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Research Article

Keywords: Breast cancer, Awareness, Knowledge, Adolescents, School-based, Risk factors, Prevention, Nigeria

Posted Date: November 17th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11323063/v1

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Additional Declarations: No competing interests reported.

Awareness and knowledge of breast cancer risk factors, signs and symptoms, and prevention among in-school female adolescents in Ibadan North-West Local Government Area, Oyo State, Nigeria: a cross-sectional study

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Abstract

Background: Breast cancer is the leading cause of cancer death in Nigeria, and many women present late. Early breast health literacy may support lifelong preventive behaviour, but evidence on adolescents' knowledge in Southwest Nigeria is limited. We assessed awareness and knowledge of breast cancer risk factors, signs and symptoms, and prevention among in-school female adolescents in Ibadan North-West Local Government Area (LGA), Oyo State, Nigeria.

Methods: This descriptive cross-sectional study included 396 female students aged 11–18 years from four randomly selected public secondary schools, recruited by multistage sampling. A structured questionnaire, assessed socio-demographic characteristics, awareness, and 44 knowledge items (signs and symptoms, 9; risk factors, 20; prevention, 15). Correct responses scored 1, and "No" or "I don't know" scored 0. Scores were categorised as good (≥80%), moderate (60–79%) or poor (<60%) using the modified Bloom's cut-off. Data were analysed with chi-square tests, Welch's t-test, one-way ANOVA, Pearson correlation, and multiple linear and binary logistic regression ($\alpha = 0.05$).

Results: The mean age was 14.7 ± 1.7 years. Most respondents (82.6%) had heard of breast cancer, mainly through the internet (27.7%) and mass media (24.3%); the school curriculum (18.5%) and health workers (12.9%) were less often cited. Overall knowledge was poor in 80.1%, moderate in 17.9% and good in 2.0% of respondents (mean score 46.7 ± 16.8%). Knowledge was lowest for risk factors (mean 40.3%; 81.8% poor), followed by signs and symptoms (49.8%; 67.3% poor) and prevention (53.4%; 54.0% poor). Domain scores were positively correlated ($r = 0.20–0.43$, $p < 0.001$). Knowledge category was not associated with

age group, class, parental education, ethnicity or prior awareness in bivariate analyses. Neither multivariable model was significant overall (linear regression p = 0.326; logistic regression likelihood-ratio p = 0.475), although higher-class level was associated with higher odds of adequate (moderate or good) knowledge (adjusted odds ratio 1.37, 95% CI 1.04–1.82).

Conclusions: Although most in-school female adolescents in this setting had heard of breast cancer, their knowledge of its risk factors, signs and symptoms, and prevention was generally poor, and the deficit was similar across socio-demographic subgroups.

Keywords: Breast cancer; Awareness; Knowledge; Adolescents; School-based; Risk factors; Prevention; Nigeria

Background

Breast cancer is the most commonly diagnosed cancer in women worldwide. In 2022, female breast cancer was the second most frequently diagnosed cancer overall, accounting for 11.6% of all new cancer cases, and the fourth leading cause of cancer death (6.9% of cancer deaths) [1]. Earlier estimates showed that it had overtaken lung cancer as the most commonly diagnosed cancer, with about 2.3 million new cases in 2020 [2]. In sub-Saharan Africa the incidence is rising, and late presentation contributes to poor outcomes [3, 4].

In Nigeria, breast cancer is the leading cancer, with an estimated 32,278 new cases (25.3% of all new cancer cases) and 16,332 deaths (20.5% of all cancer deaths) in 2022 [5]. Because outcomes depend strongly on stage at diagnosis, public awareness of risk factors and warning signs is an important component of control in settings without organised screening.

Breast cancer is uncommon in adolescence, but adolescence is a formative period for health literacy. Knowledge of risk factors, warning signs and preventive behaviours acquired early may shape lifelong health behaviour and later engagement with screening [6, 7]. Adolescent girls have therefore been identified as an important target group for breast cancer education and breast awareness promotion [7]. Schools offer a structured and scalable setting for this education. In Nigeria, peer-led and classroom-based school programmes have improved adolescents' knowledge of breast cancer and breast self-examination [8–10].

Baseline surveys, however, indicate low knowledge among young Nigerians. Secondary school girls in Delta State had poor knowledge of breast cancer, its risk factors and its symptoms [11]. Among students and staff of educational institutions in Ota, Ogun State, adolescents aged 13–19 years had the lowest mean knowledge score of all age groups (38.8%) [12], and 90.3% of

female undergraduates in a Southwest Nigerian university had poor knowledge of breast cancer and screening [13]. Similar gaps have been reported among adolescents in Sri Lanka and Malaysia [14, 15].

Several Nigerian school-based studies have focused on breast self-examination or on the short-term effects of educational interventions. Fewer have described adolescents' knowledge across risk factors, signs and symptoms, and prevention using a common scoring framework, or examined whether that knowledge varies with socio-demographic characteristics and prior awareness. To our knowledge, such data are scarce for Ibadan, the capital of Oyo State.

This study therefore assessed awareness and knowledge of breast cancer risk factors, signs and symptoms, and prevention among in-school female adolescents in Ibadan North-West LGA, Oyo State. Specifically, we (i) described respondents' socio-demographic characteristics; (ii) determined the proportion aware of breast cancer and their sources of awareness; (iii) assessed and categorised knowledge of signs and symptoms, risk factors and prevention; (iv) compared knowledge across the three domains and examined their inter-relationships; and (v) examined the association of socio-demographic characteristics, prior awareness and source of awareness with overall knowledge.

Methods

Study design and reporting

A descriptive cross-sectional study was conducted among in-school female adolescents in Ibadan North-West Local Government Area (LGA), Oyo State, Nigeria. The study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies [16]. The data were originally collected in May,2023 for a Master of Science dissertation at the University of Ibadan. The present report applies a revised knowledge-scoring scheme and additional bivariate and multivariable analyses to the same data set.

Study setting

Ibadan North-West is one of the five urban LGAs of Ibadan, the capital of Oyo State in Southwest Nigeria. Public secondary schools in the LGA, numbering 13 at the time of the study, formed the sampling frame. Nigerian secondary education comprises three years of Junior Secondary School (JSS1–JSS3) followed by three years of Senior Secondary School (SS1–SS3).

Study population and eligibility

The study population comprised female students aged 11–18 years enrolled in public secondary schools in the LGA. Students were eligible if they were female, aged 11–18 years, and had parental or guardian consent and gave their own assent to participate. Students whose parents or guardians did not consent, or who did not assent, were not included.

Sample size determination

The minimum sample size for a single proportion in a large population was calculated using Cochran's formula [17, 18]: $n_0 = Z^2pq/d^2$, where Z = 1.96 (95% confidence level), p = 0.5 (the expected proportion with adequate knowledge was unknown, so the value giving maximum variability was used), q = 1 − p = 0.5, and d = 0.05 (margin of error). This gave $n_0 = (1.96^2 \times 0.5 \times 0.5)/0.05^2 = 384.16$, rounded up to 385. Allowing for 10% non-response or attrition (approximately 40 students), the target sample was 425. A total of 396 respondents were included in the analysis, which exceeds the minimum required sample of 385.

Sampling technique

A multistage sampling procedure was used. In stage 1, four of the 13 public secondary schools in the LGA were selected by simple random sampling (balloting). The selected schools were Eleyele High School, Eleyele Secondary School, Oba Abass Alesinloye School and Anwarul-Islam Secondary School. In stage 2, one class was selected from each school based on the availability of students during the period of data collection. In stage 3, respondents were selected from the selected classes by simple random sampling until the required number was reached.

Data collection instrument

Data were collected with a structured questionnaire developed from the existing literature and the 4th edition of the European Code Against Cancer (ECAC), whose 12 recommendations to reduce cancer risk informed the risk-factor and prevention items [19]. The questionnaire (Additional file 1) had five sections. Section A covered socio-demographic characteristics: age, ethnicity, religion, class, fathers' and mothers' educational level (primary, secondary or tertiary) and occupation (professional, civil servant, artisan or other), and fathers' and mothers' monthly income in Naira. Section B asked whether the respondent had ever heard of breast cancer and, if so, the main source of that awareness (internet, media, school curriculum, health workers, friends or relatives, or other). Sections C, D and E assessed knowledge of signs and symptoms (9 items), risk factors (20 items) and prevention (15 items), giving 44 knowledge

items in total. Each knowledge item was a declarative statement with three response options: "Yes", "No" and "I don't know".

All risk-factor and prevention statements were worded as true statements (for example, "Being physically inactive increases the risk of breast cancer"), so "Yes" was the keyed correct response for every item. The first item in Section C ("Are you aware of any signs or symptoms of breast cancer?") is a self-reported awareness item and was scored together with the eight sign- and symptom-specific statements in that domain.

The questionnaire was reviewed for face and content validity by supervisor and experts in nutrition, public health or oncology and pretested among 20 students in a school that was not part of the study, after which ambiguous items were reworded. Internal consistency of the 44 knowledge items was Cronbach's alpha = 0.74.

Data collection procedure

The purpose of the study was explained to the selected students and to their parents or guardians. Parents or guardians who agreed to their daughters' participation completed a consent statement, and the students themselves completed an assent form before receiving the questionnaire. Participation was voluntary, no names were recorded on the questionnaire, and respondents were assured of confidentiality. The questionnaire was self-administered and completed at school. The principal investigator and trained research assistants administered and supervised the questionnaire and items were read aloud to younger students.

Variables and scoring

The outcomes were awareness of breast cancer (yes/no), source of awareness, and knowledge scores for each domain and overall. Each knowledge item was scored dichotomously: "Yes" (the correct response) = 1 and "No" or "I don't know" = 0. A domain score was calculated as the percentage of correctly answered items among valid (non-missing) responses, provided the respondent had answered at least 80% of the items in that domain; respondents below this threshold were excluded from that domain's score. The overall score was the percentage correct across all 44 items. Scores were categorised using the modified Bloom's cut-off [20], as commonly applied in knowledge, attitude and practice surveys [21]: good (≥80%), moderate (60–79%) and poor (<60%). The same cut-offs were applied to each domain and to the overall score. The original dissertation used domain-specific score bands; the uniform percentage cut-off was adopted here to allow comparison across domains and with other studies.

Explanatory variables were age (years, and grouped as 11–13, 14–15 and 16–18 years), class (JSS2 to SS3), treated as an ordinal variable with four levels in regression, religion, ethnicity (Yoruba, Igbo, Hausa, others), fathers' and mothers' education (ordinal: primary, secondary, tertiary), and household income. Household income was calculated as the sum of fathers' and mothers' reported monthly income and log-transformed to reduce positive skew. Awareness status (yes/no) and source of awareness were also examined as explanatory variables.

Statistical analysis

Data were entered and analysed using IBM SPSS Statistics version 27. Continuous variables were summarised as means ± standard deviations (SD) or medians, and categorical variables as frequencies and percentages. Associations between categorical variables and overall knowledge category were tested with the chi-square test of independence; where expected cell counts were below 5, categories were collapsed and Fisher's exact test was used as a robustness check. Mean overall knowledge scores were compared between aware and unaware respondents using Welch's t-test, which does not assume equal variances [22], and across class levels and sources of awareness using one-way analysis of variance (ANOVA) with Tukey's honestly significant difference post-hoc test. Pearson's product-moment correlation was used to examine relationships among the three domain scores and between each domain score and age. The overall composite score was not correlated with its own component domains because the domains are algebraic components of it.

Two multivariable models were fitted to adjust for confounding. Multiple linear regression modelled the overall knowledge score (%) as a continuous outcome. Multivariable binary logistic regression modelled adequate knowledge (moderate or good) versus poor knowledge [23]. Both models included age, class, fathers' and mothers' education, log-transformed household income, religion, ethnicity and awareness status. Multicollinearity was assessed with variance inflation factors (VIF), with values below 5 considered acceptable. Results are presented as unstandardised coefficients (B) or adjusted odds ratios (AOR) with 95% confidence intervals (CI). Analyses used available data, and the denominator for each analysis is reported. All tests were two-tailed, with statistical significance set at $p < 0.05$.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki [24]. Ethical approval was obtained from the University of Ibadan/University College Hospital (UI/UCH) Ethics Committee, College of Medicine, University of Ibadan (approval number UI/EC/23/0155).

Written informed consent was obtained from parents or guardians, and assent from the adolescents, before data collection. Participation was voluntary and confidential, and participants were not exposed to any risk. The additional analyses reported here used de-identified data. Permission was obtained from school principals, and the date of ethical approval was 3/5/23.

Results

Socio-demographic characteristics of respondents

A total of 396 in-school female adolescents were analysed. Their ages ranged from 11 to 18 years (mean 14.7 ± 1.7 years), and most (61.6%) were aged 14–16 years (Figure 1). Most respondents were of Yoruba ethnicity (73.0%), followed by Igbo (17.7%), Hausa (4.0%) and other ethnic groups (5.3%). Two-thirds were Christian (66.4%) and one-third were Muslim (33.6%). Respondents were evenly distributed across class levels, from JSS2 (25.8%) to SS3 (25.3%) (Table 1). More than half of fathers (54.5%) and nearly half of mothers (47.0%) had secondary education as their highest level, and 41.4% of fathers and 48.0% of mothers had tertiary education. Civil service was the most common occupation among fathers (36.1%) and artisanship among mothers (48.9%). Median monthly income was ₦50,000 for fathers and ₦30,000 for mothers.

Table 1. Socio-demographic characteristics of respondents (N = 396)

Characteristic	N	%
Age (years); mean ± SD 14.7 ± 1.7; range 11–18		
11–13	91	23.0
14–15	151	38.1
16–18	154	38.9
Ethnicity		
Yoruba	289	73.0
Igbo	70	17.7
Hausa	16	4.0
Others	21	5.3
Religion		
Christianity	263	66.4
Islam	133	33.6
Class		
JSS2	102	25.8
SS1	103	26.0
SS2	91	23.0
SS3	100	25.3

Characteristic	N	%
School		
Eleyele High School	103	26.0
Eleyele Secondary School	102	25.8
Oba Abass Alesinloye School	100	25.3
Anwarul-Islam Secondary School	91	23.0
Father's educational level		
Tertiary	164	41.4
Secondary	216	54.5
Primary	16	4.0
Father's occupation		
Professional	130	32.8
Civil servant	143	36.1
Artisan	122	30.8
Others	1	0.3
Mother's educational level		
Tertiary	190	48.0
Secondary	186	47.0
Primary	20	5.1
Mother's occupation		
Professional	126	31.9
Civil servant	75	19.0
Artisan	193	48.9
Others	1	0.3
Monthly income (₦), median (mean ± SD)		
Father	50,000 (56,124 ± 34,886)	
Mother	30,000 (40,193 ± 25,713)	

Note. SD = standard deviation; JSS = Junior Secondary School; SS = Senior Secondary School. Percentages are of valid responses (n = 395 for mother's occupation). Percentages for some variables do not sum to exactly 100 because of rounding.

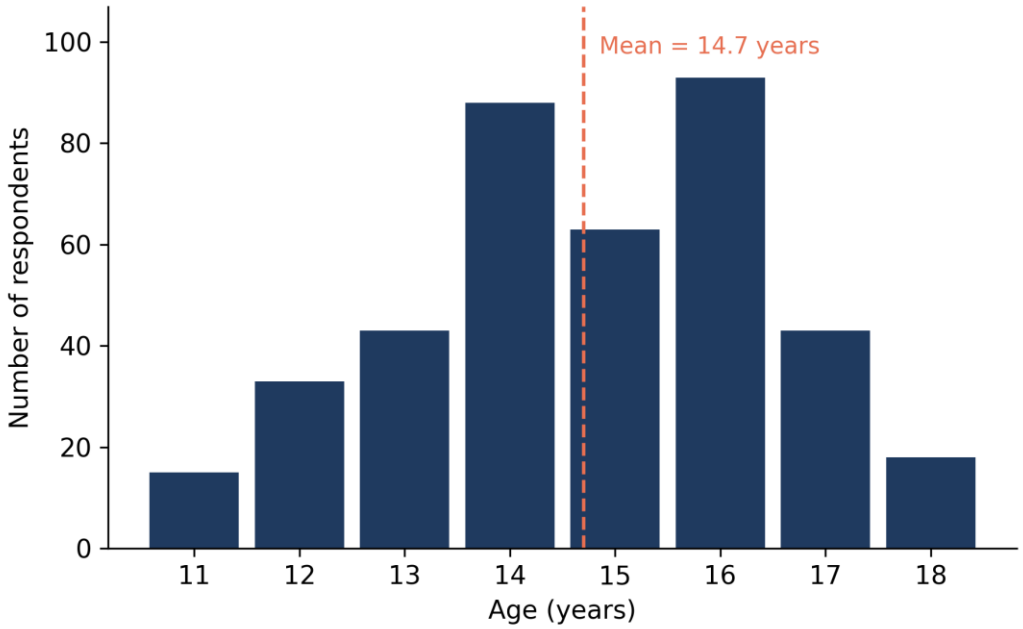


Figure 1. Age distribution of respondents (N = 396).

Awareness of breast cancer

Most respondents (82.6%; n = 327) had heard of breast cancer, whereas 17.4% (n = 69) had not (Table 2). Of the 327 aware respondents, 325 specified a source of awareness. The internet was the most frequently cited source (27.7%), followed by mass media (24.3%), the school curriculum (18.5%), friends or relatives (16.6%) and health workers (12.9%) (Figure 2).

Table 2. Awareness of breast cancer among respondents (N = 396)

Has heard of breast cancer before	N	%
Yes	327	82.6
No	69	17.4

Note. Among the 327 aware respondents, 325 specified a source of awareness (Figure 2).

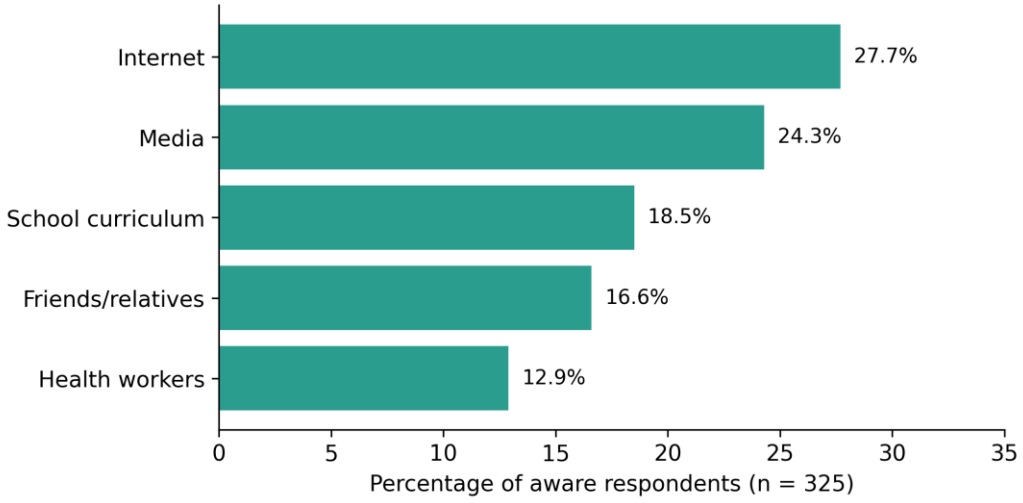


Figure 2. Source of first awareness of breast cancer among respondents who had heard of the disease (n = 325).

Knowledge of signs and symptoms

Item-level responses are shown in Table 3. Of the nine items, the lowest proportion of correct responses was for the item asking whether the respondent was aware of any signs or symptoms of breast cancer (39.6%). Breast pain (63.4%) and breast lump (57.8%) were the most frequently recognised signs, whereas nipple itchiness (45.6%) and nipple discharge (46.2%) were recognised by fewer than half of respondents. The mean domain score was 49.8 ± 25.9% (raw score 4.5 ± 2.3 out of 9). By the modified Bloom's cut-off, 67.3% of respondents had poor knowledge, 23.3% moderate knowledge and 9.4% good knowledge (Figure 3).

Table 3. Item-level knowledge of breast cancer signs and symptoms (N = 395–396)

Statement	n	Yes (correct) %	No %	Don't know %
Are you aware of any signs/symptoms of breast cancer?	396	39.6	45.2	15.2
Pain in the breast can be a symptom	396	63.4	20.0	16.7
A lump in the breast can be a sign	396	57.8	20.5	21.7
Nipple discharge can be an indicator	396	46.2	31.3	22.5
Nipple itchiness can be a sign	395	45.6	32.7	21.8
Change in breast shape can be an indicator	395	48.1	29.1	22.8
Dimpling of breast skin can be a symptom	395	51.6	21.5	26.8
Discoloration/redness of breast skin can be a symptom	395	47.8	24.8	27.3
Wrinkled or scaly breast skin can be a sign	395	48.9	22.8	28.4

Note. "Yes" was scored as correct for every item. Percentages are of valid responses per item.

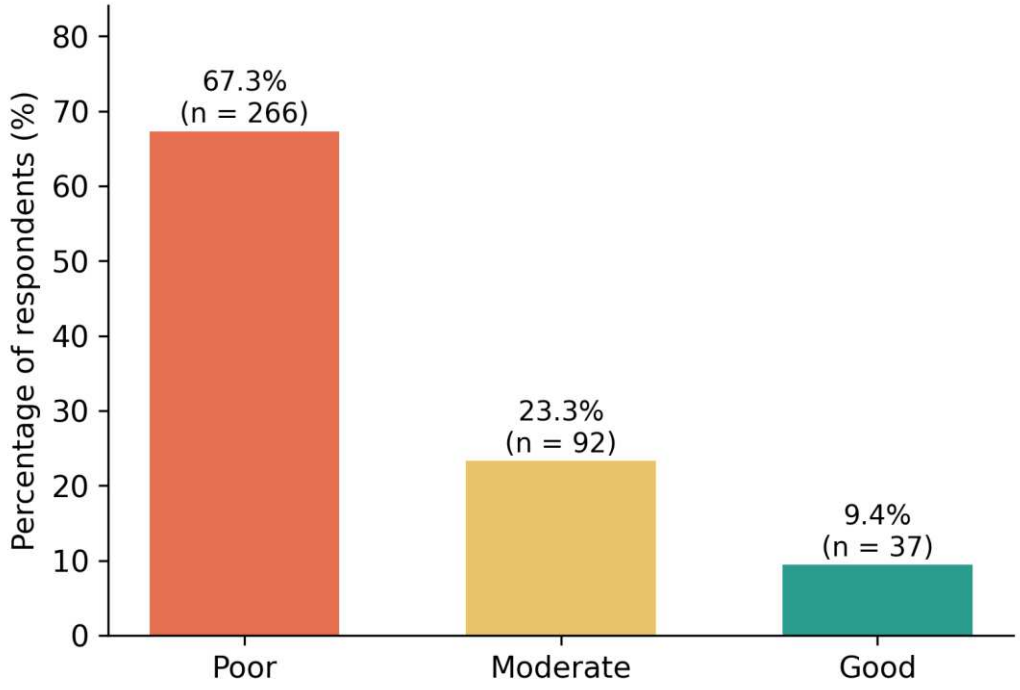


Figure 3. Categorised level of knowledge of breast cancer signs and symptoms (modified Bloom's cut-off; n = 395).

Knowledge of risk factors

Item-level responses are shown in Table 4. No more than 52.9% of respondents correctly identified any individual risk factor, and only tobacco smoking (52.9%) exceeded 50%. The least recognised items were increasing age (27.8%), late menopause (28.4%), early menarche (30.9%), overweight or obesity (32.6%) and being female (33.1%). Tobacco smoking (52.9%), alcohol intake (48.4%), family history (48.0%) and high fruit and vegetable intake (47.5%) were the most recognised. The mean domain score was 40.3 ± 20.6% (raw score 8.1 ± 4.1 out of 20). Knowledge was poor in 81.8% of respondents, moderate in 13.7% and good in 4.6% (Figure 4).

Table 4. Item-level knowledge of breast cancer risk factors (N = 393–396)

Statement	n	Yes (correct) %	No %	Don't know %
Being born female increases risk	396	33.1	46.0	21.0
Increasing age increases risk	396	27.8	49.2	23.0
Physical inactivity increases risk	396	39.9	33.3	26.8
Overweight/obesity increases risk	396	32.6	42.2	25.3
High-fat diet increases risk	396	37.9	35.1	27.0
High fruit/vegetable intake decreases risk	396	47.5	34.3	18.2
High calcium intake decreases risk	393	44.8	32.3	22.9
Inherited genes (e.g., CHEK2) increase risk	396	41.4	29.8	28.8
Family history increases risk	396	48.0	32.6	19.4
Tobacco smoking increases risk	395	52.9	22.8	24.3
Excess alcohol intake increases risk	395	48.4	27.3	24.3
Early menarche (<12 years) increases risk	395	30.9	49.4	19.7
Late menopause (>55 years) increases risk	395	28.4	43.0	28.6
Breastfeeding decreases risk	395	41.5	35.7	22.8
Birth-control pill use increases risk	395	39.7	31.4	28.9
Hormone replacement therapy increases risk	396	42.9	28.5	28.5
Chest radiation at a young age increases risk	396	45.2	32.6	22.2
Exposure to estrogen-like drugs (e.g., DES) increases risk	396	44.7	30.3	25.0
Exposure to carcinogens (e.g., radon) increases risk	396	38.6	30.8	30.6
Environmental pollution increases risk	396	40.9	30.3	28.8

Note. "Yes" was scored as correct for every item. Percentages are of valid responses per item. DES = diethylstilbestrol.

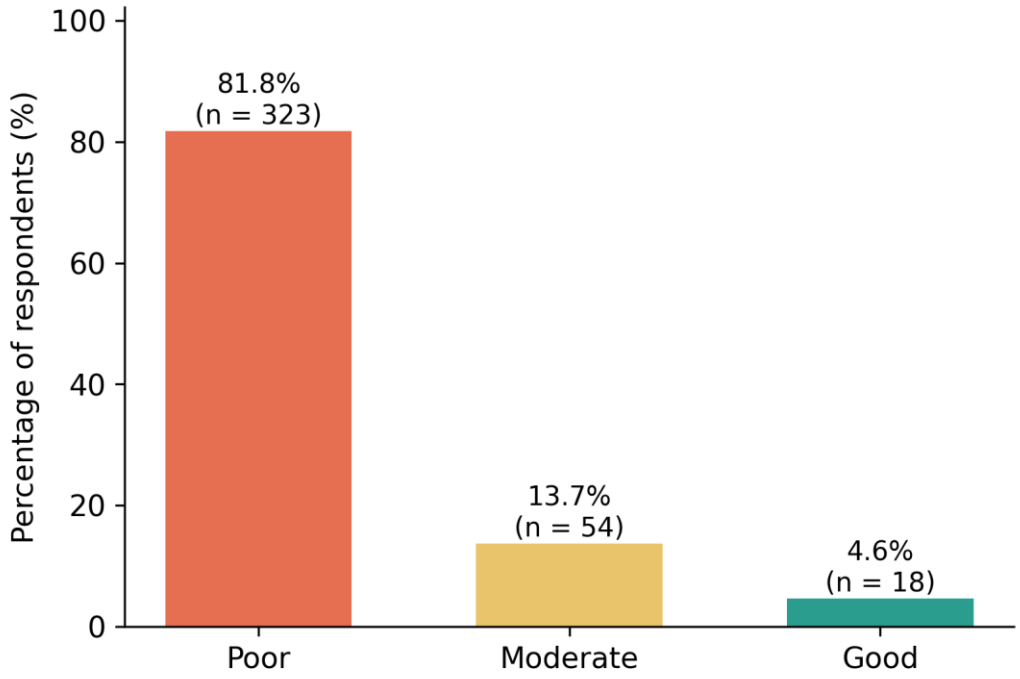


Figure 4. Categorised level of knowledge of breast cancer risk factors (modified Bloom's cut-off; n = 395).

Knowledge of prevention

Twelve of the 15 prevention items were answered correctly by more than half of respondents (Table 5); correct-response rates ranged from 43.2% (smoke-free home or workplace policy) to 59.8% (consuming at least 400 g/day of fruit and vegetables). The items answered correctly by fewer than half were the smoke-free policy (43.2%), avoiding household radon exposure (46.0%) and limiting foods high in fat (49.0%). The mean domain score was 53.4 ± 24.3% (raw score 8.0 ± 3.6 out of 15). Knowledge was poor in 54.0% of respondents, moderate in 27.8% and good in 18.2% (Figure 5).

Table 5. Item-level knowledge of breast cancer prevention (N = 392–396)

Statement	n	Yes (correct) %	No %	Don't know %
Maintaining a healthy weight prevents BC	392	57.1	26.8	16.1
Regular physical activity prevents BC	396	55.3	23.5	21.2
Desisting from tobacco smoking prevents BC	396	55.6	24.7	19.7
Smoke-free home/workplace policy prevents BC	396	43.2	32.8	24.0
Consuming ≥35 g/day whole grains and pulses prevents BC	396	50.5	26.5	23.0
Consuming ≥400 g/day fruit and vegetables prevents BC	396	59.8	21.7	18.4
Limiting foods high in sugar prevents BC	396	50.3	28.3	21.5
Limiting foods high in fat prevents BC	396	49.0	26.0	25.0
Limiting alcohol intake prevents BC	396	54.0	26.8	19.2

Statement	n	Yes (correct) %	No %	Don't know %
Workplace protection against carcinogens/safety rules prevents BC	393	57.8	19.8	22.4
Avoiding household radon exposure prevents BC	396	46.0	24.5	29.5
HPV vaccination reduces risk	396	57.3	20.2	22.5
Participation in organised screening prevents BC	396	52.8	24.0	23.2
Monthly breast self-examination prevents BC	396	57.6	21.0	21.5
Yearly mammogram (women >40 years) prevents BC	396	54.3	18.4	27.3

Note. BC = breast cancer; HPV = human papillomavirus. "Yes" was scored as correct for every item. Percentages are of valid responses per item.

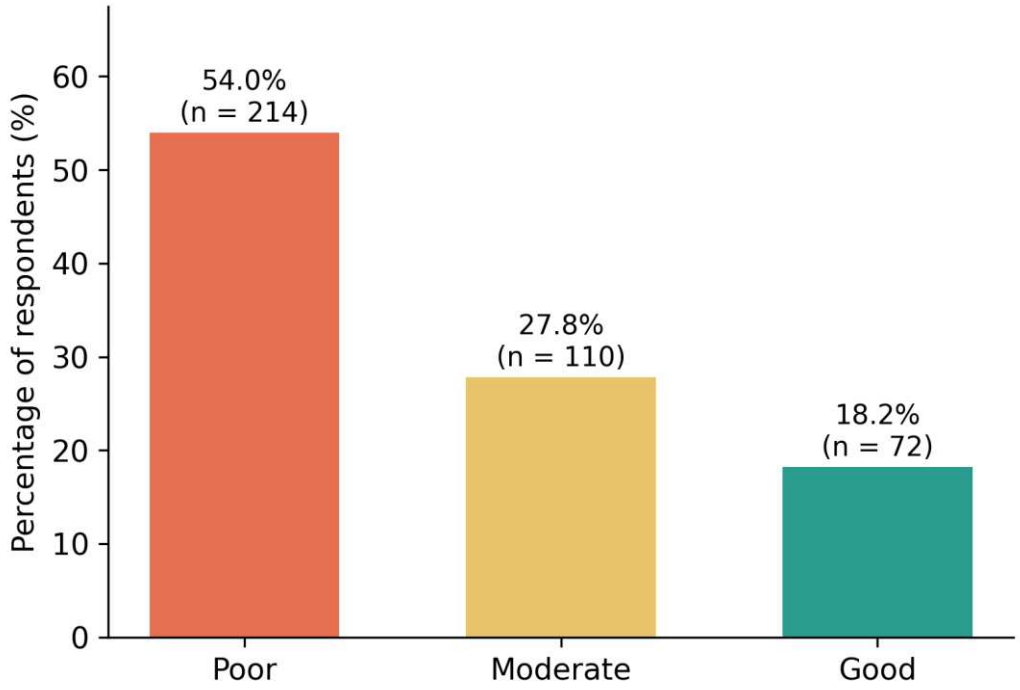


Figure 5. Categorised level of knowledge of breast cancer prevention (modified Bloom's cut-off; n = 396).

Comparison of knowledge domains

Table 6 and Figure 6 compare the three domains and the 44-item composite score. Mean overall knowledge was 46.7 ± 16.8% (raw score 20.5 ± 7.4 out of 44). Overall knowledge was poor in 80.1% of respondents, moderate in 17.9% and good in 2.0%. Ranked by mean score, prevention was highest (53.4%), followed by signs and symptoms (49.8%) and risk factors (40.3%). The proportion with good knowledge was highest for prevention (18.2%) and lowest for risk factors (4.6%) among the three domains.

Table 6. Knowledge scores and category distribution by domain

Domain	Items	Mean % ± SD	Poor % (n)	Moderate % (n)	Good % (n)
Signs and symptoms	9	49.8 ± 25.9	67.3 (266)	23.3 (92)	9.4 (37)
Risk factors	20	40.3 ± 20.6	81.8 (323)	13.7 (54)	4.6 (18)

Domain	Items	Mean % ± SD	Poor % (n)	Moderate % (n)	Good % (n)
Prevention	15	53.4 ± 24.3	54.0 (214)	27.8 (110)	18.2 (72)
Overall composite	44	46.7 ± 16.8	80.1 (317)	17.9 (71)	2.0 (8)

Note. Categories: poor <60%, moderate 60–79%, good ≥80% (modified Bloom's cut-off). n = 395 for signs and symptoms and for risk factors, and n = 396 for prevention and overall.

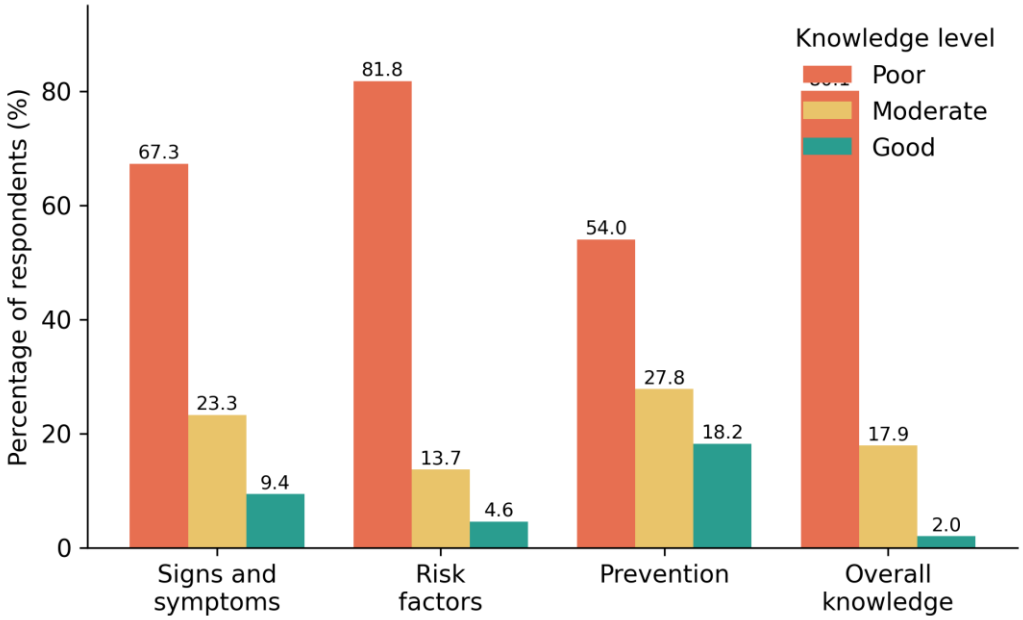


Figure 6. Distribution of knowledge categories across the three domains and overall.

Relationship among knowledge domains

All three domain scores were positively and significantly correlated (Table 7, Figure 7). The strongest correlation was between signs and symptoms and risk factors ($r = 0.43$, $p < 0.001$), followed by signs and symptoms and prevention ($r = 0.28$, $p < 0.001$); risk-factor and prevention scores were weakly correlated ($r = 0.20$, $p < 0.001$). Age was not significantly correlated with signs and symptoms ($r = 0.09$, $p = 0.084$) or prevention ($r = -0.01$, $p = 0.884$), and showed a small negative correlation with risk-factor knowledge ($r = -0.10$, $p = 0.045$).

Table 7. Pearson correlations among knowledge domain scores and age (n = 394)

Variable	Signs and symptoms	Risk factors	Prevention
Risk factors	0.426**		
Prevention	0.280**	0.200**	
Age	0.087	−0.101*	−0.007

Note. *p < 0.05;* *p < 0.001 (two-tailed). Correlations with the overall composite score are not shown because the domains are components of it. The age row gives the correlation of age with each domain score.

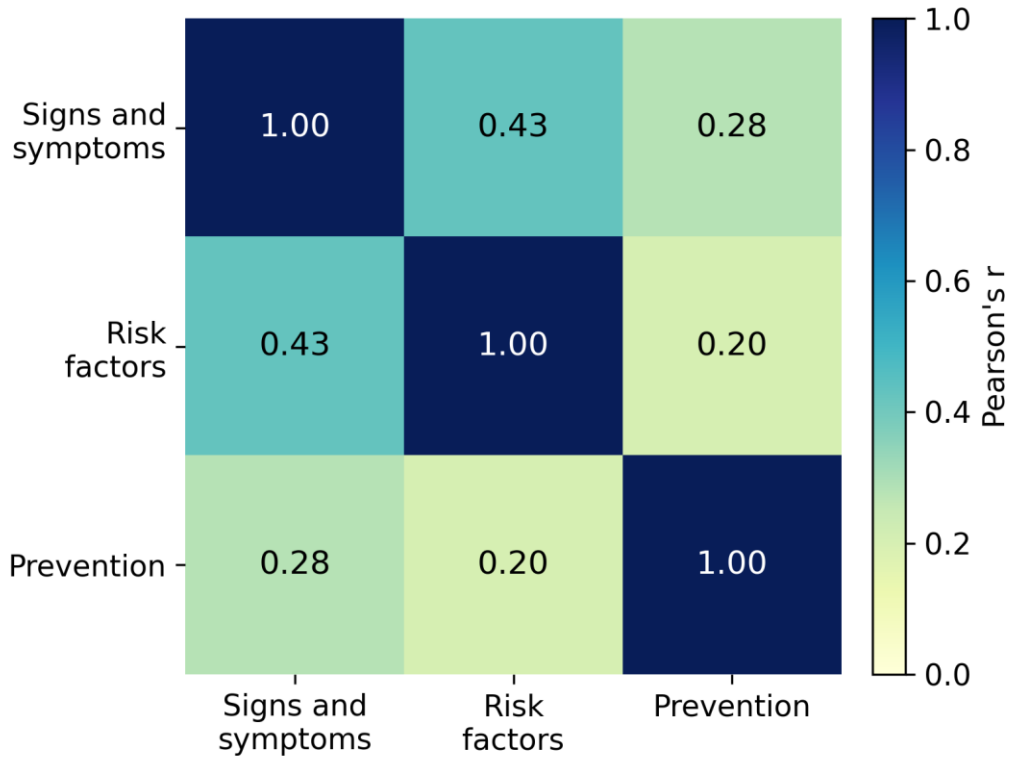


Figure 7. Pearson correlation matrix among the three knowledge domain scores.

Socio-demographic and awareness correlates of overall knowledge

Overall knowledge category was not significantly associated with class ($\chi^2 = 5.92$, df = 6, p = 0.432), father's education ($\chi^2 = 5.50$, df = 4, p = 0.240), mother's education ($\chi^2 = 4.56$, df = 4, p = 0.335), ethnicity ($\chi^2 = 5.38$, df = 6, p = 0.496), age group ($\chi^2 = 3.70$, df = 4, p = 0.448) or prior awareness of breast cancer ($\chi^2 = 0.69$, df = 2, p = 0.709) (Table 8, Figure 8). Mean overall score did not differ significantly across class levels (one-way ANOVA F = 0.63, p = 0.594). Aware respondents did not score significantly higher than unaware respondents (47.5 ± 15.4%, n = 327, versus 43.2 ± 21.7%, n = 69; Welch's t = 1.55, p = 0.124).

Religion was the only variable with a nominally significant chi-square result ($\chi^2 = 6.67$, df = 2, p = 0.036). However, this test rested on sparse cells (the expected count for the Christian–good cell was 2.7). When moderate and good knowledge were combined, the association disappeared ($\chi^2 = 0.00$, p = 1.000; Fisher's exact OR = 1.03, p = 0.895).

Table 8. Association of socio-demographic and awareness characteristics with overall knowledge

Characteristic (test)	Test statistic	Df	p-value
Class (chi-square)	$\chi^2 = 5.92$	6	0.432
Father's education (chi-square)	$\chi^2 = 5.50$	4	0.240
Mother's education (chi-square)	$\chi^2 = 4.56$	4	0.335
Ethnicity (chi-square)	$\chi^2 = 5.38$	6	0.496

Characteristic (test)	Test statistic	Df	p-value
Age group (chi-square)	$\chi^2 = 3.70$	4	0.448
Religion (chi-square, three knowledge categories)	$\chi^2 = 6.67$	2	0.036*
Religion (chi-square, poor vs moderate/good; robustness check)	$\chi^2 = 0.00$	1	1.000
Prior awareness of breast cancer (chi-square)	$\chi^2 = 0.69$	2	0.709
Class (ANOVA of mean overall score)	F = 0.63	3, 391	0.594
Awareness status (Welch's t-test of mean overall score)	t = 1.55	—	0.124

Note. *Nominally significant, but based on sparse expected cell counts (<5) and not confirmed in the collapsed analysis (Fisher's exact OR = 1.03, p = 0.895). Two-tailed α = 0.05.

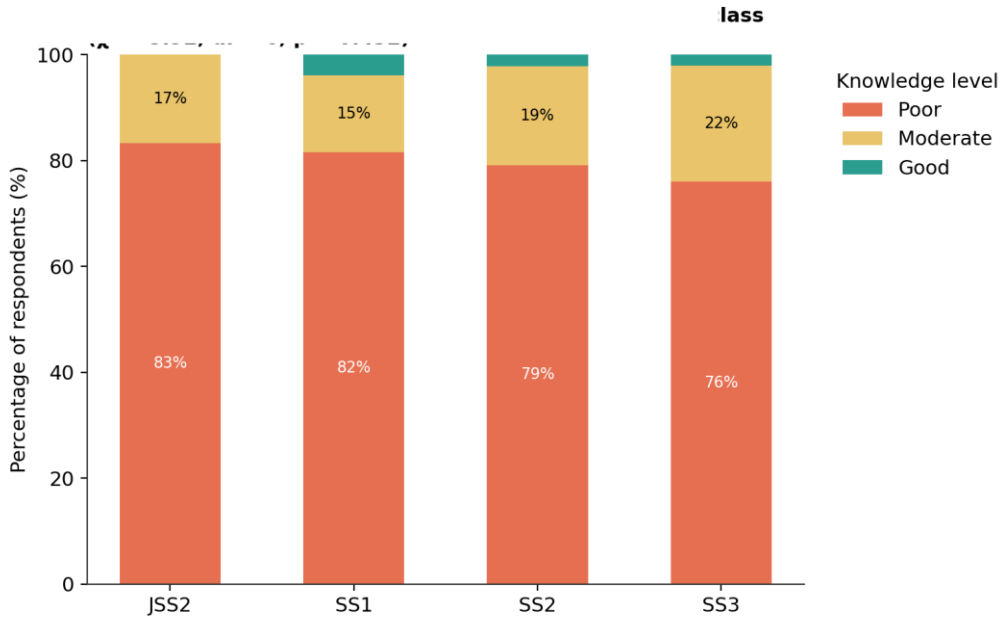


Figure 8. Overall breast cancer knowledge category by class ($\chi^2 = 5.92$, df = 6, p = 0.432).

Overall knowledge by source of awareness

Among the 325 respondents who specified a source of awareness, mean overall knowledge was highest for those first informed through the internet (48.7 ± 13.2%, n = 90) and lowest for those informed by a health worker (42.9 ± 20.4%, n = 42); media (48.3 ± 16.1%, n = 79), school curriculum (48.6 ± 15.4%, n = 60) and friends or relatives (46.3 ± 13.2%, n = 54) fell in between (Table 9, Figure 9). The differences were not statistically significant (one-way ANOVA F = 1.27, df = 4, 320, p = 0.282), and no pairwise comparison reached significance in Tukey's post-hoc test (all adjusted p > 0.27).

Table 9. Mean overall knowledge score (%) by source of first awareness

Source of awareness	n	Mean % ± SD
Internet	90	48.7 ± 13.2
School curriculum	60	48.6 ± 15.4
Media	79	48.3 ± 16.1

Source of awareness	n	Mean % ± SD
Friends/relatives	54	46.3 ± 13.2
Health workers	42	42.9 ± 20.4

Note. One-way ANOVA: F = 1.27, df = 4, 320, p = 0.282. Tukey's HSD post-hoc comparisons: all pairwise adjusted p > 0.27.

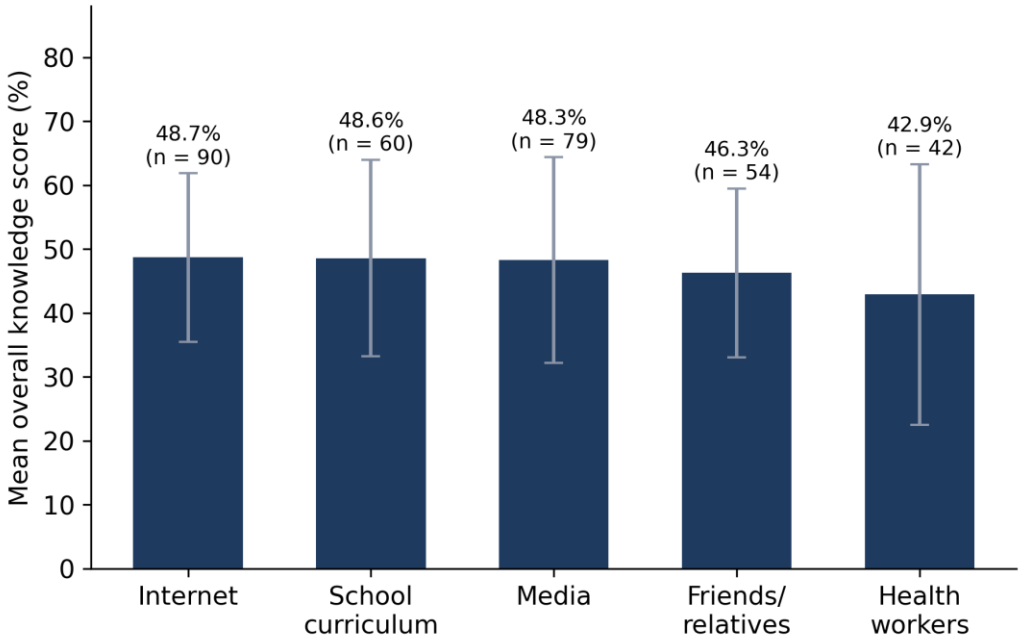


Figure 9. Mean overall knowledge score by source of first awareness (error bars show SD; one-way ANOVA F = 1.27, p = 0.282).

Multiple linear regression

The linear model including age, class, parental education, log-transformed household income, religion, ethnicity and awareness status did not explain a significant proportion of the variance in overall knowledge ($R^2 = 0.029$, adjusted $R^2 = 0.004$; $F(10, 385) = 1.15$, $p = 0.326$; Table 10). No individual coefficient was significant at $p < 0.05$. Age (B = −1.32, p = 0.090) and class level (B = 1.72, p = 0.056) showed borderline associations in opposite directions. Age and class were strongly correlated (r = 0.77, p < 0.001), and the VIF was 2.5 for each, below the threshold of 5.

Table 10. Multiple linear regression of overall knowledge score (%) on socio-demographic and awareness predictors (N = 396)

Predictor	B	SE	t	p	95% CI
Intercept	38.49	18.14	2.12	0.035*	2.82, 74.16
Age (years)	−1.32	0.78	−1.70	0.090	−2.84, 0.21
Class level (JSS2–SS3)	1.72	0.90	1.91	0.056	−0.05, 3.49
Father's education (ordinal)	1.48	1.85	0.80	0.422	−2.15, 5.12
Mother's education (ordinal)	0.72	1.80	0.40	0.688	−2.82, 4.26
Log (household income)	1.10	1.49	0.74	0.459	−1.82, 4.03
Religion: Islam (ref. Christianity)	0.21	1.94	0.11	0.914	−3.61, 4.03

Predictor	B	SE	t	p	95% CI
Aware of breast cancer (ref. not aware)	3.44	2.33	1.47	0.141	−1.15, 8.03
Ethnicity: Hausa (ref. Yoruba)	1.39	4.41	0.32	0.753	−7.29, 10.07
Ethnicity: Igbo (ref. Yoruba)	−0.60	2.35	−0.25	0.799	−5.23, 4.03
Ethnicity: Others (ref. Yoruba)	−3.47	3.91	−0.89	0.376	−11.15, 4.22

Note. $R^2 = 0.029$; adjusted $R^2 = 0.004$; overall model $F(10, 385) = 1.15$, $p = 0.326$. *$p < 0.05$. B = unstandardised coefficient; SE = standard error; CI = confidence interval.

Multivariable logistic regression

The logistic model was not significant overall (likelihood-ratio test $p = 0.475$; pseudo-R^2 = 0.024; Table 11, Figure 10). Class level was the only predictor with a statistically significant adjusted association: each one-level increase in class was associated with 37% higher odds of adequate knowledge (AOR 1.37, 95% CI 1.04–1.82, $p = 0.028$). Age showed a non-significant association in the opposite direction (AOR 0.82, 95% CI 0.65–1.04, $p = 0.104$). Parental education, household income, religion, ethnicity and prior awareness were not significantly associated with adequate knowledge.

Table 11. Multivariable logistic regression: adjusted odds ratios for adequate (moderate or good) versus poor overall knowledge (N = 396)

Predictor	AOR	95% CI	P
Age (years)	0.82	0.65, 1.04	0.104
Class level (JSS2–SS3)	1.37	1.04, 1.82	0.028*
Father's education (ordinal)	1.24	0.71, 2.16	0.457
Mother's education (ordinal)	1.24	0.72, 2.16	0.439
Household income (log)	1.02	0.66, 1.58	0.944
Religion: Islam (ref. Christianity)	1.10	0.62, 1.95	0.738
Aware of breast cancer (ref. not aware)	0.69	0.35, 1.34	0.275
Ethnicity: Hausa (ref. Yoruba)	0.84	0.22, 3.18	0.794
Ethnicity: Igbo (ref. Yoruba)	0.87	0.42, 1.80	0.708
Ethnicity: Others (ref. Yoruba)	1.51	0.53, 4.25	0.440

Note. AOR = adjusted odds ratio; CI = confidence interval. *$p < 0.05$. Reference outcome: poor knowledge. Overall model: pseudo-$R^2 = 0.024$; likelihood-ratio test $p = 0.475$.

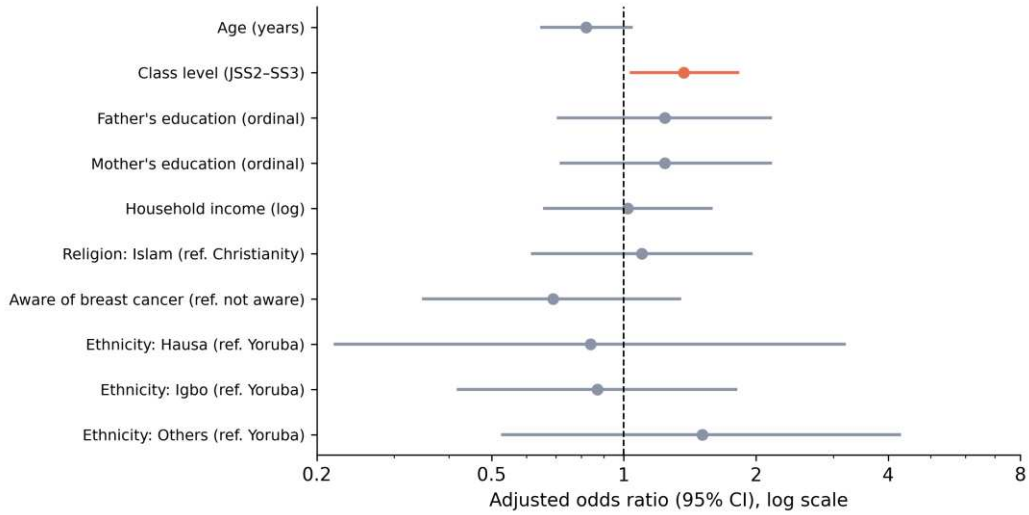


Figure 10. Adjusted odds ratios (95% CI) for adequate versus poor overall knowledge from multivariable logistic regression (log scale; reference line at 1).

Discussion

In this cross-sectional study of 396 in-school female adolescents in Ibadan North-West LGA, awareness of breast cancer was high (82.6%), but knowledge was poor: four in five respondents (80.1%) had poor overall knowledge and only 2.0% had good knowledge. Knowledge was weakest for risk factors (mean score 40.3%; 81.8% poor) and strongest, though still inadequate, for prevention (53.4%; 54.0% poor). Knowledge category did not differ by socio-demographic characteristics in bivariate tests, and the multivariable models explained very little of the variation in knowledge. This findings is in constrast to the study of Ademiluyi et al. [25] carried out among in-school adolescents in Ogun State reported predominantly moderate nutrition knowledge. Adolescents with stronger nutrition knowledge and supportive behavioural perceptions are more likely to adopt healthy eating practices that reduce the risk of diet-related non-communicable disease (like breast cancer) conditions that disproportionately affect adolescent girls [25, 26].

The high level of awareness is consistent with a study of secondary school girls in Kota Bharu, Malaysia [27]. The internet and mass media were the leading sources of awareness, as reported among adolescent girls in Colombo, Sri Lanka [15]. This may reflect adolescents' heavy use of the internet and social media for information. In contrast, females older than 14 years in India named health workers as their leading source [28], which may reflect differences in setting and contact with health services. In the present study, health workers and the school curriculum were among the least cited sources. Awareness status and source of awareness were not associated with overall knowledge, which suggests that having heard of breast cancer,

through any channel, does not by itself translate into knowledge of its risk factors, signs and prevention.

Knowledge of risk factors was the poorest of the three domains. Only 27.8% recognised increasing age as a risk factor, a finding that Hassan and Shitu [29] also reported among university students in Yola, Nigeria. Reproductive risk factors were poorly recognised (early menarche, 30.9%; late menopause, 28.4%), consistent with a study of Malaysian female university students in which most were unaware of these factors [30]. Family history was recognised by 48.0% of respondents, similar to adolescents in Sri Lanka [15], and 37.9% identified a high-fat diet as a risk factor, similar to the findings of Hassan and Shitu [29]. By contrast, 38.6% identified exposure to carcinogens as a risk factor, lower than reported by Hassan and Shitu [29] among undergraduates, who may have more formal education than the adolescents studied here. Differences from studies of adult women [31] may likewise reflect differences in health literacy and age. The high proportion with poor risk-factor knowledge is consistent with studies among Malaysian adolescents aged 15–19 years [14] and secondary school girls in Delta State, Nigeria [11].

Recognising symptoms is important because it enables women to seek care early. Only 39.6% of respondents reported being aware of any sign or symptom of breast cancer. Breast pain and breast lump were the most frequently recognised signs, whereas skin changes and nipple changes were less well recognised. This pattern, in which common symptoms are recognised but less typical ones are not, mirrors findings among adolescent girls in Colombo, where a lump was widely recognised but knowledge of other signs was poor [15], and among Malaysian university students, most of whom knew that breast cancer could present as a lump in the armpit and breast pain [30]. Hassan and Shitu [29] found that most undergraduates were aware of signs and symptoms, which may reflect their higher level of education compared with the adolescents in this study.

Knowledge of prevention was comparatively higher. More than half of respondents recognised physical activity (55.3%), a healthy weight (57.1%) and limiting alcohol (54.0%) as preventive measures, and 54.3% to 57.6% endorsed mammography and breast self-examination. A likely explanation is that these messages overlap with general health promotion on diet, physical activity and tobacco, which adolescents may encounter through several channels, whereas risk-factor knowledge, particularly of reproductive and genetic factors, requires more specific instruction. Parental communication may be a limited channel: in a US study, only 2% of college women reported that their mothers had mentioned exercise as a way of preventing

breast cancer [32], and we found no association between parental education and adolescents' knowledge. Respondents' views on screening differed from those of adult women in Ede, Osun State [31], possibly because of differences in health literacy. Breast self-examination, mammography and organised screening are early-detection measures rather than primary prevention, and they were keyed as preventive in the instrument; this should be considered when interpreting prevention scores.

The three knowledge domains were positively but modestly correlated (r = 0.20–0.43), suggesting that they capture partly distinct aspects of breast cancer knowledge. Educational content should therefore address risk factors, symptoms and prevention separately, rather than assuming that improving one will improve the others.

None of the socio-demographic variable was robustly associated with knowledge category. The nominal association with religion was not sustained in the collapsed analysis and rested on sparse cells, so it should not be interpreted as evidence of a real difference. Age was not associated with knowledge category, in line with Akpo et al. [11], who found no relationship between age and knowledge among Nigerian secondary school girls. The small negative correlation between age and risk-factor knowledge (r = −0.10) was of borderline significance among many tests and should be interpreted cautiously. Parental education was not associated with knowledge, which suggests that breast cancer knowledge is not substantially acquired through the home environment, although this study did not measure parent–child communication.

In the logistic regression, higher class level was independently associated with higher odds of adequate knowledge (AOR 1.37), whereas age tended in the opposite direction. This association was not seen in unadjusted analyses, and age and class were strongly correlated (r = 0.77). Because the overall regression models were not significant, this finding is exploratory and should be interpreted with caution. It is, however, in the same direction as a study of Nigerian undergraduates in which year of study was associated with knowledge of breast cancer [13]. If confirmed, it would support reinforcing breast health content at successive class levels.

Poor knowledge was widespread and similar across subgroups, which supports a universal school-based approach rather than targeting particular groups. The school curriculum was cited by fewer than one in five aware respondents, and those who cited it did not have higher knowledge than those who cited other sources. This suggests that incidental references to breast

cancer are unlikely to build the depth of knowledge required. Structured, age-appropriate, curriculum-integrated breast health education, with emphasis on risk factors, is warranted. Peer education and teaching tools have improved adolescents' knowledge in Nigerian schools [8–10], and involving health workers in school health talks could strengthen a channel that respondents cited least often.

Strengths include random selection of schools and respondents, a sample exceeding the calculated minimum, scoring of three knowledge domains with a uniform and widely used categorisation, and adjustment for multiple covariates. Several limitations should be considered. First, the cross-sectional design precludes causal inference. Second, only four public schools in one LGA were sampled, so the findings may not generalise to private schools, other LGAs or other parts of Nigeria. Third, all 44 knowledge items were keyed "Yes", so acquiescence bias could inflate scores, and scoring "I don't know" as incorrect combines uncertainty with misconception. Fourth, some items reflect general cancer-prevention recommendations rather than established breast-cancer-specific measures (for example, HPV vaccination and radon exposure), and the first signs-and-symptoms item measures self-reported awareness rather than knowledge. Responses to these items should be interpreted as agreement with the instrument rather than as independent epidemiological claims. Fifth, the sampling and analysis did not account for clustering of students within schools and classes. [one class per school was sampled; the class finding was exploratory] Sixth, only 8 respondents had good overall knowledge, which limited the power of subgroup comparisons and made at least one chi-square test unstable. Seventh, many statistical tests were performed without adjustment for multiple comparisons. Finally, the data were self-reported and collected in 2023, and instrument validation is described under Methods.

Conclusions

Most in-school female adolescents in Ibadan North-West LGA had heard of breast cancer, but their knowledge of its risk factors, signs and symptoms, and prevention was generally poor, and this was true across age, class, parental education, ethnicity and religion. Knowledge of risk factors was the weakest. These findings support the introduction of structured, curriculum-based breast health education in secondary schools, delivered to all students and with particular attention to risk factors. Future studies should evaluate such programmes using pre–post or quasi-experimental designs, use balanced knowledge instruments that include false statements, and include schools from more LGAs and from private schools.

List of abbreviations

AOR: adjusted odds ratio; ANOVA: analysis of variance; BC: breast cancer; CI: confidence interval; ECAC: European Code Against Cancer; HPV: human papillomavirus; JSS: Junior Secondary School; KAP: knowledge, attitude and practice; LGA: Local Government Area; SD: standard deviation; SS: Senior Secondary School; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology; VIF: variance inflation factor.

Declarations

Ethics approval and consent to participate

Ethical approval was granted by the University of Ibadan/University College Hospital (UI/UCH) Ethics Committee, College of Medicine, University of Ibadan (approval number UI/EC/23/0155). Written informed consent was obtained from parents or guardians, and assent was obtained from all adolescent participants. The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request. The questionnaire is provided as Additional file 1.

Competing interests

The authors declare that they have no competing interests.

Funding

The authors received no specific funding for this work.

Authors' contributions

EOA and MOO conceived and designed the study, supervised data collection. EOA and DDA contributed to drafting the manuscript, study design and critically reviewed the manuscript. DDA and BAO, performed the formal analysis, interpreted the data, and drafted and revised the manuscript. JGI and ASA contributed to data curation and manuscript review. HGF contributed to data collection and reviewed the manuscript. All authors read and approved the final manuscript

Acknowledgements

The authors thank the students, parents and guardians, teachers and of the participating schools.

Supplementary information principals

Additional file 1: Study questionnaire (Sections A–E).

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