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The relationships between breast volume, breast dense volume and volumetric breast density with body mass index, body fat mass and ethnicity

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Abstract. It has been shown that breast density and obesity are related to breast cancer risk. The aim of this study is to investigate the relationships of breast volume, breast dense volume and volumetric breast density (VBD) with body mass index (BMI) and body fat mass (BFM) for the three ethnic groups (Chinese, Malay and Indian) in Malaysia. We collected raw digital mammograms from 2450 women acquired on three digital mammography systems. The mammograms were analysed using Volpara software to obtain breast volume, breast dense volume and VBD. Body weight, BMI and BFM of the women were measured using a body composition analyser. Multivariable logistic regression was used to determine the independent predictors of increased overall breast volume, breast dense volume and VBD. Indians have highest breast volume and breast dense volume followed by Malays and Chinese. While Chinese are highest in VBD, followed by Malay and Indian. Multivariable analysis showed that increasing BMI and BFM were independent predictors of increased overall breast volume and dense volume. Moreover, BMI and BFM were independently and inversely related to VBD.

1. Introduction

Previous studies have shown that breast cancer has been linked to obesity [1, 2] and also to breast density [3, 4]. Breast tissue is often regarded as consisting of two components, adipose and fibroglandular (dense) tissues. The ratio of the fibroglandular tissue volume to the total breast volume, expressed in percentage, is termed volumetric breast density (VBD). Overweight and obese women tend to have larger breast volumes compared to slimmer women, and subsequently lower overall VBD. In addition, previous studies have shown that breast volume may be a useful metric for plastic surgery and breast conservation surgery, as it can help the surgeon to predict the aesthetic effect of various breast surgeries on women and offer the most appropriate treatment decision. Measurement of breast volume also allows for better surgical planning and implant selection in breast reconstruction. The aim of this study was to investigate the association of breast volume, breast dense volume and VBD with anthropomorphic parameters such as body mass index (BMI), body fat mass (BFM) and ethnicity in an Asian women setting.

2. Materials and methods
2.1. Study population
We collected raw digital mammograms from 2450 women (1275 Chinese, 679 Malays and 496 Indians) who underwent mammography examination from June 2012 to August 2014 at the University of Malaya Medical Centre, Kuala Lumpur. Only women with no breast abnormality (BI-RADS 1 to 3) and no breast cancer cases were included in this study.

2.2. Measurement of body parameters
Anthropomorphic parameters were collected for all the subjects involved. The data included body weight, BMI and BFM, which were measured using a body fat analyser (Tanita, Japan).

2.3 Assessment of mammographic density
The mammograms for all the subjects were acquired on three digital mammography systems (General Electronic Essential, Siemens Novation and Hologic Selenia). The images were analyzed using a VBD assessment system (Volpara 1.5.1, Matakina Technology, New Zealand) to obtain breast volume, breast dense volume and VBD values.

2.4 Data analysis
Multivariable logistic regression (SPSS version 16.0) was used to determine the independent predictors of increased overall breast volume, breast dense volume and VBD.

3. Results and discussion
Table 1 shows the demographic information for the three ethnic groups (Chinese, Malay and Indian). The median age of participants was 57 years, with Chinese women (median = 58 years) being significantly older than the Malay (median = 53 years), and Indian women (median = 57 years). Chinese women had significantly lower BMI (median = 23.2 kgm$^{-2}$) compared to their Malay (26.9 kgm$^{-2}$) and Indian (26.1 kgm$^{-2}$) counterparts.

![Figure 1](image1.png)  
**Figure 1.** Box plot of breast volume for the three ethnic groups.

![Figure 2](image2.png)  
**Figure 2.** Box plot of breast dense volume for the three ethnic groups.
The median overall breast volume was highest in Indian women (736 cm\(^3\)) followed by Malay (666 cm\(^3\)), and Chinese women (440 cm\(^3\)); p<0.001 (figure 1). Moreover, breast dense volume was highest in Indian women (58 cm\(^3\)) followed by Malay (55 cm\(^3\)), and Chinese women (48 cm\(^3\)); p<0.001 (figure 2). VBD was highest in Chinese women (median = 9.4%) followed by Malay (8.15%), and Indian women (7.69%); p<0.001 (Fig. 3). This finding is in agreement with the studies reported by Jamal et. al. [5], Zulfiqar et. al. [6] and Mariapun et. al. [7]. Multivariable analysis showed that increasing BMI and BFM were independent predictors of increased overall breast volume and breast dense volume. Moreover, BMI and BFM were independently and inversely related to VBD, whereas ethnicity was independently associated with VBD.

Table 1. Demographic, anthropomorphic and body composition data for the three ethnic groups. The values are presented as median (inter-quartile range).

<table>
<thead>
<tr>
<th></th>
<th>Overall (N= 2450)</th>
<th>Chinese (N= 1275)</th>
<th>Malay (N= 679)</th>
<th>Indian (N= 496)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>57 (50, 63)</td>
<td>58 (52, 65)</td>
<td>53 (47, 59)</td>
<td>57 (50, 63)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>BMI (kg(m^2))</td>
<td>24.9 (22.0, 28.1)</td>
<td>23.2 (21.0,26.05)</td>
<td>26.9 (24.1, 30.15)</td>
<td>26.1 (23.6, 26.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Breast vol (cm(^3))</td>
<td>549 (371, 786)</td>
<td>440 (302.606)</td>
<td>666 (492, 891)</td>
<td>736 (513,1010)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Breast dense vol (cm(^3))</td>
<td>48 (32.8, 72.3)</td>
<td>41 (26.4, 54.4)</td>
<td>55 (43.9, 82.0)</td>
<td>58 (46.5, 94.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>VBD (%)</td>
<td>8.7 (6.3,13.1)</td>
<td>9.4 (6.8,14.0)</td>
<td>8.2 (6.1,12.1)</td>
<td>7.7 (5.8,11.5)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

4. Conclusion
Higher BMI and BFM are predictive of larger breast volumes and larger breast dense (glandular) volumes in Indian women followed by Malay and Chinese women. We also observed that BMI and BFM are inversely associated with VBD across the three ethnic groups in our study.

References

[6] Zulfiqar M, Rohazly I and Rahmah M 2011 Do the majority of Malaysian women have dense breasts on mammogram? *Biomedical imaging and intervention journal* **7** e14


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