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Sociodemographic And Breast Density Patterns In Women Undergoing Screening Mammography: Implications For Tailored Screening Protocols

Chia D. Msuega [1], Aligba S. Tornyor [2], Kotor D. Terungwa [2], Agaba C. Oboyi[2]
Department Of Radiology, College Of Health Sciences, Rev. Fr. Moses Orshio Adasu University, Makurdi, Benue State, Nigeria
Department Of Radiology, Benue State University Teaching Hospital, Makurdi, Benue State, Nigeria

Abstract:
Background*: Despite variations in sociodemographic, reproductive, and lifestyle factors that may influence breast cancer risk, mammographic screening still remains uniform/non-tailored in resource-limited settings. Breast density, apart from being a well-established determinant of breast cancer risk, also affects mammographic sensitivity. Understanding breast density patterns can facilitate targeted risk-based screening, boosting early cancer detection, resource allocation and overall screening efficacy. However, there is paucity of empirical data supporting the use of sociodemographic characteristics and breast density in personalized screening. This study, thus examines breast density patterns, sociodemographic associations, and implications for tailored risk-based mammography screening.*
Materials and Methods*: A hospital-based cross-sectional study at Benue State University Teaching Hospital (BSUTH), Makurdi, with retrospective data from 150 women over 40 years old who had screening mammography in August/September 2024.Mammograms were interpreted with ACR BI-RADS lexicon. Sociodemographic, reproductive, and lifestyle data were extracted from clinical records. Data were analyzed using Excel 2016 and SPSS version27 with ANOVA, chi-square, and Pearson's correlation, at $p<0.05$ significance*
Results*: Mean age was 48.9±8.5 years. Three breast density patterns were identified; scattered fibroglandular most common 77(51.3%), followed by almost entirely fatty 50(33.3%) and heterogeneously dense breast 23(15.3%). Breast density correlated significantly with marital status and occupation, and negatively with age ($r=-0.749$, $p<0.001$). Positive associations existed with physical activity, menopausal age, and family history, but not with ethnicity, education, parity, BMI, nor gravidity.*
Conclusion: *Breast density pattern, age and other sociodemographic and lifestyle factors are strongly correlated. This emphasizes the need for risk-based breast cancer screening to improve early detection and reduce screening disparities. However, low rates of participation in routine breast cancer screening suggest insufficient awareness.*
Key Word: *BI-RADS; Breast cancer risk; Breast density patterns; Screening mammography; Sociodemographic factors; Tailored Screening Protocols.*

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I. Introduction

Breast cancer remains a leading cause of morbidity and mortality among women worldwide. A key factor in reducing the mortality from breast cancer is early detection with screening mammography. However, breast density, a condition where dense fibro-glandular tissue appears radiographically similar to tumors, limits the efficacy of mammography and potentially disguise cancers. Women over 40 with dense breast tissue account for around 43% of the population, and are 1.6 to 2 times more likely to develop breast cancer than women with less dense breast tissue.[1,2]

Sociodemographic characteristics, such as age, education, socioeconomic status and ethnicity, play a significant role in both breast density and access to screening programs. Studies, for example, have found that Black women with denser breasts are more likely than white women to suffer from breast cancer. Likewise, women with limited education, discuss breast density less with their doctors, missing opportunities for individualized or modified screening.[3]

The purpose of this study is to explore the association of sociodemographic factors and breast density patterns among women who are screened with mammography to design personalized screening methods that take into account these differences. Nonetheless, current guidelines tend to utilize a uniform non-tailored approach to screening, despite sociodemographic characteristics and breast density being known to affect both

the risk of breast cancer and the effectiveness of screening. This neglect of specific demands for sociodemographic characteristics from patients may translate into disparities in early detection and results. [4]

To date, no studies have been done at our center to evaluate the association between sociodemographic variables and breast density patterns in women receiving screening mammography. Nevertheless, the scientific community in other parts of the world has offered valuable insights into this topic. [1–4] Yet, screening programs often neglect the sociodemographic implications on breast density and cancer risk, particularly in resource-limited regions, leading to higher chances of missing diagnoses.[5] Despite this, there is a lack of empirical data to support the use of sociodemographic characteristics and breast density in personalized screening efforts. [6]

This study aims to close the gap by examining relationships between breast density and sociodemographic characteristics in mammographic screening. In addition, we intend to categorize breast density patterns and document their relationships with variables including age, ethnicity, socioeconomic status, and educational attainment. Thus, producing evidence-based recommendations for risk-driven screening strategies to facilitate early detection and improve screening outcomes.

It is our hope that there will be a significant impact on Clinico-radiologic practice and public health as a result of this research which advocates for a shift from a universal one-size-fits-all screening approach to a more tailored and personalized imaging protocols. By emphasizing breast density and sociodemographic characteristics as critical risk factors for breast cancer, the study will also provide valuable data that can inform policy formulation, guide updates to screening protocols, and support efficient equitable resource allocation globally but especially more so in our environment.

II. Material And Methods

This retrospective cross-sectional study consisted of 150 women aged 40 years or older who came for screening mammography at the Radiology Department of Benue State University Teaching Hospital (BSUTH), Makurdi, between August and September 2024.BSUTH is a tertiary referral center and provides mammographic services to the general public and to individuals referred for screening or diagnostic imaging. The Benue State capital, Makurdi, in North-central Nigeria is accessible by road, rail, air and water. The urban population was estimated at 517,342 in the 2017 census.[7]

Study Design: A hospital-based retrospective cross-sectional descriptive study.

Study Location: The study was conducted at the Radiology Department of Benue State University Teaching Hospital (BSUTH), Makurdi, Benue State, Nigeria.

Study Duration: August and September 2024.

Sample size: 150 participants.

Sample size calculation: The sample size for this study was determined based on the number of eligible women who underwent screening mammography at BSUTH, Makurdi, during the study period. A total enumeration (census) sample strategy[8] was used, because the number of women presenting for screening mammography was rather small. Hence, all women of the age 40 years and above who met the inclusion criteria during the month of August and September 2024 were included in the study. Final sample size was 150 individuals.

Subjects & selection method: The study population was women 40 years and above who underwent screening mammography at BSUTH, Makurdi between August and September 2024 and had complete mammographic records accessible for analysis. A total enumeration (census) sampling method was used to include all 150 eligible women who met the inclusion criteria during the study period.

Inclusion criteria

1. Female patients aged 40 years and above
2. Women who presented for screening mammography at BSUTH between August and September 2024
3. Patients with complete mammographic records available for analysis

Exclusion criteria

1. Women with conditions that potentially influence mammographic interpretation and breast density assessment (e.g., history of mastectomy, breast implants, or technically inadequate mammograms)
2. Women with insufficient mammographic records
3. Women who applied lotions, powders or deodorants to the chest or underarms on the same day of assessment, as these compounds potentially impair mammography images

Procedure methodology

Ethical clearance was obtained from the Health Research Ethics Committee of Benue State University Teaching Hospital with approval number BSUTH/MKD/HREC/2025/154. Access to mammographic records was authorized by the hospital management. As the study was a retrospective evaluation of existing records and previously completed questionnaires, the ethical committee waived the need for fresh informed consent. All data were anonymized before analysis in order to ensure confidentiality and safeguard participant identity in compliance with institutional regulations.

Relevant demographic and clinical information, such as age and mammographic findings, was obtained from the participants' records. Mammographic examinations were performed on a Philips Mammodiagnost 9890 010 83201, model number 06438506, serial/lot number 12060, German-made, year 2006.Conventional screening mammography was used to obtain routine cranio-caudal (CC) and medio-lateral oblique (MLO) views of both breasts. Additional views (e.g., cleavage, magnification and spot compression views) were obtained only where required.

Mammograms were reviewed by three consultant radiologists experienced in breast imaging using the American College of Radiology Breast Imaging Reporting and Data System (ACR BI-RADS) vocabulary. Data on breast density, calcifications, asymmetry, lymphadenopathy, and final BI-RADS assessment categories were extracted from records and previously completed patient questionnaires. Clinical records provided sociodemographic, reproductive, and lifestyle data.

Breast density was classified according to the American College of Radiology Breast Imaging Reporting and Data System (ACR BI-RADS), which divides mammograms into four breast density patterns: Category A (almost entirely fatty), Category B (scattered areas of fibroglandular density), Category C (heterogeneously dense), and Category D (extremely dense). [9,10] The classification of breast density was performed by the radiologists reading the mammographic images and was recorded using standard BI-RADS nomenclature.

Statistical analysis

The collected data were entered into a Microsoft Excel 2016 spreadsheet, cleaned and checked for completeness, and subsequently exported to IBM SPSS Statistics version 27 (IBM Corp., Armonk, NY, USA) for statistical analysis. Descriptive statistics were used to describe the characteristics of the individuals. Continuous variables were reported as mean ± standard deviation, and categorical variables as frequencies and percentages. Normality of continuous variables was tested before parametric analysis.

The correlation between categorical variables was analyzed using Chi-square test. Continuous variables were compared between breast density groups using one-way Analysis of Variance (ANOVA). Statistical significance was set at $p < 0.05$.

III. Result

The demographic characteristics of the study population.

Among the 150 participants in the study, 92 (61.3%) were in the age group of 40 to 49 years, followed by 50 to 59 years 36 (24.0%). Of these, 109 (72.7%) were married and 28 (18.7%) were widowed. Majority of the participants had tertiary education 120 (80.0%) and 105 (70.0%) of them were gainfully employed in the formal sector. As shown in table no I, the Tiv ethnic group made up the largest percentage of respondents 122(81.3%), with smaller representations from Idoma, Igede, and other ethnic groups.

Table no I: The Distribution of Demographic Characteristics of Study Population (N=150)

Variable	Frequency	Percentage (%)
Age(years)		
40-49	92	61.3
50-59	36	24
60-69	18	12
70-79	4	2.7
Total	150	100.0
Marital status		
Married	109	72.7
Widowed	28	18.7
Single	9	6.0
Divorced	4	2.7
Total	150	100.0
Educational attainment		
Tertiary education	120	80.0
Secondary education	19	12.7
Primary education	8	5.3
Non-formal education	3	2.0

Total	150	100.0
Occupation		
Formal	105	70.0
Informal	37	24.7
Retiree	8	5.3
Total	150	100.0
Ethnicity		
Tiv	122	81.3
Idoma	13	8.7
Igede	10	6.7
Others	5	13.4

Descriptive statistics for the age of the study population

The mean age of the respondents was 48.9 years (SD =8.49), median 47 years and mode 40 years indicating that the population was middle aged. Respondents were between the ages of 40 and 78 years with a total sample size of 150. The age distribution was positively skewed (1.11) and the kurtosis value was 0.85, indicating a slight concentration in the lower age groups and a distribution that was moderately peaked. The 95% confidence range for the mean age was ±1.37 years, this indicates a satisfactory precision around the computed mean age as shown in table no 2.

Table no 2: Distribution of descriptive statistics of respondents' age

Statistic	Value
Mean	48.9
Standard error	0.69
Median	47
Mode	40
Standard deviation	8.49
Sample variance	72.12
Kurtosis	0.85
Skewness	1.11
Range	38
Minimum	40
Maximum	78
Count	150
Confidence level (95.0%)	1.37

Breast Density Classification

In this study, we found three main categories of breast density. The most common one, making up about77(51.3%) of the group, was scattered fibroglandular density. This was followed by almost entirely fatty density in 50(33.7%) of participants and then, 23(15.3%) had heterogeneously dense breasts as shown in figure no 1.

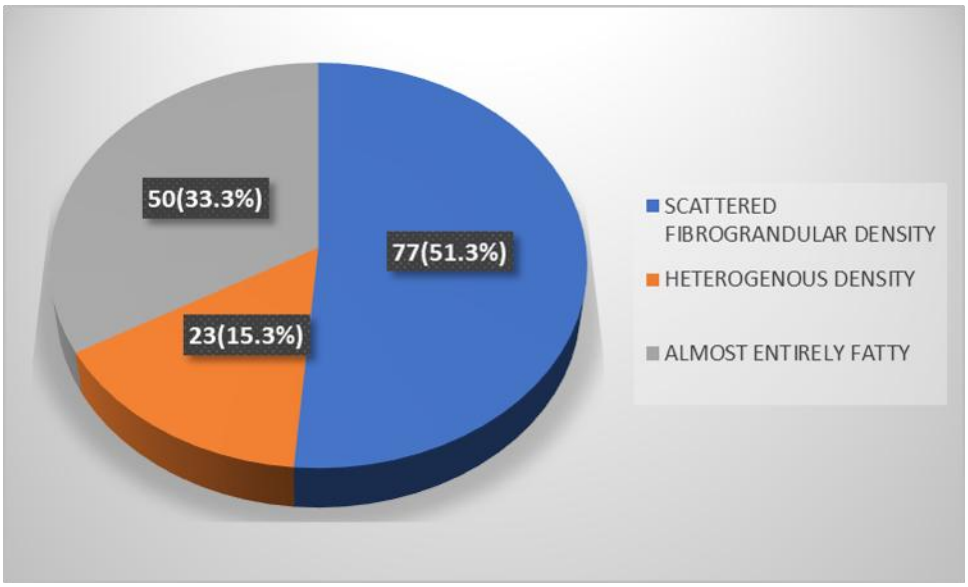

Figure no 1: Distribution of Breast Density Patterns

Correlation Between Breast Density and Sociodemographic Variables

In our study, the Pearson's correlation (r) analysis showed a high association between breast density and some of the sociodemographic and reproductive characteristics. There was a strong inverse association between age and breast density ($r = -0.749$, $p < 0.001$), showing that breast density tends to decline with increasing age. Marital Status ($r = -0.271$, $p < 0.001$) and occupation ($r = -0.291$, $p < 0.001$) showed comparable negative trends with age at first baby ($r = -0.178$, $p = 0.029$) and nursing ($r = -0.165$, $p = 0.043$) exhibiting weak negative correlation. In contrast, breast density was positively associated with family history of breast carcinoma ($r = 0.173$, $p = 0.035$), age at menopause ($r = 0.618$, $p < 0.001$), and physical activity ($r = 0.220$, $p = 0.007$).

Other variables, including gravidity, parity, and educational level, were not significantly associated with breast density ($p > 0.05$), indicating that there is no linear association in the study group. These are shown in table no 3 below:

Table no 3: Pearson's correlation (r) between Breast Density and Sociodemographic Variables

Sociodemographic Variable	N	Pearson's correlation (r)	*p*-value
Statistically significant association			
Age	150	-.749	<0.001
Marital status	150	-.271	<0.001
Occupation	150	-.291	<0.001
Family history of breast cancer	150	+.173	0.035
Age at menopause	150	+.618	<0.001
Physical activity	150	+.220	0.007
Age at first baby	150	-.178	0.029
Breast feeding	150	-.165	0.043
Statistically non-significant association			
Gravidity	150	+.117	0.153
Parity	150	+.031	0.709
History of breast lump	150	+.046	0.573
Educational attainment	150	+.061	0.456
Ethnicity	150	+.075	0.364
Age at menarche	150	+.152	0.063
BMI	150	-.149	0.068
Age at first childbirth	150	-.119	0.148
Result of mammography findings	150	-.114	0.163

Age and Breast Density

A significant association was found between age group and breast density, $p < 0.001$(Table no 3). Relatively younger women (40-49) were more likely to have scattered fibroglandular breasts 69(46.0%) and heterogeneously dense breasts 23(15.3%) compared to older women ≥50 who predominantly had almost entirely fatty breast tissue 50(33.3%). Overall, figure no 2 shows an inverse relationship between age and breast density, with denser breast patterns being more prevalent in younger women and a steady shift toward fatty breast composition with advancing age.

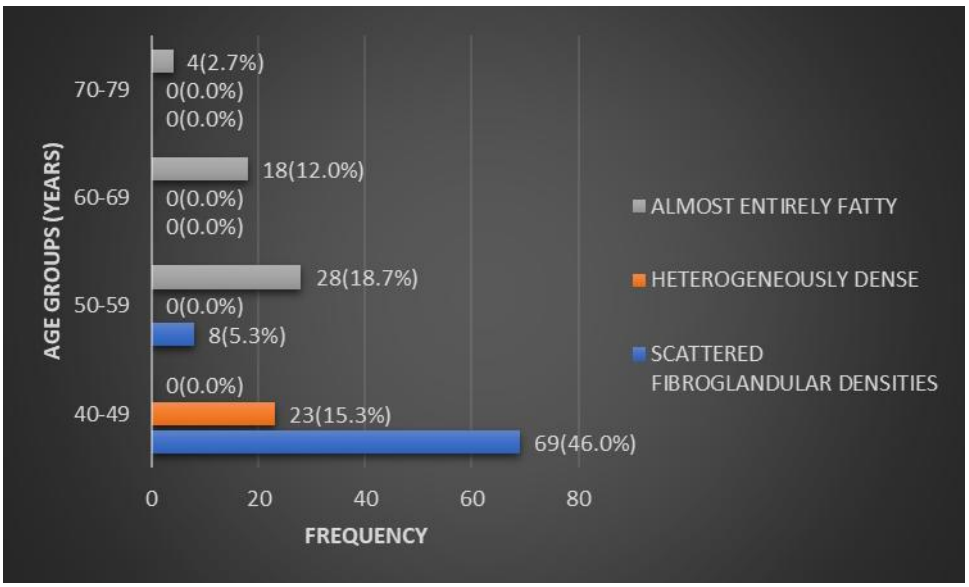

Figure no 2: Distribution of Breast Density by Age Group

Marital status and breast density

Figure no 3 shows that the most common breast density pattern among married women was scattered fibroglandular density 59 (39.3%), which is what would be expected from younger or perimenopausal women. On the other hand, 16 (10.7%) of the widowed women had fatty breast composition, which is what would be expected from older or postmenopausal women.

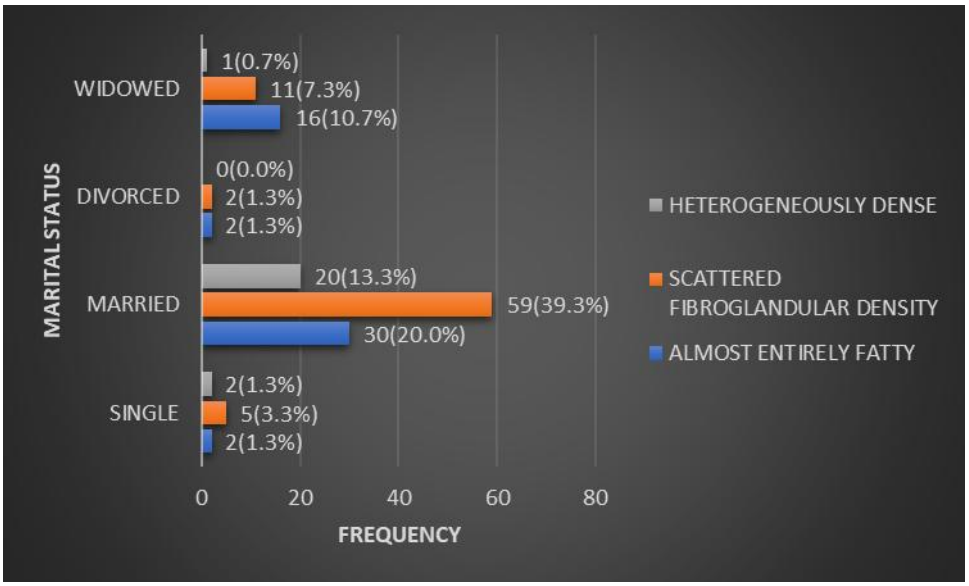

Figure no 3: Breast Density Distribution by Marital Status

Occupational groups and breast density patterns

In general, as shown in figure no 4, retirees and those in the informal sector of the economy, such as market traders and artisans, were more likely to have almost entirely fatty breast composition in 8 (5.3%) and 17 (11.3%) of the respondents, respectively; whereas women in formal employment, such as civil servants and bankers, were more likely to have scattered fibroglandular density, 65 (43.3%). This implies that socioeconomic(occupational) status affects breast density patterns, which is important for tailoring health interventions and screening strategies to meet various population needs.

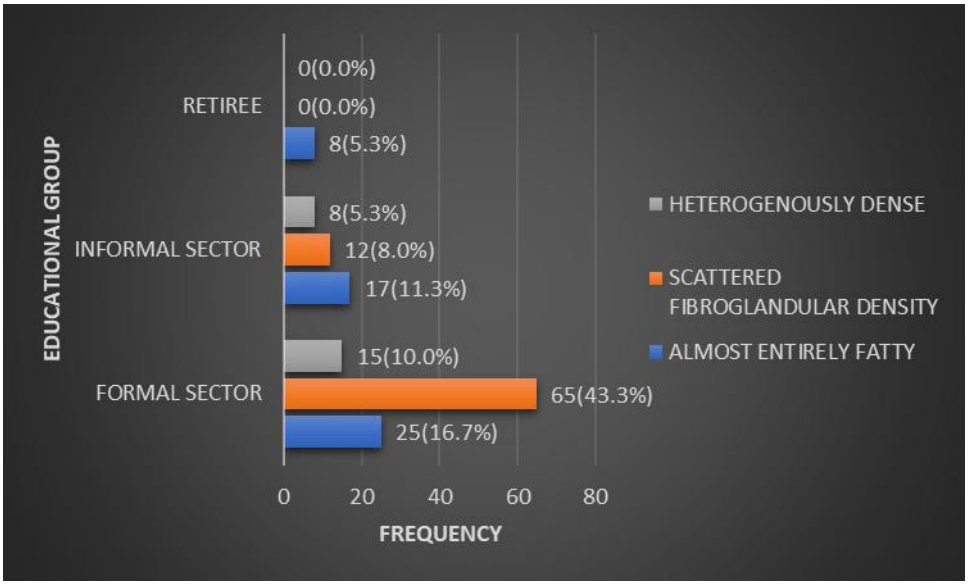

Figure no 4: Breast Density Distribution by Occupation

Some reproductive factors and breast density

Figure no 5 shows the frequency distribution of breast density categories with respect to age at first childbirth. Women less than 20 years exhibited mainly 'Scattered Fibroglandular' density 41(27.3%). On the other hand, women aged 25-34 showed a mix-range of categories, indicating considerable variations in

fibroglandular density related to the age of childbirth. The low breast density of nulliparous women may be due to factors such as age-related breast involution, body mass index, hormonal influences and genetic or ethnic variances, which may overshadow the effects of nulliparity on breast density.

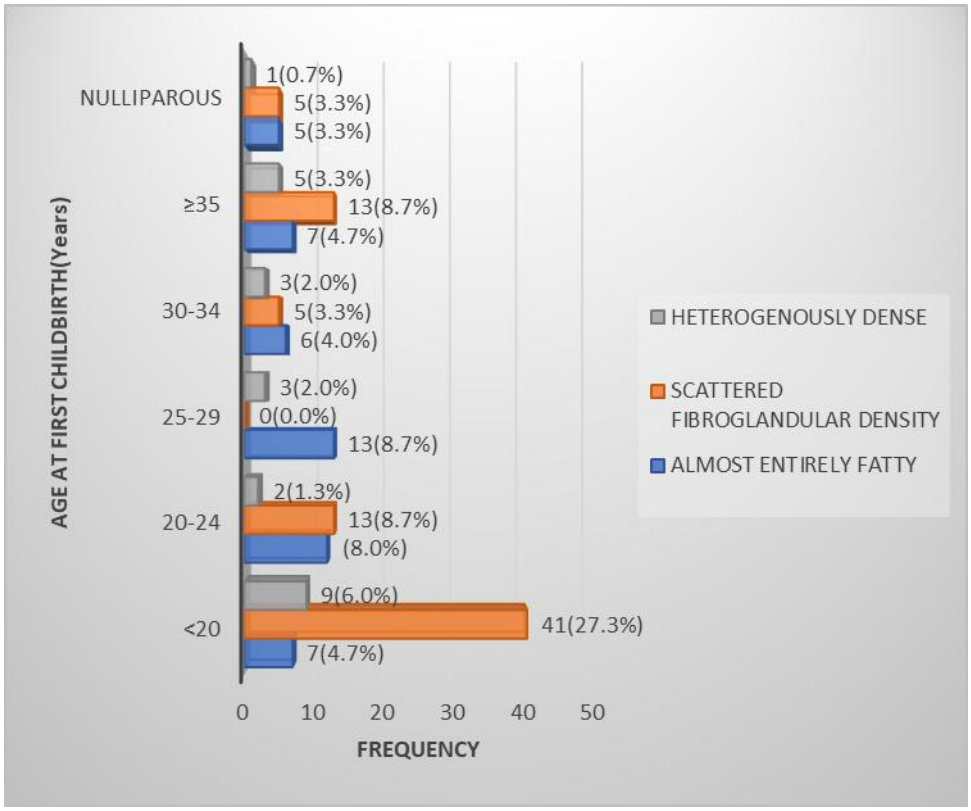

Figure no 5: Distribution of some reproductive factors (Age at First Childbirth) against breast density

Breast Density by Physical Activity Status

Figure no 6 shows the distribution of breast density categories according to physical activity. The most common finding among 83 (55.3%) physically active individuals was scattered fibroglandular density 47 (31.3%), followed by almost entirely fatty density 31 (20.7%), with heterogeneously dense breasts being uncommon in 5 (3.3%) participants. In comparison, scattered fibroglandular density continued to be the most common among the 67 (44.7%) non-active individuals 30 (20.0%), while heterogeneously dense breasts were more common 18 (12.0%) and almost entirely fatty density was less common 19 (12.7%) than in the active group.

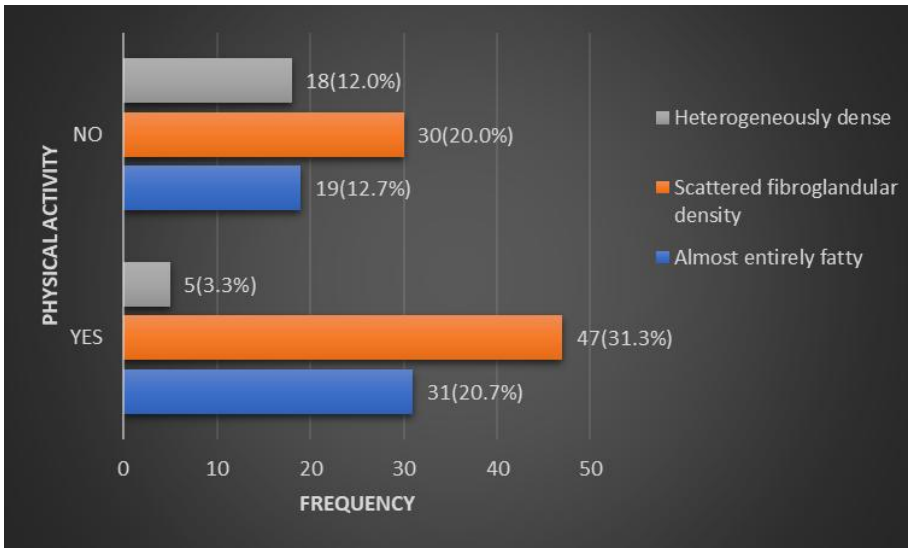

Figure no 6. Distribution of Breast Density by Physical Activity Status

Association Between Breastfeeding and Breast Density

Breastfeeding status (Yes or No) had an impact on the distribution of breast density. Scattered fibroglandular density 68(45.3%) was most common among breastfeeding participants, followed by almost entirely fatty 36(24.0%) and heterogeneously dense 20(13.3%) breast. On the other hand, non-breastfeeding individuals had almost entirely fatty density 14(9.3%), with scattered fibroglandular 9(6.0%) and heterogeneously dense 3(2.0%) breast. In general, participants who were nursing had higher breast densities as demonstrated in figure no 7.

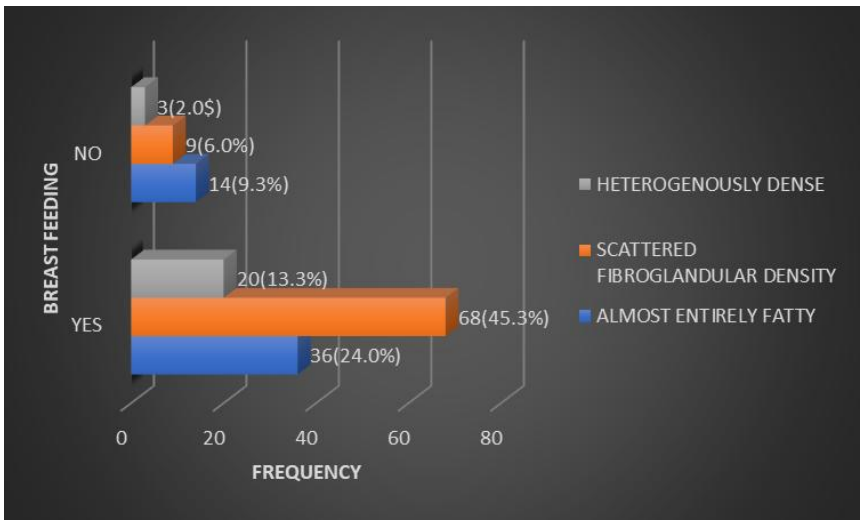

Figure no 7: Distribution of association between breastfeeding and breast density

Other Sociodemographic Factors

Reproductive factors such as gravidity (r = 0.12; p = 0.15), parity (r = 0.03; p = 0.71), age at menarche (r = 0.15; p = 0.06), and age at first childbirth (r = −0.12; p = 0.15) did not show statistically significant correlations with breast density. Similarly, there was no significant relationship between breast density and body mass index (BMI) (r = −0.15; p = 0.07), educational achievement (r = 0.06; p = 0.46), ethnicity (r = 0.08; p = 0.36), history of breast lumps (r = 0.05; p = 0.57), or mammographic results (r = −0.11; p = 0.16), as depicted in table no 3, above.

IV. Discussion

Patterns of Breast Density

Among 150 women undergoing mammography, our index study categorized patterns of breast density into three types. The most prevalent pattern was scattered fibroglandular density 77 (51.3%), which was followed by almost entirely fatty breasts 50 (33.3%) and heterogeneously dense breasts 23 (15.3%). The predominant scattered fibroglandular density 77(51.3%) suggests that the majority of women in this study had non-dense breasts, which is a pattern associated with greater mammographic sensitivity and better lesion identification than dense breasts.[11,12] This is in line with other findings which have identified scattered fibroglandular density as the most prevalent pattern in middle-aged and older women as a consequence of the replacement of fibroglandular tissue with fat owing to ageing and menopause.[13,14] Also, the very high proportion of entirely fatty breasts 50 (33.3%) is in line with the known effect of increasing age and adiposity on decreasing breast density.[14] However, the reduced prevalence of heterogeneously dense breasts 23(15.3%) contrasts with reports in various populations, which is probably a reflection of age, ethnicity, reproductive characteristics and assessment methodologies.[15] Increased breast density, although less common, is clinically relevant because it affects mammographic sensitivity and the risk of breast cancer, which justifies the adoption of screening methods targeted to breast density and individual risk factors.[11,12]

Age and Breast Density

The study revealed a strong negative correlation between age and breast density (r = −0.749, p < 0.001). Older women (≥50 years) were more likely to have fatty breast tissue, while younger women (40–49 years) were more associated with heterogeneously dense or scattered fibroglandular breasts. This trend is consistent with fat accumulation and involution of glandular tissue with ageing. [16-18] The observed inverse relationship is clinically important in breast screening programs because of the age factor, as younger women with dense breasts may benefit more from adjunctive imaging, using ultrasound or magnetic resonance imaging (MRI), rather than mammography to improve the diagnosis of cancer.

Marital Status, Occupation, and Other Sociodemographic Factors

Breast density was significantly correlated with both marital status and occupation ($r = -0.271$ and $r = -0.291$, $p < 0.001$, in that order). While retirees and widowed women were more likely to have fatty breast composition, married women and women in formal employment were more inclined to having scattered fibroglandular density. These findings may be the result of lifestyle and age-related factors, in association with hormonal changes, activity levels, and reproductive history, which have been demonstrated in earlier research to affect the parenchymal composition of the breast.[9,19] Sociodemographic characteristics, such as body mass index (BMI), ethnicity or educational achievement, were not statistically associated with breast density in our index study. This implies that lifestyle factors associated with age and occupation could be more important determinants of breast density in our environment much more than anthropometric parameters as described in similar community-based studies.[4, 14]

Lifestyle and Reproductive Factors

Associations between reproductive variables and breast density were not always consistent. Breast density was weakly inversely associated with age at first birth and parity. Breastfeeding was related with increased prevalence of scattered fibroglandular density. These observations support prior reports showing that breast tissue composition is altered by cumulative hormonal exposure during reproductive proces.[15,19, 20,] Physical activity was positively associated with breast density in a small but statistically significant manner ($r = 0.220$, $p = 0.007$) suggesting that physically active women may preserve greater amounts of fibroglandular tissue. Resent research indicates that lifestyle factors, such as physical activity, may affect breast tissue composition and mammographic features. [21] Similar correlations have been reported in earlier investigations of lifestyle factors and breast density. [9,19]

Breast density was substantially related with age at menopause and family history of breast cancer indicating that long-term hormonal exposure and genetic predisposition are predicators of breast parenchymal patterns.[19]

Implications for Tailored/Personalized screening guidelines

Our findings are suggestive of the importance of tailored breast cancer screening, particularly by age and breast density. Other imaging methods, such as ultrasound or magnetic resonance imaging (MRI), may assist reduce the masking effect of thick breast tissue on mammography for women with denser breasts especially in younger women, who are more likely to have dense breast tissue on mammograms. [19,22,23]

Therefore, in the utilization of these screening methods, population-specific patterns of breast density must be taken into account, together with the characteristics of sociodemographic, reproductive and lifestyle risk factors. These risk-adapted screening methods could potentially enhance early cancer detection and lessen screening disparities, especially in resource-limited settings like ours.[19, 24]

Limitations of the study

There are certain limitations of this study to be considered when interpreting the findings. Firstly, information on some lifestyle and reproductive factors, such as physical activity and breastfeeding history, was obtained via self-reported replies. Since the data are based on the participants' recollections and personal reporting, they are subject to recall bias and misreporting, which may adversely affect the accuracy of the information obtained. Secondly, the study sample was ethnically homogeneous, with a plurality of Tiv participants 122 (81.3%) and as such the conclusions may not be broadly relevant to other ethnic groups with various socio-cultural and genetic origins. Thirdly, the cross-sectional nature of the study does not permit us to establish causality between sociodemographic factors and breast density, which limits the ability to observe associations entirely. Fourthly, the limited sample size of 150 subjects restricts the generalizability of the results to a larger population. These limitations consequently underscore the necessity of careful interpretation of findings, and the need for further research with larger, more diverse populations, longitudinal designs and objective assessments to validate and extend the findings of the research.

V. Conclusion

We observed low participation rates in routine breast cancer screening, indicating a lack of awareness about breast cancer within the study population. Nevertheless, there was significant correlations between breast density and factors such as age, marital status, occupation, as well as various reproductive and lifestyle factors. Younger women had more dense breast tissue or scattered fibroglandular tissue than older, married or formally employed women. The association of dense breast tissue with higher incidence of abnormal mammography, emphasizes the clinical importance of breast density for screening effectiveness. These resuls support the development of risk-based and tailored breast cancer screening programs that use reproductive, sociodemographic, and lifestyle factors to promote early cancer detection. The present study found age as the

largest predictor of breast density, followed by employment and age at menopause, suggesting that local age-specific reference values would be the most relevant parameters for breast density evaluation in women who are undergoing screening mammography. Such references may help to better examine the links between sociodemographic characteristics and patterns of breast density, and may assist in designing individualized screening strategies that address community-specific imbalances in our environment. We thus, recommend enhanced education on breast density, standardized density reporting, risk-based screening with supplemental imaging, adoption of digital breast tomosynthesis(3D-mammography), population-specific screening guidelines, and longitudinal research to improve breast cancer detection, risk assessment, and improved screening outcomes.

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