

Original Article

Relationship between body mass index and incidence of breast cancer

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Abstract: Objective: To investigate the relationship between body mass index (BMI) and the breast cancer incidence, so as to making contribution to breast cancer screening in high-risk groups, to adjustment from passive medical treatment to active treatment Methods: BMI status of 206 breast cancer patients and that of 210 healthy subjects at different ages were compared and analyzed. Results: The mean BMI was significantly higher in breast cancer patients than in healthy subjects 24.45 ± 3.50 vs. 23.80 ± 3.10 kg/m², $t = -2.189$, $P = 0.001$. When stratified by age, BMI were significantly higher in ≥ 60 age for breast cancer than that of control group ($Z = -3.408$, $P = 0.001$) and no significant difference in < 60 years old. Logistic regression analysis showed that BMI was a risk factor of breast cancer (OR = 1.886, 95% CI: 1.122-3.009). Conclusion: BMI have a relationship with the occurrence of breast cancer, especially for ≥ 60 years old.

Keywords: Obesity, body mass index, breast cancer

Instruction

It was shown from studies that obesity is associated with the incidence of breast cancer [1-3]. Overweight patients with breast cancer often have higher mortality rate than patients with normal weight. Obesity is a factor leading to poor prognosis in breast cancer [4-6]. At present, body mass index (BMI) is applied to measure whether a person is obese or not. Both the weight and the height of the body are considered in BMI, which reflect the relationship between body mass and height. BMI is easy to measure, and it is currently the standard index used internationally to measure the extent of obesity and to evaluate the overall fitness. In this study, we reviewed the BMIs of 206 patients with breast cancer and 210 healthy individuals to discuss the correlation between BMI and breast cancer pathogenesis in Chinese female patients with breast cancer.

Materials and methods

Subjects

Case group: retrospective analysis was conducted in patients with breast cancer admitted from January, 2012 to September, 2014 for

surgical treatment. Patients that meet the following criteria were selected: ① pathologically diagnosed with breast cancer for the first time; ② at least 20-year old. As a result, 206 female patients aged 27-86 were selected, with the median age of 53 years old. The control group consisted of healthy individuals that have participated in our cancer screening program from January, 2012 to September, 2014 and meet the following criteria: ① no breast lumps as evidenced by the screening; ② no breast diseases identified in the follow-up molybdenum target X-ray photography or ultrasonography, with a BIRADS category of 1 or 2; ③ females at least 20-year old; ④ not pregnant; ⑤ not carrying any other kind of malign tumor.

210 healthy individuals were selected in cross sections across age groups that roughly correspond with the age groups of patients from the case group. Only female subjects aged 28-85 years old were selected, with the median age of 53-year old.

Research contents

For the case group, the age, gender, height and weight upon admission, pathological diagnosis of each patient was surveyed. For the control

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Table 1. Comparison of BMI across different age groups in case group and control group

Age	Case group		Control group		T	P
	Case number	BMI (kg/m ²)	Case number	BMI (kg/m ²)		
20-	2	21.67±1.32	2	22.36±3.07	-0.292	0.798
30-	19	23.24±3.78	18	23.47±3.16	-0.200	0.843
40-	57	24.43±3.12	64	23.46±2.66	1.846	0.0674
50-	72	25.17±3.46	67	24.98±3.44	0.324	0.746
60-	32	25.21±2.90	36	23.90±2.10	2.150	0.0352
70-	20	25.51±2.40	20	24.05±2.11	2.043	0.0480
80-	4	22.86±5.06	3	22.19±3.26	0.198	0.851
Total	206	24.45±3.50	210	23.80±3.10	2.006	0.046

Table 2. Comparison of BMI between case group and control group after grouping by age

BMI (kg/m ²) value	Case group (%)	Control group (%)	Z	P value
<60				
<18.5	3	3	Z=-0.294	0.769
18.5~23.9	52	56		
24.0~27.9	47	49		
≥28.0	48	43		
Total	150	151		
≥60				
<18.5	3	2	Z=-3.408	0.001
18.5~23.9	15	28		
24.0~27.9	13	20		
≥28.0	25	9		
Total	56	59		

group, the age, gender, height and weight of each individual was researched. In addition, clinical physical examination, molybdenum target X-ray photography or ultrasonography for each individual in control group were also conducted in order to determine that nobody suffered from breast diseases and rule out other malign tumors in other parts of the body. BMI was used to assess the extent of obesity. BMI= weight (kg)/height² (m²).

In both groups, the individuals were further divided into four groups based on the standards on obesity and overweight published by the Working Group on Obesity in China [7]. These four groups were: underweight group, with BMI <18.5 kg/m²; normal range group, with BMI in the range of 18.5-23.9 kg/m²; overweight group, with BMI in the range of 24.0-

27.9 kg/m²; and obese group, with BMI ≥28.0 kg/m².

Statistical analysis

All data were analyzed by using SPSS13.0. General data were presented in frequencies. Data following normal distribution were presented in mean value and standard deviations. T-test was performed to evaluate the difference in BMI between case group

and control group. Unconditional binary logistic regression was performed to assess the factors impacting onset risk of breast cancer. $P<0.05$ was considered statistically significant.

Results

Mean BMI across different age groups in case group and control group

The mean BMI was 24.45±3.50 kg/m² in case group and 23.80±3.10 kg/m² in control group. The case group had a higher BMI than control group. The difference was statistically significant ($P<0.05$). The BMI of the 60 and 70 age groups in case group were significantly higher than that in control group ($P<0.05$), see **Table 1**.

Comparison of mean BMI in cross sections of age groups between case group and control group

All subjects were grouped according to BMI and divided into subgroups by age. Two-sample rank sum test was performed. The results showed that, among the individuals in case group, 150 patients (72.82% of the case group) were less than 60-year old. The mean BMI of these patients did not differ significantly from that of the corresponding subgroup in control group (151 individuals). 56 patients (27.18% of the case group) were at least 60-year old. The mean BMI of these patients was higher than that of the corresponding subgroup in control group (59 individuals). The difference was statistically significant ($P<0.01$). Furthermore, the obese population proportion at least 60-year

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Table 3. Logistic regression analysis result of risk factor of breast cancer

Projects	β	Wald χ^2	P	OR	95% CI
Age*	-0.420	1.566	0.218	0.672	0.316-1.270
BMI				0.982	0.870-1.107
<18.5		7.212	0.065	1.026	0.901-1.378
18.5~	-0.399	3.598	0.057	0.670	0.447-1.008
24~	0.188	1.080	0.294	1.198	0.854-1.699
≥ 28.0	0.629	5.679	0.009	1.889	1.119-3.176

*The groups were divided into subgroups with an interval of 9 years old.

old in case group was significantly higher than that in control group (70.43% vs. 42.07%). See **Table 2**.

Logistic regression of BMI and age of breast cancer patients

The groups were divided into subgroups by age, with an interval of 9 years. The results of Logistic regression showed that an elevated BMI was a major risk factor of incidence of breast cancer (OR=0.982, 95% CI: 0.870-1.107). The obese group (BMI \geq 28.0) had a significantly higher incidence of breast cancer than the underweight group (BMI<18.5). These data suggested that age is not a statistically significant factor related to the incidence of breast cancer. See **Table 3**.

Discussion

Currently, obesity is a major health issue in the world [8]. Obesity is associated with hypertension, cardiovascular diseases, type II diabetes, and dyslipidemia. Moreover, it is also associated with the pathogenesis and development of several types of cancer, including endometrial carcinoma, ovarian cancer, colorectal cancer, head and neck cancers, etc. [9, 10]. Association between obesity and the incidence of breast cancer has also been reported in foreign countries [11]. Among Chinese population, female individuals tend to have a higher amount of lipid when compared to western female individuals with the same BMI. Therefore, a higher BMI could present an even greater risk factor of the incidence of breast cancer for these individuals. However, it is worth noting that the incidence of breast cancer is lower in China, which suggests that the established studies in western countries on how BMI is associated with

the incidence of breast cancer might not fully apply to Chinese population. In addition, studies have suggested that the impact of BMI on incidence of breast cancer might be race-dependent [12]. Thus, elucidating the exact correlation between BMI and incidence of breast cancer among Chinese female will contribute to the discovery and the characterization of the risk factors of breast cancer. It will also facilitate public education to raise awareness of cancer prevention. Finally, it could improve the prognosis and the devising of therapeutic regimen against breast cancer.

BMI, a value that assesses both the weight and the height of the body, is currently the standard index used internationally to measure the extent of obesity and to evaluate the overall fitness. This index is thought to reliably reflect the status of protein-energy malnutrition or obesity. BMI was used in this study to assess obesity to minimize the impact of height on the study results. With the characteristics of BMI among Chinese people, the 206 patients from case group and the 210 healthy individuals from control group were further divided into four groups for studying based on their BMI measurements. This was to minimize any impacts on the results that arisen from inappropriate grouping of subjects.

The mean BMI was 24.45 \pm 3.50 kg/m² in case group and 23.80 \pm 3.10 kg/m² in control group based on the retrospective study on 206 patients with breast cancer and 210 healthy individuals. The difference was statistically significant (t=-2.189, P<0.001). This result showed that the mean BMI of patients diagnosed with breast cancer was higher than that in control group. Moreover, the mean BMI of the age groups with age 60 and above was significantly higher than that of the corresponding subgroup in control group, suggesting that obesity is a risk factor associated with breast cancer, especially so for elder female individuals.

This data suggests that obese females at 60 years or older have increased risk of breast cancer. Females at 60 years or older are in the post-menopause stage, at which point the endogenous sex hormone levels change significantly compared to pre-menopause levels, creating a great impact on the health of females in this age. Specifically, an increased level of estrogen has been confirmed to lead to oncogenesis, development, and malignancy of

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breast cancer in females that have reached their menopause [13]. For women in their menopause, the body utilizes aromatase to convert androgen (testosterone) to estrogen as the hypofunction of ovary. Estrogen serves as a mitogen of mammary gland cells, promoting proliferation of these cells via transcriptional activity mediated by estrogen receptor and downstream intracellular signaling pathways [14]. Obese female individuals in menopause have higher expression level of aromatase in their adipose tissues than female individuals with normal BMI in their menopause. This leads to elevated endogenous estrogen level in obese females and proliferation of mammary gland cells. The thickening of subcutaneous adipose tissue can lead to an increased level of 17β -hydroxysteroid dehydrogenase in the body, which in turn promotes conversion of androstenedione to androgen, thereby indirectly increasing the level of estrogen level [15-18]. Thus, for females in menopause, obesity leads to increased incidence of breast cancer [19-21].

In this study, logistic regressions were performed with the age and BMI as independent variables. The results showed that BMI is an independent risk factor contributing to incidence of breast cancer (OR=0.982). Thus, it can be concluded that BMI is associated with incidence of breast cancer in Chinese females. The obese group (BMI \geq 28.0) tends to have a higher incidence of breast cancer than underweight group (BMI<18.5).

Elucidating the exact correlation between BMI and the incidence of breast cancer among Chinese females will contribute to the discovery and the characterization of the risk factors of breast cancer. The prevention of obesity can be used as a strategy to actively prevent breast cancer, and thereby reduce the financial expenditure on medical resources to a certain extent. Finally, this could contribute to the improvement of public education regarding the prevention of breast cancer.

Disclosure of conflict of interest

None.

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