

Exploring correlations between the breast density of the women of Papua New Guinea and breast cancer risk factors

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ABSTRACT

Introduction: Papua New Guinea (PNG), has experienced an increase in breast cancer incidence correlating to the westernisation of the country. Increased breast density is known to increase breast cancer risk. This study investigates if there are any factors unique to the women of PNG that may impact breast density and breast cancer risk.

Method: A survey was undertaken of 1,161 women who had undergone mammographic imaging at the Pacific International Hospital (PIH). Results were correlated with the five Tabar mammographic parenchymal patterns (TP), recorded for each woman and geographical location, parity, breast size, occupation, marital and menstrual status, smoking and alcohol consumption, hormone replacement therapy (HRT), and exercise. Statistical analysis was undertaken using chi-square test, Fisher's exact test and Odds Ratio (OR).

Results: Relationships were identified between TP and parity ($p < 0.001$), marital status ($p < 0.001$), smoking ($p < 0.001$), alcohol intake ($p = 0.029$) and HRT ($p = 0.029$). There was no evidence of a relationship between pattern type and geographical location ($p = 0.290$), breast size ($p = 0.592$), occupation ($p = 0.724$), menstruation ($p = 0.866$) or exercise ($p = 0.290$). Married women, OR = 0.4004, CI 95% (0.2873–0.5579) and those with higher parity, OR 0.5034, CI 95% (0.3693–0.6862) were half as likely to have increased breast density reducing risk.

Conclusion: There was no clear relationship across almost all data. Factors associated with increased breast density in PNG included parity, marital status, smoking, alcohol, and HRT use were evidenced in this snapshot of PNG women. Breast cancer risk was shown to be reduced for married women and those with increased parity.

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Introduction

All women are at risk of developing breast cancer.¹ There are, however, some risk factors that may increase a woman's chance of developing breast cancer in her lifetime. These include breast density. Meta-analysis of the literature reports mammographic breast density is one of the strongest risk factors for breast cancer.^{2–4} International reporting of mammographic breast density has consistently identified a correlation between increased density

and an increased risk of developing breast cancer.^{2,5–7} Reflecting the importance of breast density profile and breast cancer risk, it is mandatory in more than 20 states in the United States of America to report density.^{8,9}

In the absence of pathology, the mammographic image is a reflection of the normal structures of the breast (terminal ductal lobular units [TDLUs], fibrous tissues, Cooper's ligaments, blood vessels, ducts and adipose tissue), their different X-ray attenuation coefficients, and their relative proportion to each other.^{10,11} Radiographic density is demarcated by those structures of the breast where the X-ray beam undergoes the greatest attenuation. In the normal breast it is the fibroglandular tissue that exhibits the greatest attenuation appearing whiter on the mammographic

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image; adipose tissue with a lower attenuation appears darker.¹⁰ The dense breast is therefore a radiographic representation of the increased ratio of fibroglandular tissue to adipose tissue within a breast.

Mammographic density can be measured by quantitative and qualitative methods. Quantitative methods utilise digital technology to establish density via computer based software such as Volpara, Quantra, and single energy x-ray absorptiometry (SXA), the percentage of dense tissues present on the image.¹² Qualitative measurement of breast density is more commonly aligned with the film screen acquisition era. During this time, various visual analysis and description methodologies were developed for determining the ratio of dense to adipose tissue. These included classification of breast density into distinct categories of mammographic parenchymal patterns (MPPs). Examples of qualitative evaluation systems include the Wolfe, Tabár, Boyd and the Breast Imaging Reporting and Data System (BI-RADS).^{7,13–15} Regardless of how density is measured a single mantra applies; the greater the density of a breast the greater the risk of breast cancer, and conversely the lower the density the lower the risk of breast cancer.

Breast cancer in Papua New Guinea (PNG)

The westernisation of Papua New Guinea (PNG) has seen the proliferation of many so-called western diseases including an increase in the incidence of breast cancer.^{16,20} An escalation in breast cancer incidence has also been observed within Japan, Taiwan, China, and among American Indians, Hawaiians, and Alaska natives.²⁰ The largest impact of westernisation in PNG has been on the populations of the cities and towns. Their experience of westernisation differs substantially from the majority (87%) of the population who reside in small isolated villages in geographically diverse rural areas.^{20,21} PNG is divided into twenty two provinces, one autonomous region and one district. The provinces are grouped into four regions: Highlands, Islands, Momase (rural), and Southern (metropolitan), with four to six provinces in each region. Thirty-nine percent of the PNG population reside in the Highlands region; 26% in the Momase region and 20% and 15% in the Southern and Island regions respectively.²² This represents a unique and diverse population for breast cancer risk factors. Most of the rural population are subsistence farmers. Halder and colleagues described PNG women as being "... extremely active, eat very little fat, consume lots of fruits and vegetables, bear many children, are shorter of stature than Western women, and menarche occurs relatively late. Because the average female life expectancy is short, most women also never reach menopause, when the risk of breast cancer is highest in Western women ...".¹⁶ These significant differences mean that rural women overall have fewer recognised risk factors for breast cancer such as age, height (>175 cm), weight (BMI > 25), early menarche (<12 years), late menopause (after 55 years), compared to Western women, and women in the cities and towns of PNG.¹

Between 1958 and 1998, breast cancer incidence in PNG has steadily risen, with greatest increase in the islands region.^{16,17} Unlike countries such as Australia where the peak incidence of breast cancer is reported in postmenopausal in women aged 50–69 years (52.5%), the greatest breast cancer incidence in PNG is in women aged between 45 and 54 years,¹⁶ with the majority (75%) being premenopausal.^{18,19} In PNG, 83.9% of women diagnosed with breast cancer are reported to be aged 54 years or less, with the incidence falling in the elderly.¹⁶ Research is currently trying to reveal the cause of this increase and varied incidence profile.

Investigating breast density variations of Papua New Guinean women is relatively incomplete. The MPPs and breast cancer risk profile of Papua New Guinean women have been investigated

previously in a landmark study by Pape et al. (2017). This study reported no increased risk of breast cancer based on breast density profile as no unique distribution of MPPs was established. The result of this study failed to explain the high incidence of breast cancer in PNG.²³ Results from this study have now been correlated with additional data from these women to investigate other extrinsic factors that may influence breast density including a woman's geographical location, parity, breast size, occupation, marital status, menstrual status, smoking history, alcohol consumption, hormone replacement therapy (HRT), and exercise. It is important to know if there are any factors unique to the women of PNG that may impact breast density and increased breast cancer risk. This knowledge would enable targeted education and other preventative strategies. The aim of this study is to investigate factors that may influence breast density in women of PNG.

Method

A previously described survey²³ of 1,161 women who had undergone imaging at the Pacific International Hospital (PIH) was undertaken and results correlated with the MPPs of the women using the Tabár Pattern I-V classification system (Table 1). The Tabár classification system describes five MPPs. Patterns I–III are dominated by adipose tissue and considered low-risk for breast cancer. Patterns IV have prominent nodular and linear densities and Pattern V extensive fibrosis and are categorised as high-risk for breast cancer.¹¹

Key variables recorded for correlation with each woman's MPP included geographical location (Papua, Momase, Highlands, Islands), parity (number of live births) and breast size as defined by the size of the image receptor used: 18 cm × 24 cm (small) and 24 cm × 30 cm (large), occupation as defined by the Australian Bureau of Statistics (ABS),²⁴ marital status (married/not married), menstrual status (regularly menstruating/ceased menstruating reason not investigated), smoking (smoker/non-smoker at the time of the study), alcohol intake (drinker/non-drinker at the time of the study amount not investigated), HRT (taking HRT/not taking HRT at the time of the study) and exercise (partaking in exercise/not partaking in exercise at the time of the study). Statistical analysis was undertaken using chi-square test and Fisher's exact test. A p value of 0.05 was considered statistically significant. Odds ratios (ORs) with 95% confidence intervals (CIs) were used to provide estimates of the relative risk of breast cancer.

Ethics approval and permission to collect data was granted through the University of Papua New Guinea, School of Medicine and Health Sciences Research and Ethics Committee (Project number: 0115) and by the Medical Director and Chief Operating Officer of PIH. Consent to collaborate in this research project was granted from the Head of Division of Radiology at PIH.

Results

Geographical location

There was no evidence of a relationship between geographical location and MPPs. It was observed that there was a lower proportion of women from Papua (and a slightly higher proportion from the Highlands) for Pattern II, a slightly higher proportion from Momase (and a slightly lower proportion from the Highlands) for Pattern V, a slightly lower proportion from the Highlands for Pattern IV, a slightly higher proportion from Papua for Pattern I and a slightly lower proportion from the Islands for Pattern III (Table 2 & Fig. 1). None of the variations between locations reached statistical significance (p = 0.290).

Table 1
Summary breast density (Tabár) pattern type versus age.

Age Years	Pattern I	Pattern II	Pattern III	Pattern IV	Pattern V	Total Women
30–49	49.8% (260)	32.4% (169)	4.0% (21)	7.1% (37)	6.7% (35)	100.0% (522)
40–59	53.4% (254)	29.2% (139)	5.1% (24)	7.4% (35)	5.0% (24)	100.0% (476)
50+	50.9% (283)	28.8% (47)	3.1% (5)	7.4% (12)	9.8% (16)	100.0% (163)
Total	51.4% (597)	30.6% (355)	4.3% (50)	7.3% (84)	6.5% (75)	100.0% (1161)

Table 2
Key variables versus mammographic (Tabár) pattern type.

Variable	Pattern I	Pattern II	Pattern III	Pattern IV	Pattern V	Total
Age years						
30–39	49.8% (260)	32.4% (169)	4.0% (21)	7.1% (37)	6.7% (35)	100.0% (522)
40–49	53.4% (254)	29.2% (139)	5.0% (24)	7.4% (35)	5.0% (24)	100.0% (476)
50+	51.0% (83)	28.8% (47)	3.1% (5)	7.4% (12)	9.8% (16)	100.0% (163)
Total	51.4% (597)	30.6% (355)	4.3% (50)	7.2% (84)	6.5% (75)	100.0% (1161)
Parity						
0	48.7% (171)	25.1% (88)	4.8% (17)	7.4% (26)	14.0% (49)	100.0% (351)
1–2	54.2% (144)	29.0% (77)	4.1% (11)	9.0% (24)	3.8% (10)	100.0% (266)
3–4	49.6% (184)	37.5% (139)	4.3% (16)	5.1% (19)	3.5% (13)	100.0% (371)
5+	51.4% (98)	29.5% (77)	3.5% (6)	8.7% (15)	1.7% (3)	100.0% (173)
Total	51.4% (597)	30.6% (355)	4.3% (50)	7.2% (84)	6.5% (75)	100.0% (1161)
Breast Size						
Large	48.7% (91)	32.6% (61)	3.2% (6)	7.0% (13)	8.6% (15)	100.0% (187)
Small	52.0% (506)	30.2% (294)	4.5% (44)	7.3% (71)	6.1% (59)	100.0% (974)
Total	51.4% (597)	30.6% (355)	4.3% (50)	7.3% (84)	6.5% (75)	100.0% (1161)
Occupation*						
ABS Category 1	51.1% (141)	28.6% (79)	3.6% (10)	9.06% (25)	7.6% (21)	100.0% (276)
ABS Category 2	58.1% (36)	24.2% (15)	4.9% (3)	9.7% (6)	3.2% (2)	100.0% (62)
ABS Category 4	50.5% (282)	32.6% (180)	4.8% (27)	5.7% (32)	6.6% (37)	100.0% (558)
ABS Category 5	52.1% (138)	30.6% (81)	3.8% (10)	7.9% (21)	5.7% (15)	100.0% (265)
Total	51.4% (597)	30.6% (355)	4.3% (50)	7.2% (84)	6.5% (75)	100.0% (1161)
Marital Status						
Not Married	52.5% (95)	16.0% (29)	4.2% (8)	11.1% (20)	16.0% (29)	100.0% (181)
Married	51.2% (502)	33.3% (326)	4.3% (42)	6.5% (64)	4.7% (46)	100.0% (980)
Total	51.4% (597)	30.6% (355)	4.3% (50)	7.2% (84)	6.5% (75)	100.0% (1161)
Menstrual Status						
Menstruating	51.1% (145)	29.2% (83)	4.6% (13)	7.4% (21)	7.8% (22)	100.0% (284)
Ceased Menstruating	51.5% (452)	31.0% (37)	4.2% (37)	7.2% (63)	6.0% (53)	100.0% (877)
Total	51.4% (597)	30.6% (50)	4.3% (50)	7.2% (84)	6.5% (75)	100.0% (1161)
Smoker						
No	51.0% (526)	32.4% (334)	4.0% (41)	6.4% (66)	6.2% (64)	100.0% (1031)
Yes	54.6% (71)	16.2% (21)	6.9% (9)	13.9% (18)	8.5% (11)	100.0% (130)
Total	51.4% (597)	30.6% (355)	4.3% (50)	7.2% (84)	6.5% (75)	100.0% (1161)
Alcohol Intake						
No	49.8% (412)	33.0% (273)	4.5% (37)	7.1% (59)	5.6% (46)	100.0% (827)
Yes	55.4% (185)	24.6% (82)	3.9% (13)	7.5% (25)	8.7% (29)	100.0% (334)
Total	51.4% (597)	30.6% (355)	4.3% (50)	7.2% (84)	6.5% (75)	100.0% (1161)
HRT						
No	51.6% (429)	28.9% (240)	4.7% (39)	7.1% (59)	7.7% (64)	100.0% (831)
Yes	50.9% (168)	34.9% (115)	3.3% (11)	7.6% (25)	3.3% (11)	100.0% (330)
Total	51.4% (597)	30.6% (355)	4.3% (50)	7.2% (84)	6.5% (75)	100.0% (1161)
Exercise						
No	50.0% (232)	32.8% (152)	5.0% (23)	7.3% (34)	5.0% (23)	100.0% (464)
Yes	52.4% (365)	29.1% (203)	3.8% (27)	7.2% (50)	7.5% (52)	100.0% (697)
Total	51.4% (597)	30.6% (355)	4.3% (50)	7.2% (84)	6.5% (75)	100.0% (1161)
Region						
Highlands	49.8% (112)	35.6% (80)	5.3% (12)	4.9% (11)	4.4% (10)	100.0% (225)
Islands	49.5% (98)	33.8% (67)	2.5% (5)	7.6% (15)	6.6% (13)	100.0% (198)
Momase	48.7% (76)	29.9% (46)	3.90% (6)	7.8% (12)	9.7% (15)	100.0% (154)
Papua	53.4% (312)	27.7% (162)	4.6% (27)	7.9% (46)	6.3% (37)	100.0% (584)
Total	51.4% (597)	30.6% (355)	4.3% (50)	7.2% (84)	6.5% (75)	100.0% (1161)

*ABS Categories: 1 = Managers and professionals (ABS categories 1 & 2); 3 = Technicians & Trade Workers, Machinery Operators & Drivers and Labourers (ABS categories 3, 7 & 8); 4 = Community & Personal Service Workers (ABS category 4); 5 = Clerical & Administrative Workers and Sales Workers (ABS categories 5 & 6).²⁴

Parity

A chi-square test based on categorised parity confirmed evidence of a relationship between parity and pattern type ($p < 0.001$). It was observed that a much higher proportion of Pattern V women were childless and that a higher proportion of Pattern II had a parity of 3–4 children (Table 2 & Fig. 2). The OR for parity 0.5034, CI 95% (0.3693–0.6862) was very similar to that for marital status and may

be representative of the same women (Table 3). Women who have given birth are half as likely to have increased breast density.

Breast size

The chi-square test reported no evidence of a relationship between breast size and pattern type ($p = 0.592$); there was slightly higher proportion of large breasts with Pattern V (Table 2 & Fig. 3).

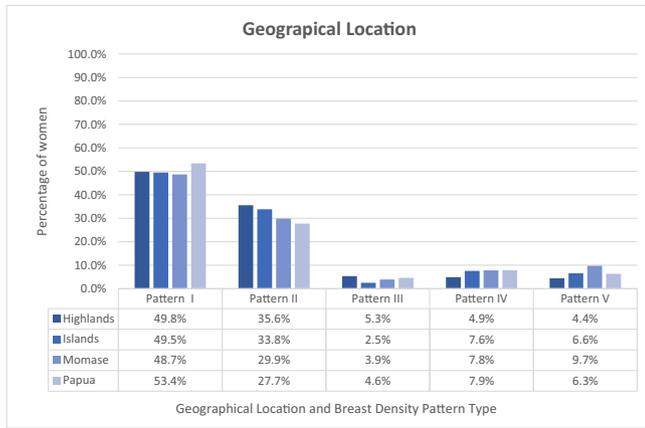


Figure 1. Geographical location (Highlands, Islands, Momase, Papua) versus breast density pattern type.

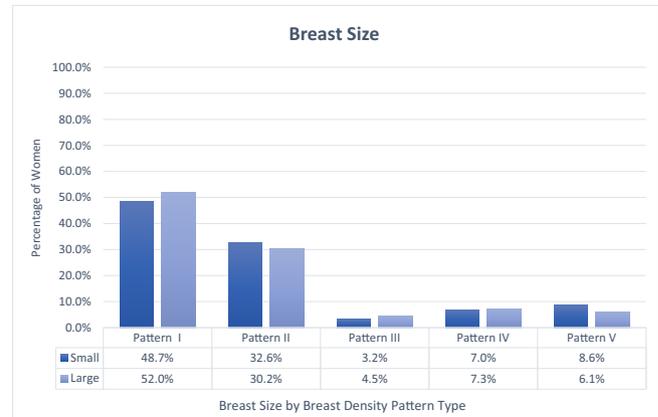


Figure 3. Breast size (18 × 24 cassette small and 24 × 30 cassette large) versus breast density pattern type.

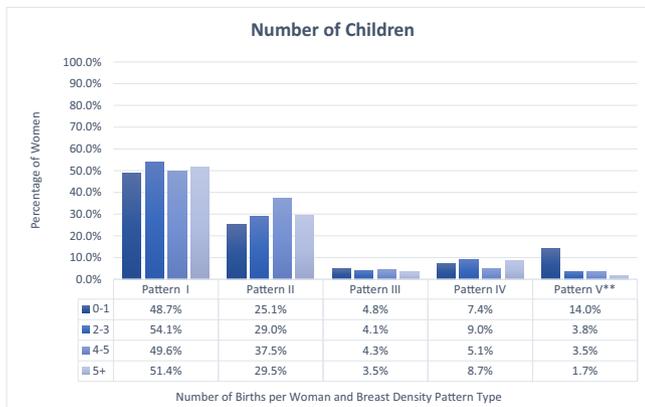


Figure 2. Number of children (parity) versus breast density pattern type. **p < 0.001.

OR = 0.95, CI 95% 0.62–1.46 reflecting no association between breast size and breast density (Table 3).

Occupation

Twenty nine percent of respondents (T = 338) were identified as managers or professionals (ABS categories 1 & 2); 50.7% (T = 558) community or personal service workers (ABS category 4); 22% (T = 265) clerical, administrative and sales workers (ABS categories 5 & 6).²⁴ No respondents identified as working as technicians, trade workers, machinery operators, drivers or labourers (ABS categories 3, 7 & 8).

There was no evidence of a statistically significant relationship between occupation and pattern type (p = 0.724). It was observed

that for Pattern IV there was a slightly higher proportion of managers and professionals and a slightly lower proportion of community and personal service workers (Table 2 & Fig. 4). For occupation OR = 0.0327, CI 95% (0.0134–0.0799), (Table 3), the association was significant however whether this can be explained by occupation alone is unlikely.

Marital status

There was a statistically significant relationship between marital status and pattern type (p < 0.001). It was observed that there was a much lower proportion of married women with Pattern V, a higher proportion of married women for Pattern II and a lower proportion of married women for Pattern IV (Table 2 & Fig. 5). Women who were married are half as likely to have increased breast density OR = 0.4004, CI 95% (0.2873–0.5579).

Menstrual status

There was no evidence of a relationship between menstruation status (regularly menstruating/ceased menstruating at the time of the study) and pattern type (p = 0.866). When reviewing Table 2 and Fig. 6 there were no trends worthy of note. There was no association between menstrual status and breast density (Table 3), OR = 0.8431, CI 95% (0.5895–1.2059).

Smoking and alcohol consumption

There was a statistically significant difference between smoking and pattern type (p < 0.001). There was a lower proportion of smokers with Pattern II, a higher proportion of smokers with Pattern IV and a slightly higher proportion of smokers with Pattern

Table 3 Odds Ratio (OR) for key variables and increased breast density as defined by the Tabár pattern types IV and V.

Key Variable	OR	Confidence interval (CI) 95%
Parity (birthed/never birthed)	0.5034	0.3693–0.6862
Breast Size (18 × 24 small/24 × 30 large)	0.9516	0.6208–1.4588
Occupation (blue collar/white collar)	0.0327	0.0134–0.0799
Marital Status (married/not married)	0.4004	0.2873–0.5579
Menstruation (menstruating/ceased menstruating)	0.8685	0.6059–1.245
Smoking (smoker/non-smoker)	0.9529	0.6464–1.4046
Alcohol consumption (drinker/non-drinker)	0.3762	0.9963–1.9009
HRT (taking HRT/not taking HRT)	0.7451	0.5197–1.0683
Exercise (partaking in exercise/not partaking in exercise)	1.3197	0.9528–1.8279

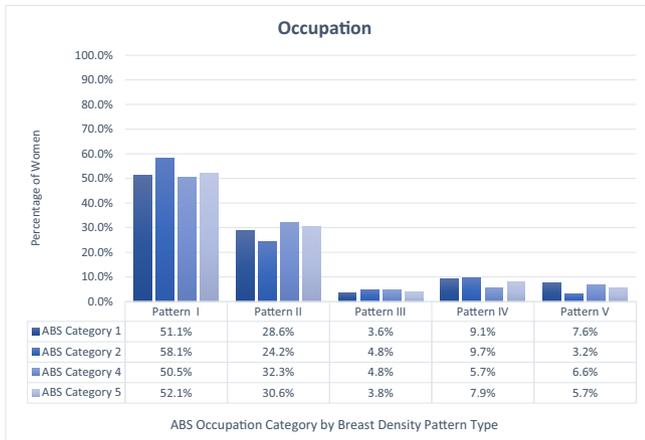


Figure 4. Occupation (Major Groups) as defined by The Australian and New Zealand Standard Classification of Occupations (ANZSCO)²⁴ versus breast density pattern type.

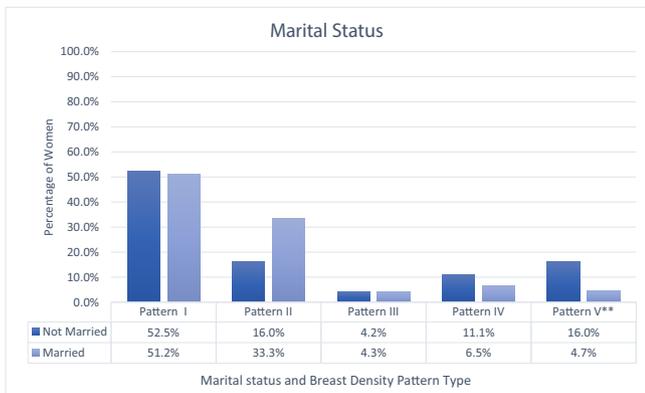


Figure 5. Marital status (married/not married) versus breast density pattern type**p < 0.001.

III (Table 2 & Fig. 7). There was evidence of a relationship between alcohol intake and breast density pattern type (p = 0.029). It was observed that there was a lower proportion of alcohol drinkers for Pattern II, a higher proportion of alcohol drinkers for Pattern V and a slightly higher proportion of alcohol drinkers for Pattern I (Table 2 & Fig. 8). There was no association between smoking, OR = 0.9529, CI 95% (0.6464–1.4046) or alcohol consumption, OR = 0.3762, CI 95% (0.9963–1.9009) and increased breast density, (Table 3).

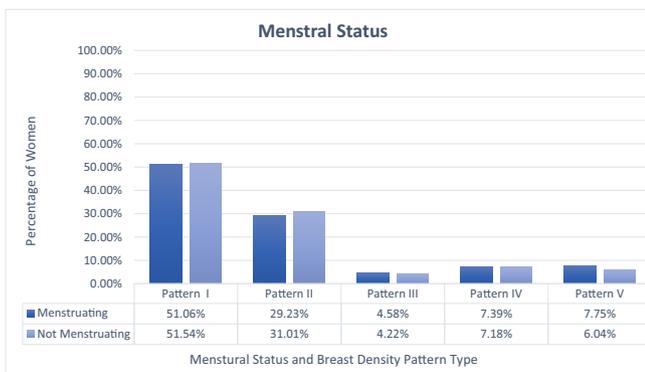


Figure 6. Menstrual status (menstruating/not menstruating) versus breast density pattern type.

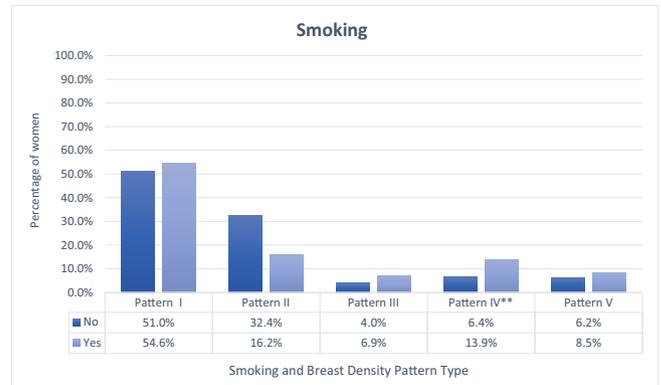


Figure 7. Smoking/non-smoking versus breast density pattern type**p < 0.001.

Hormone replacement therapy (HRT)

There was evidence of a relationship between HRT use and pattern type (p = 0.029); there was a much lower proportion of HRT use for Pattern V and a higher proportion of HRT use for Pattern II (Table 2 & Fig. 9). There was no association between the use of HRT and breast density (Table 3), OR = 1.3197, CI 95% (0.9528–1.8279).

Exercise

There was no evidence of a relationship between exercise and breast density pattern type (p = 0.290); there was a slightly higher proportion of women who undertook exercise with Pattern V (Table 2 & Fig. 10). There was an association between exercising and increased breast density OR = 1.3197, CI 95% (0.9528–1.8279) however when considered at the 0.05 CI there is no real significance.

Discussion

Geographical location

Studies outside of PNG have shown that the odds of developing breast cancer are greater for women in urban versus rural communities.²⁶ There are no known studies worldwide to confirm any evidence of a significant relationship between geographical location and MPPs. However, it should be considered that in countries such as PNG, there might be a relationship between women in particular locations (rural/metropolitan) and dietary patterns,

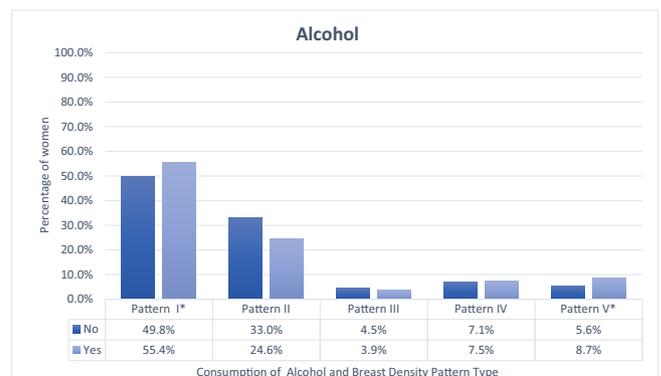


Figure 8. Alcohol consumption versus breast density pattern type*p < 0.05.

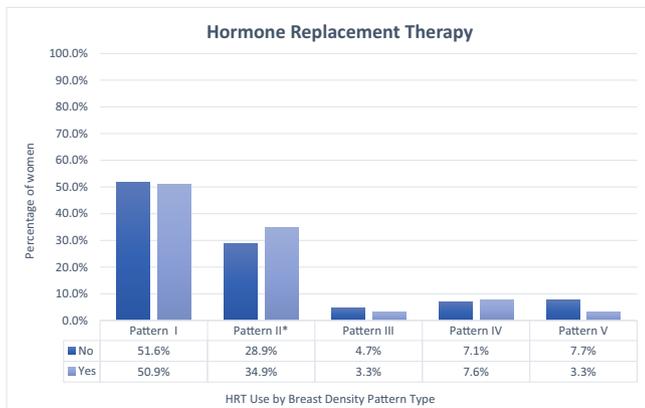


Figure 9. Use of hormone replacement therapy (HRT) versus breast density pattern type* $p < 0.05$.

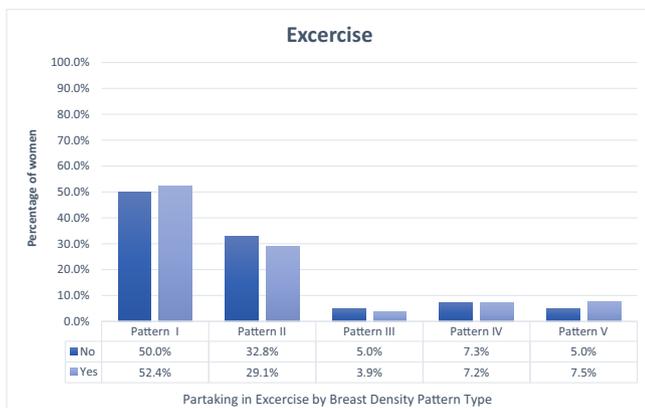


Figure 10. Partaking regular exercise versus breast density pattern type.

which may influence MPPs and subsequently breast cancer risk. Studies have reported that dietary patterns in certain ethnic screening populations may be associated with breast cancer risk.^{27,28} Two studies found that the high carbohydrate and reduced fat diet of Singapore Chinese women, along with the high soy intake²⁷ can significantly reduce breast density and impact MPPs.^{27,28} This could lead to a reduced risk of breast cancer and may even protect against the disease.

According to results of the current study it was observed that there was a slightly higher proportion from Momase (and a slightly lower proportion from the Highlands) for Pattern V, and a slightly lower proportion from the Highlands for Pattern IV (Table 2 & Fig. 1). These results could reflect the influence of dietary change between westernised and rural locals; however, as diet was not directly studied within this work a more comprehensive study is required to validate these findings.

Parity

In PNG, the first birth for women typically occurs at a mean age of 20.5 years with 15.9% of women giving birth before the age of 18.²⁹ The total fertility rate (TFR) in PNG was reported in 2017 at as 3.61 births per woman. Importantly, this reflects a 40% decrease in fertility rates from 6.2 births per woman in 1966.³⁰ An earlier age at first birth and higher parity have been associated with lower mammographic densities in South Asian and Afro-Caribbean women in the United Kingdom (UK).³¹ As low-risk MPPs are

related to a lower risk for breast cancer, this may be consistent with the lower breast cancer incidence (20–30%) in these ethnic groups.³¹ Although the results on MPPs of PNG women agree with higher parity and its relation to lower mammographic densities (Pattern II) (Table 2 & Fig. 2) and therefore breast cancer risk OR 0.5034, CI 95% (0.3693–0.6862), it may be hypothesised that as the continued decrease in TFR mirrors data for the increase incidence of breast cancer and as such should be investigated as being causal to the high incidence of breast cancer in PNG.

Breast size

Breast size is known to have a direct influence on MPPs. Larger breasts typically have a greater volume of adipose tissue and therefore a greater adipose to glandular tissue ratio aligned to Pattern II and III, and a lower risk of breast cancer.³² Breast size and MPPs are known to vary among women from different ethnic backgrounds and within groups and is independently associated with age.³³ Studies by Pape et al. (2016) and Spuur et al. (2018) include data on breast size in an indigenous Australian population reported breast size using PNL with a mean PNL of 133.2 mm and a range of 44.1–265.4 mm,³² and in a larger State (NSW) population a range of 19.8 mm–245 mm with a mean of 106.3 mm respectively.³⁴

A study of Japanese and Chinese' women demonstrated that they had a lower breast cancer incidence than Caucasian and native Hawaiian women.³⁵ However, the Japanese and Chinese women overall had a density area 15% less than the Caucasian and Hawaiian women.³⁵ The study also identified that the breast tissue of the Japanese and Chinese women was 20% more dense than that of the Caucasian women.³⁵ This suggests that the breasts of Japanese and Chinese women in general are of smaller size, and have a low prevalence of high-risk parenchymal pattern, in addition to low rates of breast cancer.³⁶

The dense tissue ratio of Japanese and Chinese' women³⁵ contrasts with that of Swedish and Caucasian women, 'who in general have small breast size, which is associated with increasing breast cancer risk through its association with high-risk parenchymal pattern'.³⁶ A study by Stuedal et al. suggested that women with larger breasts tend to have a weaker association between mammographic density and breast cancer risk than women with smaller breasts.³⁷ These results suggest that women of different ethnic backgrounds tend to have variations in breast size, which is associated with either low-risk or high-risk parenchymal patterns.

The results in PNG women demonstrated no evidence of a relationship between breast size and pattern type with a very slightly higher proportion of large breasts with Pattern V (Table 2 & Fig. 3). This result may be a limitation since there was not direct measurement of PNL and by relying on receptor size to indicate breast size would not consider overall volume.

Occupation

There are limited studies specifically investigating relationships between occupation and breast density. A study of Spanish women reported secondary school teaching and nursing as occupations with high but non-statistically significant mammographic density differences, and housewives an inverse association.³⁸ Other studies have investigated links between occupation and breast cancer and report higher incidence in women who had worked in farming and an elevated incidence in women in the automotive industry and health care.³⁹ Occupational exposures to solvents and endocrine disrupting chemicals as well as shift work have also been identified as breast cancer risk factors.⁴⁰ A study in Denmark reported a significant increased risk of breast cancer in professional occupations

including lawyers, medical doctors, dentists and physiotherapists if, nurses and clerks, and in a small number of blue-collar workers, specifically skilled tobacco workers and bookbinders.⁴¹

The current study did not provide any evidence of a relationship between occupation and pattern type ($p = 0.724$). An association was demonstrated for breast cancer risk and occupation OR = 0.0327, CI 95% (0.0134–0.0799), (Table 3), however whether this can be explained by occupation alone is outside the scope of this study. According to results of the current study, it was observed that there was a slightly higher proportion of managers and professionals and a slightly lower proportion of community and personal service workers with Pattern IV (See Table 2 & Fig. 4). As Pattern IV is a higher risk for breast cancer the results of this study align with Rix et al.⁴¹ It is known that well educated women have a trend towards delayed parity and that delayed and reduced parity does not cause a decrease in mammographic density.³¹

Marital status

Women who were married are half as likely to have increased breast density OR = 0.4004, CI 95% (0.2873–0.5579) and therefore a decreased risk for breast cancer. As PNG culture promotes child-birth within marriage this result may reflect the same women describing parity. Earlier age at first birth and higher parity were associated with lower mammographic densities in South Asian and Afro-Caribbean women in the UK.³¹ As marital status in PNG is associated with women who give birth and women with high parity, results of the current study demonstrate an evidence of a much higher proportion of married women with low-risk Patterns II and III (See Table 2 & Fig. 5). This is an important finding as breast cancer education may be better targeted to women who are unmarried and without children.

Menstrual status

There was no evidence of a relationship between menstruation and pattern type ($p = 0.866$). Younger pre-menopausal women typically have dense parenchymal tissue in comparison to post-menopausal women who have undergone breast involution. It would therefore be expected that women who had not undergone menopause and were still menstruating would have denser breast tissue. This assumption does not consider increased parity and the lower age of first birth in PNG, and as such the results of this data point are purely exploratory as no additional cross tabulations have been performed. The women in this study were not asked about any medications or therapies that might cause cessation of menstruation.

Smoking and alcohol consumption

The World Health Organisation (WHO) reported that in 2013 15% of PNG women aged over 15 years were tobacco smokers.⁴² There are no studies worldwide to confirm any evidence of a relationship between smoking and pattern type. A study by Brand and colleagues reported no association between smoking and breast density however the literature does report an increased risk of breast cancer where smoking commenced at an early age and/or was heavy prior to a first full term pregnancy.^{43,44}

Results of the current study demonstrated a relationship between smoking and pattern type ($p < 0.001$), which may influence breast cancer risk in PNG. It was observed that there was a much lower proportion of smokers for Pattern II, a higher proportion of smokers for Pattern IV, and a slightly higher proportion of smokers for Pattern III (Table 2 & Fig. 7). It may therefore be hypothesised that smoking could be a factor for increased breast density for the

women of PNG. It is more likely as with other populations that the cause of breast cancer remains multifactorial and as such a definitive statement on smoking and breast density in PNG is out of the scope of this research. A further more comprehensive study is required to validate these findings and should include more detailed data collection on per day consumption and duration of smoking.

It should be noted that this study is exploratory in nature and did not investigate key aspects of alcohol consumption such as age of first alcoholic beverage, standard drinks per day, binge drinking and alcohol abuse. As such the data concerning alcohol consumption has limited meaning. In PNG the total alcohol per capita consumption, in litres of pure alcohol for women is 1 L.⁴⁵ Increased alcohol intake of more than 10 g/day is reported to be associated with high mammographic density in both pre and post-menopausal women and increase breast cancer risk by 2–12% for daily consumption above this rate.^{46–48} In 2004 the WHO reported that in females aged 15 years who drank alcohol, 8% had consumed at least 60 g of alcohol in the previous month and that 0.7% of women who drink alcohol had a dependence on it and that 77.7% of PNG women (life time abstainers and former drinkers) had abstained for 12 months.⁴⁹ The results of the current study observed that there was a higher proportion of alcohol drinkers for Pattern V and a slightly higher proportion of alcohol drinkers for Pattern I (Table 2 & Fig. 7).

Results of the current study are consistent with research by Brennan et al. (2010) who suggested suggesting that alcohol intake at a younger age may increase breast density and subsequently increase the risk of breast cancer.²⁸ These results may indicate an extrinsic cofounder for breast cancer in the PNG population where a woman consumes alcohol.

Hormone replacement therapy (HRT)

The women in this study were not asked about prior HRT use or the types of hormones taken, only whether they were using HRT at the time of the study. According to results of the current study it was observed that there was a much lower proportion of HRT use in women with Pattern V breast densities and a higher proportion of HRT for Pattern II (Table 2 & Fig. 9). Results of the current study are not consistent with research undertaken by McCormack et al. (2008) suggesting a reduced use of HRT and its association with lower mammographic densities in South Asian and Afro-Caribbean women in the UK.³¹ HRT use is an independent risk factor for breast cancer as it can increase breast tissue density in both peri- and post-menopausal women.⁵⁰ Since HRT influences MPPs by increasing mammographic density, results of the current study is contradictory to previous studies.^{51,52} This finding may be influenced by the small sample size.

In the United Kingdom a steady and substantial decline in HRT use among postmenopausal women from 2001 (29%) to 2005 (10%) has been evidenced.⁵³ Typically the use of HRT is low in PNG women however the results of this study report that 28% of women used HRT. Given that the majority of respondents were engaged in occupations of higher socio economic standing as compared to the majority of the PNG workforce access to doctors and therefore HRT may be more prevalent in this snapshot of women.

Exercise

In PNG the WHO reported that 14.8% of women were physically inactive.⁴⁵ Physical activity in some women may be associated with specific MPPs. A study on physical activity among Greek post-menopausal women found that those who participated in physical activity during the previous five years tended to have lower

mammographic breast density compared to inactive controls. Inactivity is, an established breast cancer risk factor.⁵⁴ However, this concept may not apply to other groups of women due to individual variation in breast tissue and in lifestyle factors.

According to results of the current study it was observed that there was a slightly higher proportion of women who took exercise with Pattern V (Table 2 & Fig. 10). Results of the current study are not consistent with research by Marmara et al. (2011) suggesting physical activity and its relationship with lower mammographic breast densities.⁵⁴ In PNG 'exercise' is defined as any form of physical activity which is undertaken routinely on a normal daily basis at a relaxed pace rather than a rigorous physical training activity. The common physical activity for PNG women on a daily basis is walking and gardening. Therefore, physical activity in PNG context may not reflect westernised forms of physical activity. A further comprehensive case-control study is required to validate these findings.

Limitations

As baseline research there are a number of limitations to this study. The absolute effect of the extrinsic variables explored is outside of the scope of this study and the cause of the increase in breast cancer in PNG remains unexplained by this research. Breast size was recorded as a function of the image receptor rather than by using the posterior nipple line (PNL) as used by other studies, reducing accuracy in reporting breast size and reducing comparison with the literature. Failure to investigate consumption is also a limitation of this study. PNG is a third world country with limited research resources and limited literacy particularly amongst women. Data collection was kept simplistic (e.g. do you drink alcohol yes/no); future research should be more sophisticated. The sample size is small and limited to women who were able to overcome known environmental, economic, and social barriers to access the limited screening service at PIH.²⁵ This still remains an important study with this research being the first of its kind to report on these extrinsic factors and their influence on breast density in the PNG screening population.

Conclusion

It must be acknowledged that this exploratory study is the first of its kind and has limitations. The purpose of the analysis, was to observe any correlation with key extrinsic factors that are known to influence breast density and breast cancer risk in populations outside of PNG and to guide further research. Overall the results indicate that there are no clear relationship across almost all data noting that the data does not represent the true population of PNG women. Parity, marital status, smoking, alcohol consumption, and HRT use demonstrated statistically significant relationships with MPPs, however these relationships were not always supported by the literature. Given the distinct difference in lifestyle between rural and metropolitan populations, it was surprising that no relationships were identified between these groups. Further, more sophisticated, studies should be undertaken to identify the reason for the increase in cancer burden in this country. A focus on changes in the total fertility rate as well as diet may hold clues as this is an important aspect of PNG life not investigated by the authors of this research.

Conflict of interest

None.

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