

RELIABILITY AND PRELIMINARY VALIDATION OF AN AUTOMATED MAMMOGRAPHIC DENSITY MEASUREMENT ON FFDM: VOLPARA

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Mammographic density is usually measured on a digitized analogue screen-film, typically using a semi-automated, user-defined threshold method that is time-consuming, suffers from within- and between-observer measurement errors and potentially oversimplifies pixel information into a 2D dichotomy (dense or non-dense). Despite these limitations, percent density (PD) is a strong marker of breast cancer risk.

With increasing use of full-field digital mammography (FFDM), a fully-automated standardised and time-efficient measure of PD that also incorporates the true volumetric dimension of mammographic density would be an attractive asset to research and routine clinical use. Volpara™ (Matakina Technology) is a fully-automated volumetric mammographic density measurement tool that (i) standardizes a pre-processed FFDM to account for variations in imaging acquisition parameters (differential compression, plate tilt, exposure) and (ii) calculates the height of dense tissue in each pixel, integrating to give the total volume of dense tissue and percent volumetric density (PVD).

We used Volpara to assess left-right agreement of PVD, reliability between cranio-caudal (CC) and mediolateral oblique (MLO) views, and associations of known determinants of PVD in 273 population-based breast-cancer free women who had undergone four-view FFDM. 138 women were Caucasians in London, UK, aged 50-70 years, who had undergone routine breast screening in the National Health Service; 135 women lived in rural India and had participated in a free once-off breast health check. Between breast/view reliability was assessed using intra-class correlation coefficients (expressed as a percentage of total variance that is between-woman variance). Determinants of density were assessed using linear regression models of PVD on each correlate, adjusting for age, ethnicity and body mass index (BMI).

Median (interquartile range) PVD (left CC views) in Caucasian women was 8.6% (5.4–14.3), derived from 45.4cm³ of dense tissue in a 578.2cm³ breast. In Indian women median PVD was 10.7% (7.4-16.3), but with smaller dense (35.0cm³) and total breast (349.3cm³) volumes. Reliability of a single image's PVD was high; intraclass correlation coefficients were 90.6% for CC and 86.0% for MLO views (all women combined), with corresponding values of 95.0% and 89.4% respectively for a left-right average. For all views, reliability of the total breast volume was >95%, and left breasts tended to be larger than right.

Known correlates of density were significant determinants of PVD:

- PVD declined with increasing age (p=0.080)
- PVD was 2.1% lower (95% Confidence interval (CI): 1.7, 2.5)) in women with a BMI>30 kg/m² compared to women with a BMI<20 kg/m², arising from a much greater non-dense volume (2.3 cm³) and, to a lesser extent, larger dense volume
- PVD was 0.5% (95% CI: 0.1, 0.9) lower in women who had had five pregnancies compared to nulliparous women
- No associations were observed with age at first birth or age at menarche.

These preliminary investigations of the validity and reliability of PVD as measured by the fully-automated Volpara program indicate that the PVD measurements made are consistent with what would be expected of the known epidemiology of mammographic density. Evaluation of Volpara-measured PVD in relation to breast cancer risk is needed.