity Interventions Following Cancer Diagnosis: Methodologic Challenges to Delivery and Assessment. Cancer Investigation 2004;22(1):30–50. [PubMed: 15069762]

13. Irwin ML, Crumley D, McTiernan A, et al. Physical activity levels before and after a diagnosis of breast carcinoma: The Health, Eating, Activity, and Lifestyle (HEAL) Study. Cancer 2003;97:1746–57. [PubMed: 12655532]

14. Irwin ML, Yasui Y, Ulrich C, et al. Effect of exercise on total and intra-abdominal body fat in postmenopausal women: a randomized controlled trial. JAMA Jan 15;2003 289(3):323–30. [PubMed: 12525233]

15. Jones D, Ainsworth B, Croft J, et al. Moderate leisure-time physical activity. Arch Fam Med 1998;7:285–89. [PubMed: 9596466]

16. Kriska A. Modifiable activity questionnaire. Med Sci Sports Exer 1997;29:S73–78.

17. McTiernan A, Rajan B, Tworoger S, et al. Adiposity and sex hormones in postmenopausal breast cancer survivors. J Clin Oncol May 15;2003 21(10):1961–6. [PubMed: 12743149]

18. National Cancer Institute. NIH Pub No 92–1999. Bethesda (MD): Cancer Statistics Branch, Surveillance Program, Division of Cancer Prevention and Control. National Cancer Institue, U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health; Jun. 1992 The SEER program code manual; p. 45-48.

19. National Institutes of Health. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults – the evidence report. Obesity Res 1998;6(Suppl 2):51S–209S.

20. Rock CL, Demark-Wahnefried W. Can lifestyle modification increase survival in women diagnosed with breast cancer? J Nutr Nov;2002 132(11 Suppl):3504S–3507S. [PubMed: 12421877]

21. Thune I, Furberg A. Physical activity and cancer risk: dose-response and cancer, all sites and site-specific. Med Sci Sports Exerc Jun;2001 33(6 Suppl):S530–50. discussion S609–10. [PubMed: 11427781]

22. U.S. Department of Health and Human Services. Physical Activity and Health: A Report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion; 1996. p. 5

23. Wing RR. Physical activity in the treatment of the adulthood overweight and obesity: current evidence and research issues. Med Sci Sports Exerc Nov;1999 31(11 Suppl):S547–52. [PubMed: 10593526]
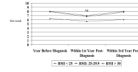
**Figure 1.**
Adjusted[1] mean moderate- to vigorous-intensity physical activity levels (hrs/week) across the breast cancer experience by BMI (N = 547). (Western Washington and New Mexico breast cancer survivors only.)

[1]Adjusted for age, disease stage, ethnicity, study site, season, and interviewer; *significantly different from year before diagnosis (only for BMI < 25 and BMI between 25–29.9), p < .05; Φ significantly different from within 3rd year post-diagnosis (only for BMI < 25 and BMI between 25–29.9), p < .05

**Figure 2.**
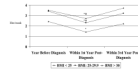Adjusted mean sports/recreational physical activity levels (hrs/week) across the breast cancer experience by BMI (N = 547). (Western Washington and New Mexico breast cancer survivors only.)

[1]Adjusted for age, disease stage, ethnicity, study site, season, and interviewer; *significantly different from year before diagnosis, $p < .05$; Φ significantly different from within 3rd year post-diagnosis, $p < .05$

**Table 1**

Physiological and demographic characteristics of HEAL breast cancer survivors by BMI (N = 806)

| | All Mean ± SD (n = 806) | BMI < 25.0 Mean ± SD (n = 307) | BMI: 25.0–29.9 Mean ± SD (n = 258) | BMI ≥ 30.0 Mean ± SD (n = 241) | P for Trend |
|---|---|---|---|---|---|
| Age (years) | 54.9 ± 10.5 | 56.2 ± 11.5 | 54.6 ± 10.2 | 53.4 ± 9.1 | .0019 |
| Weight (kg) | 75.3 ± 18.5 | 60.3 ± 7.4 | 73.1 ± 6.8 | 96.7 ± 16.8 | .0001 |
| Height (cm) | 164.5 ± 7.1 | 165.4 ± 6.6 | 163.5 ± 6.8 | 164.3 ± 7.8 | .085 |
| BMI (wt in kg/ht in m$^2$) | 27.8 ± 6.4 | 22.0 ± 2.0 | 27.3 ± 1.4 | 35.7 ± 5.0 | .0001 |
| Disease Stage | | | | | .15 |
| *In Situ* | 23% | 21% | 26% | 22% | |
| Stage I | 53% | 60% | 51% | 48% | |
| Stage II and IIIa | 24% | 19% | 23% | 30% | |
| Race | | | | | .0001 |
| Black | 32% | 20% | 29% | 50% | |
| Non-Hispanic White | 56% | 68% | 57% | 41% | |
| Hispanic | 12% | 12% | 14% | 9% | |
| Site | | | | | .0001 |
| New Mexico | 49% | 63% | 50% | 30% | |
| Seattle | 19% | 17% | 21% | 20% | |
| Los Angeles | 32% | 21% | 29% | 50% | |
| Education (% H.S. graduate) | 95% | 97% | 94% | 94% | .067 |
| Tamoxifen Users (%) | 24% | 31% | 24% | 16% | .0001 |
| Postmenopausal (%) | 57% | 59% | 55% | 57% | .93 |
| Family History of Breast Cancer [1] | 21% | 22% | 15% | 25% | .87 |
| Current Smokers (%) | 13% | 14% | 14% | 12% | .18 |
| Diagnosed with Type 2 diabetes (%) | 6% | 2% | 7% | 14% | .083 |

[1] First Degree Relative

**Table 2a**

Adjusted[1] physical activity levels (hrs/week) within the third year after a breast cancer diagnosis by BMI and age (N = 806)

| | ALL N = 806 Mean ± SD | BMI < 25.0 N = 307 Mean ± SE | BMI: 25.0 – 29.9 N = 258 Mean ± SE | BMI ≥ 30.0 N = 241 Mean ± SE | P for Trend |
|---|---|---|---|---|---|
| Total PA[2] | 23.3 ± 17.3 | 23.7 ± 1.0 | 23.0 ± 1.1 | 23.0 ± 1.1 | .66 |
| Light-Intensity PA[3] | 16.3 ± 14.4 | 15.5 ± 0.8 | 15.9 ± 0.9 | 17.6 ± 0.9 | .085 |
| Moderate-Intensity PA[4] | 6.3 ± 6.1 | 7.1 ± 0.3 | 6.6 ± 0.4 | 5.1 ± 0.4 *Φ | .0001 |
| Vigorous-Intensity PA[5] | 0.7 ± 2.2 | 1.1 ± 0.1 | 0.5 ± 0.1 * | 0.4 ± 0.1 *Φ | .0002 |
| Sports/Recreational PA | 2.9 ± 4.2 | 3.7 ± 0.2 | 3.0 ± 0.3 * | 1.9 ± 0.3 *Φ | .0001 |
| Household PA | 18.9 ± 16.3 | 18.4 ± 0.9 | 18.7 ± 1.0 | 19.9 ± 1.0 | .30 |

| | | < 50 years N = 265 Mean ± SE | 50 – 59 years N = 294 Mean ± SE | ≥ 60 years N = 247 Mean ± SE | P for Trend |
|---|---|---|---|---|---|
| Total PA[2] | | 24.0 ± 1.1 | 22.6 ± 1.0 | 23.3 ± 1.1 | .69 |
| Light-Intensity PA[3] | | 16.8 ± 0.9 | 15.7 ± 0.8 | 16.4 ± 0.9 | .70 |
| Moderate-Intensity PA[4] | | 6.2 ± 0.4 | 6.3 ± 0.3 | 6.5 ± 0.4 | .61 |
| Vigorous-Intensity PA[5] | | 0.9 ± 0.1 | 0.6 ± 0.1 | 0.5 ± 0.1 * | .047 |
| Sports/Recreational PA | | 2.9 ± 0.3 | 3.0 ± 0.2 | 2.9 ± 0.3 | .86 |
| Household PA | | 19.8 ± 1.0 | 18.1 ± 0.9 | 19.1 ± 1.0 | .61 |

[1] Physical activity levels adjusted for BMI, age, disease stage, treatment, race, study site, education, season, and interviewer

[2] Total PA is the sum of light, moderate, and vigorous intensity PA. Total PA is also the sum of sports and household PA

[3] Light intensity: < 3 METs

[4] Moderate intensity: 3 – 6 METs

[5] Vigorous intensity: > 6 METs

*
significantly different from BMI < 25.0 (p < .05)

Φ
significantly different from BMI: 25.0 – 29.9 (p < .05).

**Table 2b**

Adjusted[1] physical activity levels (hrs/week) within the third year after a breast cancer diagnosis by disease stage and ethnicity/race (N = 806)

| | In Situ N = 184 Mean ± SE | Stage I N = 430 Mean ± SE | Stage II & IIIa N = 192 Mean ± SE | P for Trend |
|---|---|---|---|---|
| Total PA[2] | 21.7 ± 1.3 | 22.9 ± 0.8 | 25.6 ± 1.3* | .031 |
| Light-Intensity PA[3] | 15.0 ± 1.1 | 16.2 ± 0.7 | 17.6 ± 1.0 | .081 |
| Moderate-Intensity PA[4] | 6.1 ± 0.5 | 5.9 ± 0.3 | 7.5 ± 0.4*Φ | .031 |
| Vigorous-Intensity PA[5] | 0.6 ± 0.2 | 0.7 ± 0.1 | 0.5 ± 0.2 | .78 |
| Sports/Recreational PA | 2.8 ± 0.3 | 2.9 ± 0.2 | 3.1 ± 0.3 | .53 |
| Household PA | 17.7 ± 1.2 | 18.5 ± 0.8 | 21.0 ± 1.2* | .055 |

| | Black N = 259 Mean ± SE | Non-Hispanic White N = 456 Mean ± SE | Hispanic N = 93 Mean ± SE |
|---|---|---|---|
| Total PA[2] | 22.9 ± 1.9 | 23.0 ± 1.1 | 25.9 ± 1.8 |
| Light-Intensity PA[3] | 18.1 ± 1.6 | 15.2 ± 1.0 | 16.4 ± 1.5 |
| Moderate-Intensity PA[4] | 4.5 ± 0.7 | 7.0 ± 0.4* | 8.4 ± 0.6*Φ |
| Vigorous-Intensity PA[5] | 0.3 ± 0.2 | 0.8 ± 0.1 | 1.1 ± 0.2* |
| Sports/Recreational PA | 1.5 ± 0.5 | 3.5 ± 0.3* | 4.1 ± 0.4* |
| Household PA | 19.4 ± 1.8 | 18.3 ± 1.1 | 20.5 ± 1.7 |

[1] Physical activity levels adjusted for BMI, disease stage, treatment, race, study site, education, season, and interviewer

[2] Total PA is the sum of light, moderate, and vigorous intensity PA. Total PA is also the sum of sports and household PA

[3] Light intensity: < 3 METs

[4] Moderate intensity: 3 – 6 METs

[5] Vigorous intensity: > 6 METs

* significantly different from BMI < 25.0 (p < .05)

Φ significantly different from BMI: 25.0 – 29.9 (p < .05).

**Table 3**

Proportion of breast cancer survivors meeting the Surgeon General's physical activity recommendation[1] by BMI and age (N = 806)

| | All N = 806 | BMI < 25.0 N = 307 | BMI: 25.0 – 29.9 N = 258 | BMI ≥ 30.0 N = 241 | P for Trend |
|---|---|---|---|---|---|
| Moderate- to vigorous-intensity sports/recreational PA | 32% | 44% | 33% * | 19% *Φ | .0001 |
| All types of moderate- to vigorous-intensity PA | 73% | 80% | 73% * | 66% * | .0001 |
| | | < 50 years N = 265 | 50–59 years N = 294 | ≥ 60 + years N = 247 | P for Trend |
| Moderate- to vigorous-intensity sports/recreational PA | | 34% | 32% | 34% | .99 |
| All types of moderate- to vigorous-intensity PA | | 75% | 73% | 73% | .63 |
| | | In Situ N = 184 | Stage I N = 430 | Stage II & IIIA N = 192 | P for Trend |
| All types of moderate- to vigorous-intensity PA | | 71% | 74% | 74% | .47 |
| Moderate- to vigorous-intensity sports/recreational PA | | 29% | 37% | 29% | .94 |
| | | Black N = 259 | Non-Hispanic White N = 456 | Hispanic N = 93 | |
| All types of moderate- to vigorous-intensity PA | | 63% | 77% * | 85% * | |
| Moderate- to vigorous-intensity sports/recreational PA | | 23% | 36% * | 45% * | |

[1] Surgeon General's physical activity recommendation = 30 mins, 5 days per week or 150 mins/week of moderate- to vigorous-intensity physical activity (i.e., ≥ 3 METs)

*
significantly different from BMI < 25.0 or Black women (p < .05)

Φ significantly different from BMI: 25.0 – 29.9 or non-Hispanic women (p < .05).

**Table 4**

Types and duration (hrs/week)[1] of physical activity reported by HEAL participants within the third year after a breast cancer diagnosis by BMI (N = 806)

| Activity Type | MET Level[2] | BMI < 25.0 (N=307) | | | BMI: 25.0 – 29.9 (N=258) | | | BMI ≥ 30.0 (N=241) | | | P for Trend |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | % | Mean ± SE | N | % | Mean ± SE | N | % | Mean ± SE | |
| *Sports/Recreational Activities* | | | | | | | | | | | |
| Moderate/Slow Walking (20–30 min mile) | 2.5 | 228 | 74% | 2.1 ± 0.2 | 191 | 74% | 1.8 ± 0.2 | 192 | 80% | 1.6 ± 0.2* | .031 |
| Fast Walking (15 min mile) | 4.0 | 164 | 53% | 1.5 ± 0.1 | 122 | 47% | 1.4 ± 0.1 | 93 | 39% | 0.9 ± 0.2*ⁿ | .005 |
| Bicycling (including stationary) | 5.5 | 126 | 41% | 0.5 ± 0.1 | 108 | 42% | 0.6 ± 0.1 | 64 | 27% | 0.6 ± 0.1 | .83 |
| Yoga/Stretching | 2.5 | 115 | 37% | 1.0 ± 0.1 | 96 | 37% | 1.1 ± 0.1 | 62 | 26% | 0.8 ± 0.1 | .19 |
| Weight lifting (free or Nautilus) | 3.0 | 91 | 30% | 0.9 ± 0.1 | 75 | 29% | 0.9 ± 0.1 | 36 | 15% | 0.6 ± 0.1 | .15 |
| Hiking/Climbing Mountains | 6.0 | 91 | 30% | 0.7 ± 0.1 | 61 | 24% | 0.5 ± 0.1 | 23 | 10% | 0.7 ± 0.2 | .97 |
| Aerobics/Stairclimber | 6.5 | 77 | 25% | 1.1 ± 0.1 | 49 | 19% | 1.0 ± 0.1 | 43 | 18% | 0.9 ± 0.2 | .32 |
| Fast Dancing (square, line) | 4.5 | 73 | 24% | 0.7 ± 0.2 | 54 | 21% | 0.6 ± 0.3 | 56 | 23% | 0.6 ± 0.3 | .82 |
| Slow Dancing (ballroom, waltz) | 3.0 | 74 | 24% | 0.3 ± 0.2 | 50 | 19% | 0.4 ± 0.2 | 49 | 20% | 0.7 ± 0.2 | .11 |
| Lt. Calisthenics/Water aerobics | 3.5 | 66 | 21% | 0.9 ± 0.1 | 63 | 24% | 1.1 ± 0.1 | 47 | 20% | 1.0 ± 0.1 | .61 |
| Jogging (13–14 min mile) | 7.0 | 55 | 18% | 0.8 ± 0.1 | 35 | 14% | 0.7 ± 0.1 | 18 | 7% | 0.6 ± 0.2 | .43 |
| Swimming laps | 7.0 | 45 | 15% | 0.6 ± 0.2 | 27 | 10% | 0.4 ± 0.3 | 18 | 7% | 0.9 ± 0.3 | .44 |
| Healthrider/Rowing | 7.0 | 24 | 8% | 0.5 ± 0.1 | 29 | 11% | 0.6 ± 0.1 | 18 | 7% | 0.4 ± 0.2 | .74 |
| Running (10–12 min mile) | 8.0 | 25 | 8% | 3.0 ± 1.3 | 16 | 6% | 0.1 ± 1.6 | 5 | 2% | 0.6 ± 3.2 | .50 |
| Bowling/Horseshoes | 3.0 | 23 | 7% | 1.0 ± 0.5 | 20 | 8% | 1.2 ± 0.5 | 14 | 6% | 0.6 ± 0.6 | .63 |
| Golf | 3.5 | 22 | 7% | 3.0 ± 0.8 | 18 | 7% | 2.5 ± 0.9 | 12 | 5% | 1.2 ± 1.1 | .21 |
| Skiing | 7.0 | 23 | 7% | 1.0 ± 0.4 | 11 | 4% | 0.4 ± 0.6 | 4 | 1% | 1.7 ± 0.9 | .49 |
| Tennis/Racquetball | 7.0 | 19 | 6% | 1.9 ± 0.6 | 11 | 4% | 0.7 ± 0.8 | 3 | 1% | 0.1 ± 1.6 | .27 |
| Nordic Track | 7.0 | 16 | 5% | 0.9 ± 0.2 | 21 | 8% | 0.5 ± 0.2 | 8 | 3% | 0.7 ± 0.3 | .69 |
| Horseback riding | 4.0 | 11 | 4% | 1.6 ± 1.1 | 6 | 2% | 2.7 ± 1.6 | 4 | 1% | 0.6 ± 2.2 | .71 |
| *Household Activities* | | | | | | | | | | | |
| Housework (cooking, laundry) | 2.5 | 301 | 98% | 11.3 ± 0.5 | 250 | 97% | 11.8 ± 0.6 | 235 | 98% | 12.6 ± 0.6 | .10 |
| Housecleaning (mopping, vacuuming) | 3.0 | 283 | 92% | 3.0 ± 0.2 | 227 | 88% | 2.4 ± 0.2* | 209 | 87% | 2.6 ± 0.2 | .19 |
| Yardwork (watering, trimming, weeding) | 3.0 | 229 | 75% | 1.5 ± 0.1 | 176 | 68% | 2.0 ± 0.2* | 145 | 60% | 1.4 ± 2.0 | .53 |
| Gardening (digging, spading, mowing, raking) | 4.0 | 170 | 55% | 0.8 ± 0.1 | 140 | 54% | 0.9 ± 0.1 | 82 | 34% | 0.8 ± 0.1 | .93 |
| Major Housecleaning (scrubbing) | 3.5 | 169 | 55% | 0.4 ± 0.1 | 135 | 52% | 0.5 ± 0.1 | 106 | 44% | 0.4 ± 0.1 | .67 |

| Activity Type | MET Level[2] | BMI < 25.0 (N=307) | | | BMI: 25.0 – 29.9 (N=258) | | | BMI ≥ 30.0 (N=241) | | | P for Trend |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | % | Mean ± SE | N | % | Mean ± SE | N | % | Mean ± SE | |
| Childcare (infants 6 yrs, dressing, feeding) | 2.5 | 74 | 24% | 5.2 ± 1.1 | 72 | 28% | 4.7 ± 1.1 | 86 | 36% | 6.7 ± 1.0 | .31 |
| Home Repair (painting, wallpaper) | 3.0 | 73 | 24% | 1.0 ± 0.2 | 60 | 23% | 1.6 ± 0.2 | 35 | 15% | 0.7 ± 0.3 | .46 |
| Caretaking (disabled/elderly, lifting, grooming) | 2.5 | 40 | 13% | 9.9 ± 2.4 | 29 | 11% | 11.7 ± 2.7 | 28 | 12% | 12.6 ± 2.8 | .47 |
| Chopping wood | 6.0 | 13 | 4% | 0.1 ± 0.1 | 7 | 3% | 0.1 ± 0.1 | 5 | 2% | 0.5 ± 0.1*Φ | .036 |

[1] Adjusted for age, race, disease stage, study site, season, and interviewer

[2] MET levels obtained from the Compendium of Physical Activities (ref # 1).