RESEARCH COMMUNICATION

Body Size, Physical Activity and Risk of Breast Cancer – A Case Control Study in Jangsu Province of China

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Abstract

To evaluate the relationship between body size, physical activity and risk of breast cancer, we conducted a case-control study with 669 cases and 682 population-based controls in Jiangsu Province of China. A structured questionnaire was used to elicit detailed information. All subjects completed an in-person interview. The body mass index (BMI) was calculated based on weights and heights. Unconditional logistic regression analysis was performed to calculate odds ratios (ORs) and 95% confidence intervals (CIs) as measures of risk for breast cancer. Current height, weight and weight at around age 20 years were significantly positively correlated with risk of breast cancer. Obese women (current BMI ≥25 kg/m^2) were at significantly increased risk for developing breast cancer (adjusted OR=1.35, 95%CI: 1.01-1.81), but, between BMI at around age 20 years and risk of breast cancer showed an inverse association (P for trend = 0.001). Women who had middle physical force work were at significantly lowered OR (0.62, 95%CI: 0.41-0.93) compared with women of headwork. Using women who standing or ambulation per day less than one hour as the reference, women who standing or ambulation more than one hour had a decreased risk of breast cancer. Using women who slept less than 5 hours per day as the reference, the women who slept 5-8 hours were at significantly decreased risk of breast cancer. Women who had habit of recreational physical activity were at significantly decreased risk (adjusted OR=0.68, 95%CI: 0.53-0.88), with an inverse association between the exercise times per week and risk of breast cancer (P for trend = 0.025). These findings support that breast cancer risk is associated with body size, and that moderate occupational and recreational physical activity has protective effects on breast cancer.

Key Words: Breast cancer - body size - physical activity

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Introduction

Breast cancer is the commonest cancer in women of worldwide. Although the incidence rate of breast cancer in China is much lower than those in Western countries, there has been a marked increase in recent years, cancer registries in China are recording annual increases in incidence of 3% to 4% (Parkin et al., 2005). From 2000 to 2005, very large increases in the number of cases of female breast cancers (+38.5%) are predicted (Yang et a.l, 2005). This large increase in cancer risk is responsible for a 27.5% increase in the number of cases, whereas population growth and aging contribute a further 11% increase (Yang et al., 2005). Along with the development of society-economy of China, the lifestyle of people also take placed very big variety. The proportion of overweight adults was doubled during last two decades, and this increase was more prominent among motor vehicle owners, indicating decreased physical activity levels could be partly responsible for increases in body weight among Chinese populations (Popkin et al., 2001; Bell et al., 2002) Together, changes in these lifestyle factors among Chinese women, including decreased physical activity and increased body weight, may be partially responsible for this rapid increase in breast cancer (Bell et al., 2002). In present study, we evaluated the effect of body size, occupational and recreational physical activity and sleep duration on breast cancer risk in Chinese women.

Materials and Methods

Study Subjects

We recruited breast cancer cases using data of the Cancer Registries in Taixing, Wuxi, Jintan and Huian Cities of Jiangsu Province of China, and also recruited cases who visited Jiangsu Province Cancer Hospital from

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Table 1.Comparison of Cases and Controls by Selected Descriptive Characteristics (n,%)

	Cases (n=669)	Controls (n=682)	2 χ	P
Age (years)				
<40	76 (11.4)	87 (12.8)	0.978	0.807
40-49	226 (33.8)	229 (33.6)		
50-59	227 (33.9)	234 (34.3)		
≥60	140 (20.9)	132 (19.4)		
Menopausal status				
Postmenopausal	360 (53.8)	390 (57.2)	1.555	0.212
Premenopausal	309 (46.2)	292 (42.7)		
Menarche				
≤13	180 (26.9)	141 (20.7)	8.449	0.038
at 14	211 (31.5)	216 (31.7)		
at 15	191 (28.6)	219 (32.1)		
≥16	87 (13.0)	106 (15.5)		
Parity				
0	32 (4.78)	14 (2.05)	10.76	0.013
1	337 (50.4)	340 (49.9)		
2	181 (27.1)	177 (26.0)		
3+	119 (17.8)	151 (22.1)		
Income/month				
Low	171 (25.6)	259 (38.0)	30.79	0.001
Middle	230 (34.4)	232 (34.0)		
High	268 (40.1)	191 (28.0)		
Smoking status				
Never	653 (97.6)	677 (99.3)	8.066	0.018
Ever	10 (1.49)	1 (0.15)		
Current	6 (0.90)	4 (0.59)		
Alcohol drinking status				
Never	637 (95.2)	662 (97.1)	7.497	0.024
Ever	14 (2.09)	3 (0.44)		
Current	18 (2.69)	17 (2.49)		
Recreational physical activity				
Never	501 (74.9)	468 (68.3)	6.534	0.011
Have	168 (25.1)	214 (31.4)		
Family history				
No	637 (95.2)	674 (98.8)	15.31	0.001
Yes	32 (4.78)	8 (1.17)		

these cities from June 2004 to December 2007. All cases were histopathologically diagnosed as having a primary breast cancer. Physicians at the hospital asked eligible cases to participate in our study, and doctors or nurses interviewed the subjects after obtaining informed consent. Population-based controls were selected from healthy residents in eleven villages or towns of Taixing, Wuxi, Jintan and Huian Cities. Doctors of the public health centers randomly selected one or two controls for each case, after matching for ethnicity and age within 2 years using the records of residents at the local governmental office, and then asked eligible residents for their participation. Interviews were performed as for the cancer cases. Totals of 669 cases and 682 controls completed interview. A few patients and residents refused to participate in our study, but the response rates were 98% for cases and 99% for controls. The ethics committee of Jiangsu Province Institute of Cancer Research approved this study.

Data Collection and Statistical Analysis

A structured questionnaire was used to elicit detailed information on demographic background, socioeconomic status, tobacco and alcohol use, dietary habits, lifetime occupational history, physical activity, height and weight, menstrual and reproductive history, and family history of cancer. All subjects completed an in-person interview. The body mass index (BMI) was calculated based on weights and heights, and stratified into three categories (<22, 22-24.9, ≥25). Tertile distributions of mean income every person per month in family, weight and height among controls were used to categorize the variables. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated by unconditional logistic regression analysis adjusted for potential confounders. All the analyses were performed in SAS 8.02 (SAS Institute Inc., Cary, NC). All tests were two-sided, with the significance level of 0.05.

Table 2. Effects of ORs for Breast Cancer According to Height,Weight and BMI

	Cases	Controls	OR* (95%CI)
Current height (cm)			
≤155	154 (23.0)	225 (33.0)	1.00
156-159	171 (25.6)	187 (27.4)	1.32 (0.96-1.82)
≥160	344 (51.4)	270 (39.6)	1.99 (1.50-2.64)
P for trend			0.001
Current weight (kg)			
≤54	199 (29.8)	243 (35.6)	1.00
55-59	135 (20.2)	144 (21.1)	1.17 (0.86-1.60)
≥60	335 (50.1)	295 (43.3)	1.48 (1.14-1.91)
P for trend			0.008
Current BMI			
≤22	225 (33.6)	244 (35.8)	1.00
22-24.9	256 (38.3)	282 (41.4)	1.00 (0.77-1.29)
≥25	188 (28.1)	156 (22.9)	1.35 (1.01-1.81)
P for trend			0.079
Height at around age 20 (cm)			
≤155	152 (22.7)	221 (32.4)	1.00
156-159	166 (24.8)	188 (27.6)	1.28 (0.93-1.75)
≥160	351 (52.5)	273 (40.0)	2.00 (1.51-2.65)
P for trend			0.001
Weight at around age 20 (kg)			
≤50	290 (43.4)	258 (37.8)	1.00
51-59	220 (32.9)	252 (37.0)	0.81 (0.62-1.04)
≥60	159 (23.8)	172 (25.2)	0.91 (0.68-1.22)
P for trend			0.105
BMI at around age 20 (kg)			
≤22	434 (64.9)	370 (54.3)	1.00
22-24.9	176 (26.3)	236 (34.6)	0.65 (0.51-0.83)
≥25	59 (8.82)	76 (11.1)	0.62 (0.42-0.91)
P for trend			0.001

*ORs were adjusted for age menopausal status, recreational physical activity, status of smoking and drinking, family history, menarche age and parity; data are No.(%)

Results

The characteristics of cases and controls are summarized in Table1. There were no significant differences between cases and controls in distribution of age and menopausal status. However, significant differences were found for menarche age, parity, mean income every person per month in family, status of smoking and alcohol drinking, recreational physical activity and family history of breast cancer. The group of cases had an earlier menarche age, less numbers of parity,

higher income and less never smokers and drinkers comparison with controls. Persons who had habit of recreational physical activity among the controls were significantly more than the cases. Persons who had family history of breast cancer among the controls were significantly less than the cases.

Data for associations between height, weight and BMI and breast cancer risk are presented in Table 2. There were significant positive association between current height, current weight and risk of breast cancer. As compared with the lowest tertile of current height, women in the highest tertile were at an increased risk of developing breast cancer. Women in the highest tertile of current weight had a 1.48-fold risk of breast cancer as compared to the lowest tertile. Obese women were also at increased risk. Similarly, ORs were calculated for height, weight and BMI at around age 20 years. The taller women at around age 20 years also were at an increased risk of developing breast cancer, but between BMI at around age 20 years and risk of breast cancer showed an inverse association.

Data for associations between the work intensity of occupation, time of standing or ambulation per day and sleep duration and the risk of breast cancer are presented in Table 3. After adjusting for age, menopausal status, recreational physical activity, current BMI, income every person every month in family, status of smoking and alcohol drinking, family history, menarche age and parity, women who had middle physical force work were at significantly lowered OR (0.62, 95%CI: 0.41-0.93) compared with women of headwork. Using women who standing or ambulation per day less than one hour as the reference group, women who standing or ambulation per day more than one hour had a decreased risk of breast cancer. Using women who slept less than 5 hours as the reference group, we found sleep duration also affect breast cancer risk. The ORs for breast cancer of women who slept 5-8 hours were significantly decreased.

Table 4 presents the risk of breast cancer in relation to recreational physical activity. After adjusting for age, menopausal status, BMI, work intensity of occupation, mean income every person per month in family, status of smoking and alcohol drinking, family history of breast cancer, menarche age and parity, women who had habit of recreational physical activity were at significantly decreased OR (0.68, 95%CI: 0.53-0.88), with an inverse association between the exercise times per week and risk of breast cancer (P for trend = 0.025). Women who exercised 60-180 minutes per week were at a significantly decreased OR for breast cancer.

Table 3. Occupational Work Intensity, Time of Standing or Ambulation per Day and Sleep Duration and Risk of Breast Cancer

	Cases	Controls	OR* (95%CI)
Work intensity of occupation			
Headwork	91 (13.6)	62 (9.09)	1.00
Light physical	236 (35.3)	228 (33.4)	0.93 (0.61-1.43)
Middle	312 (46.6)	377 (55.3)	0.62 (0.41-0.93)
Heavy	30 (4.48)	15 (2.20)	1.06 (0.46-2.44)
P for trend			0.032
Time of standing or ambulating (hr/d)			
almost none	77 (11.5)	29 (4.25)	1.00
1	90 (13.5)	57 (8.36)	0.49 (0.26-0.91)
3	170 (25.4)	255 (37.39)	0.23 (0.14-0.39)
5	197 (29.5)	242 (35.48)	0.33 (0.19-0.56)
≥7	135 (20.2)	99 (14.52)	0.60 (0.33-1.08)
P for trend			0.020
Sleep duration (hr/d)			
<5	62 (9.27)	28 (4.11)	1.00
5	123 (18.4)	176 (25.81)	0.28 (0.16-0.50)
6	152 (22.7)	185 (27.13)	0.34 (0.20-0.58)
7	225 (33.6)	224 (32.84)	0.50 (0.29-0.86)
≥8	107 (16.0)	69 (10.12)	0.72 (0.38-1.39)
P for trend			0.118

*ORs were adjusted for age, menopausal status, recreational physical activity, BMI, income/month, status of smoking and alcohol drinking, family history, menarche age and parity

Table 4. Recreational Physical Activity and Risk of Breast Cancer

	Cases	Controls	OR* (95%CI)
Recreational physical activity			
Never	501 (74.9)	468 (68.3)	1.00
Have	168 (25.1)	214 (31.4)	0.68 (0.53-0.88)
Exercise times/week			
0	501 (74.9)	468 (68.3)	1.00
≤1	18 (2.69)	18 (2.64)	0.88 (0.44-1.76)
2-3	33 (4.93)	48 (7.04)	0.64 (0.40-1.04)
4-5	28 (4.19)	47 (6.89)	0.57 (0.35-0.94)
≥6	89 (13.3)	101 (14.8)	0.72 (0.52-1.00)
P for trend			0.025
Minutes/ every time in exercise			
0	501 (74.9)	468 (68.3)	1.00
<30	29 (4.33)	52 (7.62)	0.50 (0.31-0.82)
30-59	74 (11.1)	119 (17.5)	0.55 (0.39-0.76)
≥60	65 (9.74)	43 (6.30)	1.23 (0.81-1.87)
P for trend			0.286
Minutes/week in exercise			
0	501 (74.9)	468 (68.3)	1.00
<60	25 (3.74)	30 (4.40)	0.75 (0.42-1.33)
60-119	24 (3.59)	44 (6.45)	0.51 (0.30-0.86)
120-179	27 (4.04)	58 (8.50)	0.43 (0.26-0.70)
≥180	92 (13.8)	82 (12.0)	0.91 (0.65-1.28)
P for trend			0.107

*ORs were adjusted for age, menopausal status, recreational physical activity, BMI, income/month, status of smoking and alcohol drinking, family history, menarche age and parity

Discussion

Body size has been found to be associated with risk of breast cancer in many epidemiological studies (Lubin et al, 1985; Willett et al, 1985; Marchand et al, 1988; Chu et al, 1991; Brinton et al, 1992; Pathak et al, 1992; Radimer et al, 1993; Ballard-Barbash, 1994; Chie et al, 1996; Huang et al, 1997; Franceschi et al, 1996; Trentham-Dietz et al, 1997; Sonnenschein et al, 1999). In China, the incidence rate of female breast cancer is much lower than in Western countries, and Chinese women are generally shorter and lighter than women in Western countries. Therefore we examined whether BMI exhibited a positive association with breast cancer in Chinese, as had been observed in Western countries. In present study, we found that current height, weight and BMI were related to

increased risk of breast cancer, whereas the BMI at around age 20 years was inverse association with risk of breast cancer. These findings are consistent with the observed in Japanese by Hirose et al (1999).

In the present study, we found that sleep duration affects breast cancer risk Moderate sleep duration may decrease risk of breast cancer. Melatonin is suggested to be involved in this relationship with sleep duration, a decrease that results in a shorter duration of nocturnal melatonin secretion (Wehr, 1991). A lower melatonin level was associated with an increased risk of breast cancer (Schernhammer and Hankinson, 2005; Schernhammer et al., 2008). There have been four prospective cohort studies of breast cancer in relation to sleep duration (Verkasalo et al., 2005; Pinheiro et al., 2006; Kakizaki et al., 2008; Wu et al., 2008), of which the last three reported a significantly decreased risk in long sleepers. But, another study reported no such association (Pinheiro et al., 2006), possibly studied because residential nurses were studied with rotating-shift work and varying timing of sleep, so that generalising from their results may be inappropriate.

Numerous pieces of epidemiological evidence suggest that physical activity may affect breast cancer risk (Friedenreich., 2002; 2004; Vainio et al., 2002; Monninkhof et al. 2007; Shin et al., 2008; Pan et al., 2009). The association was shown for both occupational and recreational physical activity, activity at different periods of life, and at different level of intensity of physical activity, and the association is independent of weight gain (Pan et al., 2009). A systematic review of 19 cohort studies and 29 case control studies (Monninkhof et al., 2007) demonstrated a 15–20% reduction in breast cancer risk with physical activity and a 6% (95% CI, 3–8%) decrease in breast cancer risk for each additional hour of physical activity per week. This review showed a decreased relative risk associated with leisure activities in 8 of 17 cohort studies, whereas the remaining 9 reported no association (Monninkhof et al., 2007). Three more recent cohort studies supported the risk reduction (Lahmann et al., 2007; Dallal et al., 2007; Bardia et al., 2006), whereas one found no evidence of a protective effect of physical activity on breast cancer (Mertens et al., 2006). In present study, we found that occupational work intensity and time of standing or ambulation per day are inverse association with risk of breast cancer. We also found that recreational physical activity may decrease risk of breast cancer. Our results support that physical activity has a protective effect on breast cancer.

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References

Ballard-Barbash R (1994). Anthropometry and breast cancer. *Cancer*, **74**, 1090-100.

Bardia A, Hartmann LC, Vachon CM, et al (2006). Recreational physical activity and risk of postmenopausal breast cancer based on hormone receptor status. *Arch Intern Med*, **166**, 2478-83.

Bell AC, Ge K, Popkin BM, et al (2002). The road to obesity or the path to prevention: motorized transportation and obesity in China. *Obes Res*, **10**, 277-83.

Brinton LA, Swanson CA (1992). Height and weight at various ages and risk of breast cancer. *Ann Epidemiol*, **2**, 597-609.

Chu SY, Lee NC, Wingo PA, et al (1991). The relationship between body mass and breast cancer among women enrolled in the cancer and steroid hormone study. *J Clin Epidemiol*, **44**, 1197-206.

Chie WC, Chen CF, Lee WC, et al (1996). Body size and risk of pre- and post-menopausal breast cancer in Taiwan. *Anticancer Res*, **16**, 3129-32.

Dallal CM, Sullivan-Halley J, Ross RK, et al (2007). Long-term recreational physical activity and risk of invasive and in situ breast cancer: the California teachers study. *Arch Intern Med*, **167**, 408-15.

Franceschi S, Favero A, Vecchia EL, et al (1996). Body size indices and breast cancer risk before and after menopause. *Int J Cancer*, **67**, 181-6.

Friedenreich CM, Orenstein MR (2002) Physical activity and cancer prevention: etiologic evidence and biological mechanisms. *J Nutr*, **132**, 3456S-64S.

Friedenreich CM (2004). Physical activity and breast cancer: the effect of menopausal status. *Exerc Sport Sci Rev*, **32**, 180-4.

Hirose K, Tajima K, Hamajima N, et al (1999). Effect of body size on breast-cancer risk among Japanese women. *Int J Cancer*, **80**, 349-55.

Huang Z, Hankinson SE, Colditz GA, et al (1997). Dual effects of weight and weight gain on breast cancer risk. *J Am Med Assoc*, **278**, 1407-11.

Kakizaki M, Kuriyama S, Sone S, et al (2008) Sleep duration and the risk of breast cancer: the Ohsaki Cohort Study. *Br J Cancer*, **99**, 1502-5.

Lahmann PH, Friedenreich C, Schuit AJ, et al (2007). Physical activity and breast cancer risk: the European Prospective Investigation into Cancer and Nutrition. *Cancer Epidemiol Biomarkers Prev*, **16**, 36-42.

Le Marchand L, Kolonel LN, Earle ME, et al (1988). Body size at different periods of life and breast cancer risk. *Am J Epidemiol*, **128**, 137-52.

Lubin F, Ruder AM, Wax Y, et al (1985). Overweight and changes in weight throughout adult life in breast cancer etiology. *Am J Epidemiol*, **122**, 579-88.

Mertens AJ, Sweeney C, Shahar E, Rosamond WD, Folsom AR (2006). Physical activity and breast cancer incidence in middle-aged women: a prospective cohort study. *Breast Cancer Res Treat*, **97**, 209-14.

Monninkhof EM, Elias SG, Vlems FA, et al (2007). Physical activity and breast cancer: a systematic review. *Epidemiology*, **18**, 137-57.

Pan SY, DesMeules M (2009). Energy intake, physical activity, energy balance, and cancer: epidemiologic evidence. *Methods Mol Biol*, **472**, 191-215.

Parkin DM, Bray F, Ferlay J, Pisani P (2005). Global cancer statistics, 2002. *CA Cancer J Clin*, **55**, 74-108.

Pathak DR, Whittemore AS (1992). Combined effects of body size, parity, and menstrual events on breast cancer incidence in seven countries. *Am J Epidemiol*, **135**, 153-68.

Pinheiro SP, Schernhammer ES, Tworoger SS, Michels KB (2006). A prospective study on habitual duration of sleep and incidence of breast cancer in a large cohort of women. *Cancer Res*, **66**, 5521-5.

Popkin BM, Horton S, Kim S, et al (2001). Trends in diet, nutritional status, and diet-related noncommunicable diseases in China and India: the economic costs of the nutrition transition. *Nutr Rev*, **59**, 379-90

Radimer K, Siskind V, Bain C, et al (1993). Relation between anthropometric indicators and risk of breast cancer among Australian women. *Am J Epidemiol*, **138**, 77-89.

Schernhammer ES, Hankinson SE (2005). Urinary melatonin levels and breast cancer risk. *J Natl Cancer Inst*, **97**, 1084-7.

Schernhammer ES, Berrino F, Krogh V, et al (2008). Urinary 6-sulfatoxymelatonin levels and risk of breast cancer in postmenopausal women. *J Natl Cancer Inst*, **100**, 898-905.

Shin A, Matthews CE, ShuXO, et al (???). Joint effects of body size, energy intake, and physical activity on breast cancer risk. Breast Cancer Res Treat, DOI 10.1007/s10549-008-9903-x..

Sonnenschein E, Toniolo P, Terry MB, et al (1999). Body fat distribution and obesity in pre-and postmenopausal breast cancer. *Int J Epidemiol*, **28**, 1026-31.

Trentham-Dietz A, Newcomb PA, Storer BE, et al (1997). Body size and risk of breast cancer. *Am J Epidemiol*, **145**, 1011-9.

Vainio H, Kaaks R, Bianchini F (2002) Weight control and physical activity in cancer prevention: international evaluation of the evidence. *Eur J Cancer Prev*, **11 Suppl 2**, S94-100.

Verkasalo PK, Lillberg K, Stevens RG, et al (2005). Sleep duration and breast cancer: a prospective cohort study. *Cancer Res*, **65**, 9595-600.

Wehr TA (1991).The durations of human melatonin secretion and sleep respond to changes in daylength (photoperiod). *J Clin Endocrinol Metab*, **73**, 1276-80.

Willett WC, Brown MD, Bain BC, et al (1985). Relative weight and risk of breast cancer among premenopausal women. *Am J Epidemiol*, **122**, 731-40.

Wu AH, Wang R, Koh WP, et al (2008). Sleep duration, melatonin and breast cancer among Chinese women in Singapore. *Carcinogenesis*, **29**, 1244-8.

Yang L, Parkin DM, Ferlay J, Li LD, Chen YD (2005). Estimates of cancer incidence in China for 2000 and projections for 2005. *Cancer Epidemiol Biomarkers Prev*, **14**, 243-50.