A Cluster Analysis of Substance Use, Anthropometric and Reproductive Health Profiles among Alcohol- and/or Tobacco-Using Women with Breast Cancer in Southeastern Nigeria: Implications for Risk Assessment

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Abstract

Background: Breast cancer remains a major public health challenge in sub-Saharan Africa and Nigeria, where late presentation, limited diagnostic access and health-system constraints continue to worsen outcomes. Alcohol use, cigarette smoking, adiposity and reproductive history are recognised risk domains, but their combined profiles among Nigerian women with breast cancer are not well described. This study explored whether alcohol- and/or tobacco-using women with breast cancer in Southeastern Nigeria could be grouped into clinically meaningful phenotypic clusters.

Methodology: This hospital-based cross-sectional analytical study included 139 women with histologically confirmed breast cancer who reported alcohol use and/or cigarette smoking. Data were collected using an interviewer-administered questionnaire and direct anthropometric measurements. Variables included substance-use pattern, body mass index, waist-to-hip ratio, menopausal status, parity and age at menarche. An exploratory hierarchical cluster analysis using Ward's method was performed, followed by bivariate profiling of the derived clusters.

Results: The mean age of participants was 37.3 ± 9.6 years, and 76.2% were younger than 50 years. Most participants were premenopausal (79.9%). Alcohol-only use was the commonest substance-use category (70.5%), followed by tobacco-only use (15.8%) and dual alcohol-tobacco use (13.7%). The analysis identified two clusters. Cluster 1 (n = 108; 77.7%) was characterised by younger age, premenopausal status and lower parity. Cluster 2 (n = 31; 22.3%) was characterised by older age, predominantly postmenopausal status and higher parity. Substance-use pattern, body mass index and waist-to-hip ratio did not significantly differentiate the clusters.

Conclusion: Among alcohol- and/or tobacco-using women with breast cancer in this Southeastern Nigerian hospital sample, reproductive life stage, age and parity distinguished two phenotypic clusters more clearly than substance-use pattern or anthropometric measures. These findings should be interpreted cautiously because of the cross-sectional design, hospital-based sampling and limited tumour biology data. The results support further prospective studies that combine behavioural, reproductive, anthropometric and tumour molecular variables for more refined breast-cancer risk profiling in Nigeria.

Keywords: breast cancer, alcohol, tobacco, body mass index, reproductive factors, cluster analysis, Nigeria.

Introduction

Breast cancer is an increasing public health burden in sub-Saharan Africa. A Global Burden of Disease-based analysis reported that breast cancer incidence in the region increased substantially between 1990 and 2019, with Nigeria recording the highest incidence burden within sub-Saharan Africa [1]. Nigerian cancer-registry evidence has also shown that breast cancer is one of the leading malignancies among women in the country [2]. Recent Nigerian stage-distribution evidence suggests that many women still present with advanced disease, despite improvements in awareness and clinical services [3]. The burden is also relevant to Southeastern Nigeria. Earlier work from eastern Nigeria documented breast cancer as an important clinical problem in the region [4]. More recent Southeast-focused studies continue to point to gaps in awareness, screening behaviour and timely access to care [5]. These structural and behavioural issues are especially concerning because breast cancer in many African settings affects relatively young women and is often diagnosed after symptoms have progressed.

Breast cancer aetiology is multifactorial. Alcohol consumption and cigarette smoking are modifiable exposures that have been linked to breast-cancer risk, although the strength of association varies across studies, populations and tumour subtypes [6-10].

Alcohol may contribute through acetaldehyde exposure, oxidative stress and hormonal pathways, while tobacco smoke contains carcinogens that may affect breast tissue. The combined use of alcohol and tobacco may plausibly increase risk, but the evidence remains more robust for alcohol than for smoking alone. This distinction matters because prevention messages should be accurate rather than overstated.

Anthropometric factors are also important. Body mass index, waist circumference and waist-to-hip ratio have been linked to breast-cancer risk, particularly after menopause, when adipose tissue becomes a major site of oestrogen production [11-13]. Nigerian evidence suggests that women with breast cancer may have higher anthropometric indices than controls [14]. Yet the relationship between adiposity and breast cancer is not uniform. It varies by menopausal status, hormone receptor status, age and population context [11,12].

Reproductive history remains central to breast-cancer risk assessment. Age at menarche, parity, age at first birth, breastfeeding duration and menopausal status influence lifetime hormonal exposure and breast tissue differentiation [15-17]. Nigerian studies have reported associations between parity, breastfeeding and breast-cancer risk, although these relationships may differ by age and oestrogen receptor status [16,17]. These findings suggest that reproductive variables should be analysed alongside lifestyle and anthropometric factors rather than treated as isolated exposures.

Most Nigerian breast-cancer risk studies examine variables one at a time. Such analyses are useful, but they may miss how risk factors cluster within real patients. A person-centred method such as cluster analysis can identify subgroups with shared behavioural, anthropometric and reproductive profiles [18,19]. This may be useful for tailoring risk communication, screening priorities and prevention counselling.

This study therefore explored substance-use, anthropometric and reproductive-health clusters among alcohol- and/or tobacco-using women with breast cancer in Southeastern Nigeria. The aim was not to infer causality, but to identify clinically interpretable profiles that may inform risk assessment and future research.

Methodology

Study design

This was a hospital-based cross-sectional analytical study. The primary analytical method was an exploratory hierarchical cluster analysis designed to identify phenotypic subgroups based on selected substance-use, anthropometric and reproductive variables.

Study setting and population

The study was conducted at the oncology and surgical outpatient clinics of a tertiary healthcare institution in Enugu State, Southeastern Nigeria. The facility serves as a regional referral centre for cancer care.

The study population comprised adult women aged 18 years and above with histologically confirmed breast cancer.

Eligibility criteria

Inclusion criteria were:

Histologically confirmed diagnosis of breast cancer.

Self-reported current or past regular alcohol consumption and/or cigarette smoking.

Residence in one of the five Southeastern states of Nigeria: Enugu, Anambra, Imo, Abia or Ebonyi.

Ability and willingness to provide informed consent.

Exclusion criteria were:

Inability to communicate effectively in English or Igbo.

Cognitive impairment or severe psychiatric illness that could impair reliable participation.

Being too critically ill to participate.

Sample size determination

The sample size was estimated using the Raosoft sample-size calculator, with a 95% confidence level and an 8.29% margin of error [20]. A final sample of 139 participants was included.

The sample size was considered adequate for an exploratory cluster analysis using a limited number of variables. However, the findings should be interpreted cautiously because cluster stability improves with larger samples and external validation.

Sampling technique

A consecutive sampling technique was used over a five-month study period from 1 March to 31 July

2021. All eligible women presenting at the selected clinics during the study period were invited to participate until the required sample was reached. This method was practical for the clinic setting but does not eliminate the risk of hospital-based selection bias.

Data collection

Data were collected using a structured interviewer-administered questionnaire and direct anthropometric measurements.

Sociodemographic and clinical information

Information was obtained on age, state of origin, ethnicity, occupation and marital status. Clinical information, including breast-cancer diagnosis and menopausal status, was verified from medical records where available.

Substance-use profile

Participants were asked about their alcohol consumption and cigarette-smoking history. They were classified into three mutually exclusive categories: alcohol only, tobacco only, and alcohol plus tobacco.

Anthropometric measurements

Height was measured in metres using a stadiometer, and weight was measured in kilograms using a calibrated digital scale. Participants were measured in light clothing and without shoes. Body mass index was calculated as weight divided by height squared in kg/m² and categorised using WHO classifications.

Waist circumference was measured at the midpoint between the lower rib and iliac crest. Hip circumference was measured at the widest part of the buttocks. Waist-to-hip ratio was calculated from these measurements.

Reproductive health history

Information was collected on age at menarche, parity and breastfeeding history. Menopausal status was recorded as premenopausal or postmenopausal.

Data analysis

Data were analysed using IBM SPSS Statistics for Windows, version 27.0 [21]. Descriptive statistics were used to summarise participant characteristics. Categorical variables were reported as frequencies and percentages. Continuous variables were reported as means and standard deviations.

The core analysis used agglomerative hierarchical cluster analysis with Ward's minimum variance method [18,19]. Continuous variables were standardised before clustering. The variables considered for clustering included body mass index, waist-to-hip ratio, parity, age at menarche and menopausal status.

The number of clusters was selected by visual inspection of the dendrogram and assessment of the agglomeration schedule. Mojena's stopping rule was also considered as an additional decision aid [22]. Bivariate analyses were then used to describe differences between clusters.

Ethical consideration

The study purpose, procedures, possible risks and benefits were explained to potential participants in English or Igbo. Written informed consent was obtained before enrolment. Confidentiality was maintained using anonymised identification codes, and data were stored securely with password-protected access.

Results

Sample characteristics

A total of 139 women with breast cancer who reported alcohol consumption and/or cigarette smoking were included in the analysis.

The mean age was 37.3 ± 9.6 years. Most participants were younger than 50 years: 26 (18.7%) were aged 18–29 years, 38 (27.3%) were aged 30–39 years, and 42 (30.2%) were aged 40–49 years. Thirty-three participants (23.7%) were aged 50 years and above.

Most participants were from Enugu State, 73 (52.5%), followed by Anambra, 33 (23.7%); Imo, 19 (13.7%); Abia, 10 (7.2%); and other states, 4 (2.9%). Nearly all participants were Igbo, 136 (97.8%). Most were currently married, 91 (65.5%), while 48 (34.5%) were currently single.

A high proportion of participants were overweight or obese. Forty-two women (30.2%) were overweight and 57 (41.0%) were obese. The mean body mass index was 28.20 ± 6.40 kg/m². The mean waist-to-hip ratio was 0.88 ± 0.08, and 99 participants (71.2%) had waist-to-hip ratio values above the sample mean.

Reproductive health characteristics

Most participants were premenopausal, 111 (79.9%), while 28 (20.1%) were postmenopausal. Sixty-one participants (43.9%) were nulliparous, 43 (30.9%)

had one to four children, and 35 (25.2%) had more than four children. Age at menarche was dichotomised around the sample mean, with 54 participants (38.8%) below the mean and 85 (61.2%) at or above the mean.

Substance-use patterns

Alcohol-only use was the commonest category, reported by 98 participants (70.5%). Twenty-two participants (15.8%) reported tobacco-only use, while 19 (13.7%) reported combined alcohol and tobacco use.

Cluster identification

Hierarchical cluster analysis using Ward's method identified a two-cluster solution as the most parsimonious and interpretable structure. The dendrogram showed a major separation into two groups, and the agglomeration schedule suggested a notable increase in fusion distance at the two-cluster stage.

Cluster 1 comprised 108 participants (77.7%). Cluster 2 comprised 31 participants (22.3%).

Cluster characterisation

The clusters differed mainly by age, menopausal status and parity.

Cluster 1 was younger and predominantly premenopausal. Among participants at or below the mean age, 62 (96.9%) were in Cluster 1 and 2 (3.1%) were in Cluster 2. All 108 members of Cluster 1 were premenopausal. Cluster 1 also had lower mean parity, 2.0 ± 2.4 live births.

Cluster 2 was older and predominantly postmenopausal. Among participants above the mean age, 29 (38.7%) were in Cluster 2. Of the 31 women in Cluster 2, 28 were postmenopausal and 3 were premenopausal. This means Cluster 2 was not exclusively postmenopausal, although all postmenopausal participants were classified into Cluster 2. Cluster 2 had higher mean parity, 3.5 ± 2.5 live births.

Table 1: Baseline characteristics of alcohol- and/or tobacco-using women with breast cancer (N = 139)

Characteristic	n	%
Age group		
18–29 years	26	18.7
30–39 years	38	27.3
40–49 years	42	30.2
≥50 years	33	23.7
Mean ± SD	37.3 ± 9.6	
State of origin		
Enugu	73	52.5
Anambra	33	23.7
Imo	19	13.7
Abia	10	7.2
Others	4	2.9
Ethnicity		
Igbo	136	97.8
Others	3	2.2
Occupation		
Self-employed	44	31.7
Civil servant	39	28.1
Unemployed	32	23.0
Academia	24	17.3
Marital status		
Currently married	91	65.5
Currently single	48	34.5
Body mass index (BMI)		
Underweight	3	2.2
Normal weight	37	26.6
Overweight	42	30.2
Obese	57	41.0
Mean ± SD, kg/m²	28.20 ± 6.40	
Waist-to-hip ratio (WHR)		
< Mean	40	28.8
≥ Mean	99	71.2
Mean ± SD	0.88 ± 0.08	

The clusters did not differ significantly by occupation, body mass index category, waist-to-hip ratio category, age at menarche or substance-use pattern. Substance-use pattern was similarly distributed across both clusters.

Table 2: Reproductive health characteristics of participants (N = 139)

Characteristic	n	%
Age at menarche		
< Mean	54	38.8
≥ Mean	85	61.2
Menopausal status		
Premenopausal	111	79.9

Characteristic	n	%
Postmenopausal	28	20.1
Parity		
0 children	61	43.9
1–4 children	43	30.9
>4 children	35	25.2

Table 3: Substance-use patterns among participants (N = 139)

Substance-use category	n	%
Alcohol only	98	70.5
Tobacco only	22	15.8
Alcohol and tobacco	19	13.7

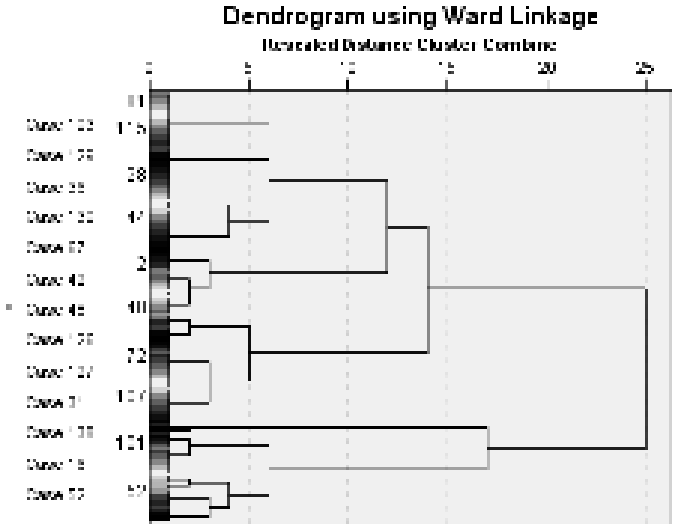

Figure 1. Dendrogram resulting from hierarchical cluster analysis using Ward's linkage method.

Table 4: Bivariate analysis of sociodemographic, anthropometric, reproductive and substance-use characteristics by cluster membership (N = 139)

Characteristic	Cluster 1 (n = 108)	Cluster 2 (n = 31)	p-value
Age group			<0.001
≤ Mean age	62 (96.9)	2 (3.1)	
> Mean age	46 (61.3)	29 (38.7)	
Occupation			0.758
Academia	18 (75.0)	6 (25.0)	
Civil servant	29 (74.4)	10 (25.6)	
Self-employed	34 (77.3)	10 (22.7)	
Unemployed	27 (84.4)	5 (15.6)	
Body mass index			0.455
Underweight	3 (100.0)	0 (0.0)	
Normal weight	31 (83.8)	6 (16.2)	
Overweight	30 (71.4)	12 (28.6)	
Obese	44 (77.2)	13 (22.8)	
BMI, mean ± SD, kg/m²	28.2 ± 6.4	39.1 ± 38.8	0.132
Waist-to-hip ratio			0.078
≤ Mean	35 (87.5)	5 (12.5)	
> Mean	73 (73.7)	26 (26.3)	
Menopausal status			<0.001
Premenopausal	108 (97.3)	3 (2.7)	
Postmenopausal	0 (0.0)	28 (100.0)	
Age at menarche			0.137
≤ Mean	40 (74.1)	14 (25.9)	
> Mean	68 (80.0)	17 (20.0)	
Parity category			0.007
0 children	54 (88.5)	7 (11.5)	
1–4 children	32 (74.4)	11 (25.6)	
>4 children	22 (62.9)	13 (37.1)	
Parity, mean ± SD	2.0 ± 2.4	3.5 ± 2.5	0.012
Substance use			0.895
Alcohol only	77 (78.6)	21 (21.4)	
Tobacco only	17 (77.3)	5 (22.7)	
Alcohol and tobacco	14 (73.7)	5 (26.3)	

Discussion

This study identified two phenotypic clusters among alcohol- and/or tobacco-using women with breast cancer in Southeastern Nigeria. The clusters were distinguished mainly by reproductive life stage, age and parity. Cluster 1 was larger, younger and premenopausal, with lower parity. Cluster 2 was smaller, older, predominantly postmenopausal and had higher parity. Substance-use pattern and anthropometric measures did not significantly separate the clusters.

The most important finding is that menopausal status and age shaped the clustering more strongly than substance-use category. This is clinically plausible. Breast cancer risk and tumour biology differ between premenopausal and postmenopausal women, and adiposity-related mechanisms are especially relevant

after menopause [11-13]. In postmenopausal women, peripheral aromatisation of androgens in adipose tissue may increase oestrogen exposure and contribute to hormone-sensitive breast-cancer pathways. The present study did not include hormone receptor status, so this interpretation remains cautious.

Cluster 1 may represent a clinically important subgroup of younger, premenopausal women with breast cancer. Nigeria has a substantial burden of breast cancer among women below 50 years, and Nigerian studies have reported a high proportion of premenopausal cases and biologically aggressive subtypes [23]. In this study, the younger cluster also had lower parity and a high representation of nulliparous women. These findings are consistent with the broader literature showing that reproductive factors, including parity and breastfeeding, influence breast-cancer risk, although the direction and magnitude of risk may vary by age and tumour subtype [15-17,24].

The relationship between parity and cluster membership deserves careful interpretation. Higher parity is often considered protective, especially when accompanied by breastfeeding, but its effect is not uniform across populations or breast-cancer subtypes [16,17,24]. In this study, Cluster 2 had higher parity and was mainly postmenopausal. Without data on breastfeeding duration, age at first birth, contraceptive exposure, hormone receptor status and tumour subtype, the biological meaning of this finding cannot be firmly established.

A notable finding was the absence of significant differences in substance-use pattern between the clusters. Alcohol-only, tobacco-only and dual-use categories were similarly distributed. This does not mean substance use is unimportant. Rather, it suggests that, within this selected sample of women already defined by alcohol and/or tobacco exposure, substance-use category did not differentiate the derived clusters. More detailed measures of duration, intensity and cumulative exposure may have produced a more refined analysis.

The absence of significant anthropometric differences should also be interpreted cautiously. Overweight and obesity were common across the sample. This may indicate that adiposity is a general background risk factor in this group rather than a cluster-defining feature. It may also reflect limited sample size, the use of broad BMI categories, or the absence of body-composition and tumour-biology data. Global and Nigerian evidence supports the relevance of anthropometry to breast-cancer risk, but the relationship depends on menopausal status and receptor status [11-14].

These findings have practical implications. First, breast-cancer risk assessment in Nigeria should move beyond single-variable risk messaging. Women's risk profiles are shaped by overlapping reproductive, behavioural and anthropometric factors. Second, younger, premenopausal women with alcohol and/or tobacco exposure may require targeted prevention messages, earlier symptom awareness and accessible clinical breast examination. Third, postmenopausal women with high adiposity and substance-use exposure may benefit from integrated counselling on weight, alcohol, tobacco and screening adherence.

The study also has implications for future research. A larger prospective study should include detailed substance-use measures, age at first birth, breastfeeding duration, contraceptive history, family history, tumour stage, histological type, hormone receptor status and molecular subtype. These variables would allow more biologically meaningful cluster formation and validation. External validation in another Southeastern Nigerian or multi-regional Nigerian sample would strengthen the usefulness of the cluster solution.

Limitations

This study has limitations. The hospital-based cross-sectional design prevents causal inference and may not represent all women with breast cancer in Southeastern Nigeria. Consecutive sampling may reduce some selection bias within the clinic setting, but it does not remove referral and attendance biases.

Substance use was self-reported and categorised broadly. The study did not measure quantity, frequency, duration, age at initiation or cumulative exposure. These omissions limit interpretation of alcohol and tobacco effects.

The cluster analysis was exploratory. The sample size was modest, and cluster stability was not tested in an independent dataset. The use of categorical or binary variables in Ward's hierarchical clustering requires methodological caution. Tumour characteristics, including stage and receptor status, were not incorporated. Breastfeeding duration was mentioned

in data collection but not reported in the results. The ethics approval details also require completion before submission.

Strengths

Despite these limitations, the study addresses an understudied group: women with breast cancer in Southeastern Nigeria who report alcohol use and/or cigarette smoking. It uses directly measured anthropometric data and a person-centred analytic approach. The findings provide preliminary evidence that reproductive life stage and parity may define clinically relevant subgroups within a high-risk behavioural sample.

Conclusion

This exploratory cluster analysis suggests that alcohol- and/or tobacco-using women with breast cancer in Southeastern Nigeria are not a single homogeneous group. They appear to form at least two phenotypic profiles: a larger, younger, premenopausal and lower-parity group, and a smaller, older, predominantly postmenopausal and higher-parity group. Substance-use pattern and anthropometric measures were important background characteristics but did not significantly distinguish the clusters.

The findings support a more nuanced approach to breast-cancer risk assessment and prevention in Nigeria. Risk communication should consider age, menopausal status, parity, adiposity and substance use together. Future studies should validate these clusters prospectively and incorporate tumour biology, genetic risk, breastfeeding history and detailed substance-use exposure.

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