

# Identifying Clusters of Reproductive-Age Women Not Screened for Cervical and Breast Cancer in Ghana

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## Abstract

**Purpose:** There is a significant rise in mortality rates from breast and cervical cancers in Low- and Middle-Income Countries. In Ghana, approximately 4482 women are diagnosed with these diseases at advanced stages. Unfortunately, the early detection rate for these cancers is low compared to other women's health services. This situation underscores the need to identify the locations of reproductive-age women who have not been screened for these cancers, to implement targeted public health interventions. This study aims to pinpoint these women's locations for tailored interventions. **Method:** Bivariate analysis assessed the relationship between the independent and outcome variables. Hot spot analysis and Kriging Ordinary interpolation were employed to pinpoint the locations of these women. **Results:** Breast cancer examination and cervical cancer test rates were low, with a strong association between the two screening services. Several significant variables were identified: place of residence ( $p < 0.001$ ), combined wealth index ( $p < 0.001$ ), visits by fieldworkers ( $p < 0.001$ ), coverage by a National Health Insurance ( $p < 0.001$ ), and awareness of family planning through various media in the past few months. It was predicted that non-screened reproductive-age women were densely concentrated in areas far from the three publicly funded hospitals designated for cancer screening. **Conclusion:** Low participation in these screening services was related to women's age and the outreach efforts of fieldworkers. Breast and cervical cancer screenings are interconnected and could be combined to improve attendance rates. The Community-based Health Planning and Services (CHPS)

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implementation strategy could be cost-effective for screening women through targeted interventions, especially in identified clusters.

## Keywords

Breast Cancer Examination, Cervical Cancer Screening, Family Planning, Community-Based Health and Planning Services (CHPS), Kriging Ordinary Analysis, Non-Screened Reproductive-Age Women

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## 1. Background

Breast cancer poses a significant public health challenge globally, with rising prevalence and mortality rates among women [1] [2]. In Ghana, it is the leading cause of cancer-related deaths, with approximately 4482 women diagnosed at advanced stages of the disease [3]-[5]. This underscores the urgent need for early examination to detect the disease in its initial stages for effective treatment.

According to the 2022 Ghana Demographic and Health Survey, only 5% of women aged 15 - 49 were tested for cervical cancer, and just 18% were examined for breast cancer by healthcare workers [6]. These rates are alarmingly low compared to other maternal health services, such as antenatal care (98%) and postnatal care (87%) [6], which have seen increases within the same demographic.

While several studies in Ghana have explored the low participation rates in clinical breast cancer and cervical cancer screening—often focused on smaller groups, such as students or patients at health facilities—there is a lack of national studies that examine the factors influencing these screening activities among women of reproductive age. There is insufficient information available to potentially enhance screening services in the country by predicting the location of non-screened reproductive-age women.

Participants in this study were asked whether they had undergone screenings for cervical cancer using common methods such as self-examination, clinical breast examination, mammography, the Human Papillomavirus (HPV) test, or Visual Inspection with Acetic Acid (VIA) [6].

The World Health Organization recommends mammograms as a key method for early breast cancer detection, especially in high-income countries [7] [8]. However, this approach is not cost-effective in low-income countries like Ghana [7] [8]. Consequently, women are advised to perform regular self-breast examinations or visit health facilities for screenings. In addition, various stakeholders periodically organize screening events in selected communities [9]. Cervical cancer testing is performed by doctors and trained midwives at designated hospitals for a fee [10].

Most women delay seeking screenings until the disease reaches a critical stage, primarily due to a lack of knowledge about self-breast examinations and challenges in accessing healthcare facilities [11]. There is a prevalent belief among

many Ghanaians that “what you don’t know won’t kill you”, leading them to avoid check-ups or early diagnoses. Additionally, concerns about the time and costs associated with healthcare further discourage them.

The recent GDHS reported that 54% of women faced at least one barrier to accessing healthcare, with 45% citing financial issues for treatment and 22% pointing to the distance to health facilities. Sixteen percent expressed a desire to be accompanied by someone for visits [6]. Furthermore, the same study revealed that some women dropped out of the National Health Insurance Scheme (NHIS) for various reasons: 22% felt they could not afford the premiums, 2% did not trust the scheme, 5% claimed the insurance did not cover the services they needed, and 3% found access to health facilities difficult. Consequently, out-of-pocket payments among these women reached 53% [6].

A study by Anaba *et al.* (2024) identified that the uptake of screening exercises was influenced by a variety of factors, including predisposing factors (age, education, contraceptive use), enabling factors (wealth index, place of residence, region, health insurance status, and frequent media exposure), and need factors (visits by fieldworkers and HIV testing) [12]. Addressing these barriers could be achieved through the Community-Based Health Planning and Services (CHPS) initiative, which aims to deliver public health services directly to vulnerable communities [9] [13] [14].

This study intended to map locations of reproductive-age women who have not been screened for cervical and breast cancer, in hopes of improving participation in these essential screening programs in Ghana.

## 2. Material and Methods

### 2.1. Data Source

The 2022 Ghana Demographic and Health Survey (2022 GDHS) is the seventh and most recent survey in the series conducted by the Ghana Statistical Service (GSS) in collaboration with the Ministry of Health and various implementing agencies. This survey received financial support from the United States Agency for International Development (USAID) and other partners [6].

Data were collected from a nationally representative sample of approximately 18,540 households across all 16 regions of Ghana. In total, 17,933 households were surveyed, including 15,014 women of reproductive age (15 - 49 years) and 7044 men aged 15 to 59. Additionally, anthropometric measurements were taken from 4935 children aged 0 - 5 years [6]. This study specifically focused on variables related to women of reproductive age based on the survey objectives.

Participants were selected using a multistage (stratified two-stage cluster) sampling design. In the first stage, rural and urban areas were identified as the Primary Sampling Units (PSUs). In the second stage, households were selected within each cluster [6]. The study included women who responded “Yes” or “No” to questions regarding breast and cervical cancer screening.

## 2.2. Study Variables

### 2.2.1. Dependent Variables

This study considered two outcome variables. Women were asked whether a doctor or other healthcare provider had examined their breasts for signs of cancer. This examination could involve a physical palpation of the breast or a mammogram. The DHS code for this variable is v484a [6].

The second outcome variable is related to cervical cancer testing (v484b). Women were asked if a doctor or other healthcare provider had ever tested them for cervical cancer, using either the Human Papillomavirus (HPV) test or Visual Inspection with Acetic Acid (VIA) [6].

### 2.2.2. Independent Variables

Based on findings from the articles reviewed, these independent variables available in the dataset were considered;

Variable	DHS code
Age in 5-year groups	v013
Place of residence	v025
Region	v024
Wealth index combined	v190
Current marital status	v501
Height level of education	v106
Religion	v130
Time accessed health facility using a National Health insurance card	s1122
Frequency of reading magazines/newspapers	v157
Frequency of listening to radio	v158
Frequency watching television	v159
Frequency of using the Internet	v171b
Visited by fieldworker	v393
Minutes to the nearest facility	v483a
Times visited health facility last 6 months	s1121
Out-of-pocket for consultation	s1123a1
Covered by health insurance	v481
Heard about family planning on TV in the last few months	v384b
Heard about family planning in the newspapers last few months	v384c
Heard about family planning by text message on my mobile phone	v384d

## 2.3. Statistical Analysis

The R programming language is utilized for statistical analysis using various packages, including *survey*, *gtsummary*, *flextable*, *performance*, *broom*, *effectsize*, and *dplyr*. The samples were weighted, and a descriptive analysis was conducted to outline the characteristics of the samples. A chi-square test assessed the relationship between the outcome variables and the independent variables.

Additionally, the geographical cluster coordinates of non-screened reproductive-age women were analyzed using hot spot analysis (Getis-Ord  $G_i^*$ ) and Kriging Ordinary to predict their locations. These cluster coordinates were integrated with the values of non-screened women in the attribute table of the Ghana map shapefile. ArcGIS Pro software was employed for these analyses.

#### 2.4. Hot Spot Analysis Using Getis-Ord $G_i^*$ Statistics

This statistical method was used in the geographical information system (GIS) to identify and evaluate clusters of high and low values within spatial data [15] [16]. A local measure of spatial autocorrelation was obtained by assessing the clustering values within a defined neighbourhood. Hot spots indicate areas with significantly high values, while cold spots indicate significantly low ones. The estimation was based on the cluster coordinates and the number of non-screened women.

The estimation compares the local sum of attribute values, weighted by spatial weights, to the expected local sum under the null hypothesis of random spatial distribution. A high positive  $G_i^*$  value indicates the presence of a hot spot, which is a cluster of high values, while a low negative  $G_i^*$  value indicates a cold spot, representing a cluster of low values [15] [16].

Mathematical Formula [15]

The Getis-Ord local statistic is given as:

$$G_i^* = \frac{\sum_{j=1}^n \omega_{i,j} x_j - \bar{X} \sum_{j=1}^n \omega_{i,j}}{S \sqrt{\frac{n \sum_{j=1}^n \omega_{i,j}^2 - \left( \sum_{j=1}^n \omega_{i,j} \right)^2}{n-1}}} \quad (1)$$

where  $x_j$  is the attribute value for feature  $j$ ,  $\omega_{i,j}$  is the spatial weight between feature  $i$  and  $j$ ,  $n$  is equal to the total number of features and:

$$\bar{X} = \frac{\sum_{j=1}^n x_j}{n} \quad (2)$$

$$S = \sqrt{\frac{\sum_{j=1}^n x_j^2}{n} - (\bar{X})^2} \quad (3)$$

The  $G_i^*$  statistic is a z-score so no further calculations are required.

#### 2.5. Kriging Ordinary Interpolation Analysis

Kriging analysis was used to predict the number of non-screened reproductive-age women in a specific location based on the cluster coordinates of nearby areas [16]. A semi-variogram spherical model function was applied to describe the degree of spatial correlation among the data points. The output is represented as a raster image on a map, showing the predicted values across the entire nation.

### 3. Results

A sample of 15,014 women of reproductive age responded to questions regarding screenings for breast and cervical cancer. The sociodemographic characteristics of the sample, and the percentages screened for both types of cancer, are detailed in **Table 1**.

**Table 1.** Sociodemographic characteristics of reproductive-age women examined for breast and cancer in Ghana, GDHS 2022.

Characteristic	Breast cancer examination			P-value <sup>2</sup>	Cervical cancer test			P-value <sup>2</sup>
	No, N = 12,536 <sup>1</sup>	Yes, N = 2477 <sup>1</sup>	Don't know, N = 1 <sup>1</sup>		No, N = 14,283 <sup>1</sup>	Yes, N = 690 <sup>1</sup>	Don't know, N = 41 <sup>1</sup>	
Age in 5-year groups								
15 - 19	2654 (94%)	180 (6.3%)	1 (<0.1%)		2807 (99%)	21 (0.7%)	7 (0.2%)	
20 - 24	2289 (86%)	380 (14%)	0 (0%)		2578 (97%)	78 (2.9%)	13 (0.5%)	
25 - 29	1924 (81%)	462 (19%)	0 (0%)		2246 (94%)	137 (5.7%)	3 (0.1%)	
30 - 34	1736 (78%)	492 (22%)	0 (0%)		2077 (93%)	146 (6.6%)	5 (0.2%)	
35 - 39	1594 (79%)	427 (21%)	0 (0%)		1888 (93%)	127 (6.3%)	6 (0.3%)	
40 - 44	1350 (82%)	296 (18%)	0 (0%)		1549 (94%)	93 (5.7%)	4 (0.2%)	
45 - 49	989 (80%)	240 (20%)	0 (0%)		1138 (93%)	88 (7.2%)	3 (0.2%)	
Type of place of Residence								
				<0.001				<0.001
Urban	5782 (79%)	1580 (21%)	0 (0%)		6877 (93%)	464 (6.3%)	21 (0.3%)	
Rural	6754 (88%)	897 (12%)	1 (<0.1%)		7406 (97%)	226 (3.0%)	20 (0.3%)	
Region								
Western	611 (77%)	186 (23%)	0 (0%)		775 (97%)	22 (2.8%)	0 (0%)	
Central	800 (82%)	179 (18%)	0 (0%)		939 (96%)	40 (4.1%)	0 (0%)	
Greater accra	736 (76%)	233 (24%)	0 (0%)		917 (95%)	52 (5.4%)	0 (0%)	
Volta	682 (81%)	155 (19%)	0 (0%)		782 (93%)	55 (6.6%)	0 (0%)	
Eastern	659 (77%)	195 (23%)	0 (0%)		799 (94%)	55 (6.4%)	0 (0%)	
Ashanti	922 (82%)	209 (18%)	0 (0%)		1069 (95%)	62 (5.5%)	0 (0%)	
Western north	676 (85%)	116 (15%)	0 (0%)		764 (96%)	28 (3.5%)	0 (0%)	
Ahafo	701 (83%)	147 (17%)	1 (0.1%)		810 (95%)	39 (4.6%)	0 (0%)	
Bono	676 (81%)	159 (19%)	0 (0%)		796 (95%)	35 (4.2%)	4 (0.5%)	
Bono east	845 (87%)	129 (13%)	0 (0%)		937 (96%)	37 (3.8%)	0 (0%)	
Oti	831 (90%)	90 (9.8%)	0 (0%)		887 (96%)	33 (3.6%)	1 (0.1%)	
Northern	992 (85%)	177 (15%)	0 (0%)		1090 (93%)	78 (6.7%)	1 (<0.1%)	
Savannah	921 (92%)	78 (7.8%)	0 (0%)		947 (95%)	19 (1.9%)	33 (3.3%)	
North east	803 (83%)	160 (17%)	0 (0%)		922 (96%)	41 (4.3%)	0 (0%)	
Upper east	842 (85%)	145 (15%)	0 (0%)		937 (95%)	49 (5.0%)	1 (0.1%)	
Upper west	839 (88%)	119 (12%)	0 (0%)		912 (95%)	45 (4.7%)	1 (0.1%)	

## Continued

Highest educational level						
No education	3065 (91%)	292 (8.7%)	0 (0%)	3251 (97%)	94 (2.8%)	12 (0.4%)
Primary	2016 (90%)	229 (10%)	0 (0%)	2161 (96%)	69 (3.1%)	15 (0.7%)
Secondary	6773 (84%)	1337 (16%)	1 (<0.1%)	7794 (96%)	303 (3.7%)	14 (0.2%)
Higher	682 (52%)	619 (48%)	0 (0%)	1077 (83%)	224 (17%)	0 (0%)
Wealth index combined						
				<0.001		<0.001
Poorest	3381 (92%)	284 (7.7%)	1 (<0.1%)	3581 (98%)	67 (1.8%)	18 (0.5%)
Poorer	2986 (89%)	380 (11%)	0 (0%)	3264 (97%)	93 (2.8%)	9 (0.3%)
Middle	2547 (85%)	461 (15%)	0 (0%)	2873 (96%)	127 (4.2%)	8 (0.3%)
Richer	2133 (79%)	553 (21%)	0 (0%)	2524 (94%)	159 (5.9%)	3 (0.1%)
Richest	1489 (65%)	799 (35%)	0 (0%)	2041 (89%)	244 (11%)	3 (0.1%)
Religion						
Catholic	1337 (80%)	332 (20%)	0 (0%)	1537 (92%)	120 (7.2%)	12 (0.7%)
Anglican	83 (75%)	27 (25%)	0 (0%)	107 (97%)	3 (2.7%)	0 (0%)
Methodist	438 (77%)	129 (23%)	0 (0%)	541 (95%)	26 (4.6%)	0 (0%)
Presbyterian	557 (79%)	150 (21%)	0 (0%)	664 (94%)	43 (6.1%)	0 (0%)
Pentecostal/charismatic	4462 (83%)	904 (17%)	0 (0%)	5099 (95%)	252 (4.7%)	15 (0.3%)
Other christian	1636 (81%)	375 (19%)	0 (0%)	1932 (96%)	77 (3.8%)	2 (<0.1%)
Islam	3468 (87%)	525 (13%)	1 (<0.1%)	3820 (96%)	162 (4.1%)	12 (0.3%)
Traditional/spiritualist	291 (95%)	14 (4.6%)	0 (0%)	303 (99%)	2 (0.7%)	0 (0%)
No religion	248 (93%)	20 (7.5%)	0 (0%)	263 (98%)	5 (1.9%)	0 (0%)
Other	16 (94%)	1 (5.9%)	0 (0%)	17 (100%)	0 (0%)	0 (0%)
Frequency of reading Newspaper or magazine						
Not at all	11,527 (85%)	2075 (15%)	1 (<0.1%)	12,994 (96%)	571 (4.2%)	38 (0.3%)
Less than once a week	711 (73%)	260 (27%)	0 (0%)	890 (92%)	79 (8.1%)	2 (0.2%)
At least once a week	298 (68%)	142 (32%)	0 (0%)	399 (91%)	40 (9.1%)	1 (0.2%)
Almost every day	0 (NA%)	0 (NA%)	0 (NA%)	0 (NA%)	0 (NA%)	0 (NA%)
Frequency of listening to radio						
Not at all	5052 (88%)	664 (12%)	0 (0%)	5524 (97%)	173 (3.0%)	19 (0.3%)
Less than once a week	3013 (85%)	550 (15%)	0 (0%)	3396 (95%)	163 (4.6%)	4 (0.1%)
At least once a week	4471 (78%)	1263 (22%)	1 (<0.1%)	5363 (94%)	354 (6.2%)	18 (0.3%)
Almost every day	0 (NA%)	0 (NA%)	0 (NA%)	0 (NA%)	0 (NA%)	0 (NA%)
Frequency of watching Television						
Not at all	4028 (90%)	425 (9.5%)	1 (<0.1%)	4340 (97%)	94 (2.1%)	20 (0.4%)
Less than once a week	2016 (85%)	363 (15%)	0 (0%)	2275 (96%)	102 (4.3%)	2 (<0.1%)
At least once a week	6492 (79%)	1689 (21%)	0 (0%)	7668 (94%)	494 (6.0%)	19 (0.2%)
Almost every day	0 (NA%)	0 (NA%)	0 (NA%)	0 (NA%)	0 (NA%)	0 (NA%)

**Continued**

Frequency of using Internet last month								
Not at all	8797 (88%)	1156 (12%)	0 (0%)		9619 (97%)	297 (3.0%)	37 (0.4%)	
Less than once a week	429 (85%)	77 (15%)	0 (0%)		477 (94%)	28 (5.5%)	1 (0.2%)	
At least once a week	1049 (78%)	292 (22%)	0 (0%)		1251 (93%)	89 (6.6%)	1 (<0.1%)	
Almost every day	2261 (70%)	952 (30%)	1 (<0.1%)		2936 (91%)	276 (8.6%)	2 (<0.1%)	
Visited by fieldworker In last 12 months	1721 (78%)	484 (22%)	0 (0%)	<0.001	2080 (94%)	124 (5.6%)	1 (<0.1%)	0.004
Minutes to nearest Healthcare facility								
0	29 (81%)	7 (19%)	0 (0%)		32 (89%)	4 (11%)	0 (0%)	
1	194 (86%)	31 (14%)	0 (0%)		208 (92%)	11 (4.9%)	6 (2.7%)	
2	175 (86%)	29 (14%)	0 (0%)		195 (96%)	9 (4.4%)	0 (0%)	
3	144 (75%)	47 (25%)	0 (0%)		180 (94%)	11 (5.8%)	0 (0%)	
4	58 (79%)	15 (21%)	0 (0%)		69 (95%)	3 (4.1%)	1 (1.4%)	
5	941 (78%)	263 (22%)	0 (0%)		1120 (93%)	79 (6.6%)	5 (0.4%)	
6	55 (86%)	9 (14%)	0 (0%)		61 (95%)	2 (3.1%)	1 (1.6%)	
7	77 (83%)	16 (17%)	0 (0%)		87 (94%)	6 (6.5%)	0 (0%)	
8	71 (86%)	12 (14%)	0 (0%)		76 (92%)	7 (8.4%)	0 (0%)	
9	12 (80%)	3 (20%)	0 (0%)		13 (87%)	2 (13%)	0 (0%)	
10	1792 (80%)	462 (20%)	0 (0%)		2120 (94%)	130 (5.8%)	4 (0.2%)	
11	2 (100%)	0 (0%)	0 (0%)		2 (100%)	0 (0%)	0 (0%)	
12	35 (76%)	11 (24%)	0 (0%)		40 (87%)	6 (13%)	0 (0%)	
13	7 (100%)	0 (0%)	0 (0%)		7 (100%)	0 (0%)	0 (0%)	
14	10 (91%)	1 (9.1%)	0 (0%)		11 (100%)	0 (0%)	0 (0%)	
15	1275 (82%)	273 (18%)	0 (0%)		1465 (95%)	80 (5.2%)	3 (0.2%)	
16	5 (71%)	2 (29%)	0 (0%)		6 (86%)	1 (14%)	0 (0%)	
17	2 (100%)	0 (0%)	0 (0%)		2 (100%)	0 (0%)	0 (0%)	
18	3 (100%)	0 (0%)	0 (0%)		3 (100%)	0 (0%)	0 (0%)	
19	1 (50%)	1 (50%)	0 (0%)		2 (100%)	0 (0%)	0 (0%)	
20	1662 (84%)	326 (16%)	0 (0%)		1912 (96%)	70 (3.5%)	6 (0.3%)	
23	3 (75%)	1 (25%)	0 (0%)		4 (100%)	0 (0%)	0 (0%)	
24	5 (71%)	2 (29%)	0 (0%)		7 (100%)	0 (0%)	0 (0%)	
25	292 (85%)	52 (15%)	0 (0%)		327 (95%)	17 (4.9%)	0 (0%)	
27	3 (75%)	1 (25%)	0 (0%)		4 (100%)	0 (0%)	0 (0%)	
28	3 (75%)	1 (25%)	0 (0%)		4 (100%)	0 (0%)	0 (0%)	
30	2460 (83%)	492 (17%)	0 (0%)		2815 (95%)	126 (4.3%)	11 (0.4%)	
31	2 (100%)	0 (0%)	0 (0%)		2 (100%)	0 (0%)	0 (0%)	
33	3 (100%)	0 (0%)	0 (0%)		3 (100%)	0 (0%)	0 (0%)	
34	7 (100%)	0 (0%)	0 (0%)		7 (100%)	0 (0%)	0 (0%)	
35	153 (84%)	30 (16%)	0 (0%)		170 (93%)	12 (6.6%)	1 (0.5%)	

## Continued

36	5 (83%)	1 (17%)	0 (0%)	5 (83%)	1 (17%)	0 (0%)
37	1 (100%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)
38	3 (60%)	2 (40%)	0 (0%)	5 (100%)	0 (0%)	0 (0%)
40	474 (86%)	74 (14%)	0 (0%)	519 (95%)	29 (5.3%)	0 (0%)
42	0 (0%)	1 (100%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)
45	398 (85%)	71 (15%)	0 (0%)	451 (96%)	18 (3.8%)	0 (0%)
46	2 (100%)	0 (0%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)
47	3 (100%)	0 (0%)	0 (0%)	3 (100%)	0 (0%)	0 (0%)
48	4 (100%)	0 (0%)	0 (0%)	4 (100%)	0 (0%)	0 (0%)
49	2 (100%)	0 (0%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)
50	156 (90%)	17 (9.8%)	1 (0.6%)	170 (98%)	4 (2.3%)	0 (0%)
54	3 (100%)	0 (0%)	0 (0%)	3 (100%)	0 (0%)	0 (0%)
55	5 (83%)	1 (17%)	0 (0%)	6 (100%)	0 (0%)	0 (0%)
59	6 (100%)	0 (0%)	0 (0%)	5 (83%)	1 (17%)	0 (0%)
60	1211 (89%)	148 (11%)	0 (0%)	1319 (97%)	39 (2.9%)	1 (<0.1%)
65	8 (89%)	1 (11%)	0 (0%)	8 (89%)	1 (11%)	0 (0%)
68	0 (0%)	2 (100%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)
70	20 (95%)	1 (4.8%)	0 (0%)	21 (100%)	0 (0%)	0 (0%)
72	2 (100%)	0 (0%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)
75	5 (100%)	0 (0%)	0 (0%)	4 (80%)	1 (20%)	0 (0%)
80	19 (100%)	0 (0%)	0 (0%)	19 (100%)	0 (0%)	0 (0%)
90	152 (91%)	15 (9.0%)	0 (0%)	165 (99%)	2 (1.2%)	0 (0%)
95	2 (100%)	0 (0%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)
100	5 (83%)	1 (17%)	0 (0%)	6 (100%)	0 (0%)	0 (0%)
105	2 (67%)	1 (33%)	0 (0%)	3 (100%)	0 (0%)	0 (0%)
110	4 (80%)	1 (20%)	0 (0%)	4 (80%)	1 (20%)	0 (0%)
115	1 (100%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)
120	398 (91%)	40 (9.1%)	0 (0%)	425 (97%)	12 (2.7%)	1 (0.2%)
130	6 (100%)	0 (0%)	0 (0%)	6 (100%)	0 (0%)	0 (0%)
135	2 (100%)	0 (0%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)
140	4 (100%)	0 (0%)	0 (0%)	4 (100%)	0 (0%)	0 (0%)
145	0 (0%)	1 (100%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)
150	15 (88%)	2 (12%)	0 (0%)	15 (88%)	1 (5.9%)	1 (5.9%)
155	0 (0%)	1 (100%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)
160	14 (100%)	0 (0%)	0 (0%)	14 (100%)	0 (0%)	0 (0%)
170	3 (100%)	0 (0%)	0 (0%)	3 (100%)	0 (0%)	0 (0%)
180	82 (96%)	3 (3.5%)	0 (0%)	83 (98%)	2 (2.4%)	0 (0%)
190	4 (80%)	1 (20%)	0 (0%)	5 (100%)	0 (0%)	0 (0%)
200	0 (0%)	2 (100%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)
210	1 (50%)	1 (50%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)
215	1 (100%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)

**Continued**

220	4 (100%)	0 (0%)	0 (0%)		4 (100%)	0 (0%)	0 (0%)	
240	9 (82%)	2 (18%)	0 (0%)		11 (100%)	0 (0%)	0 (0%)	
260	2 (100%)	0 (0%)	0 (0%)		2 (100%)	0 (0%)	0 (0%)	
300	4 (100%)	0 (0%)	0 (0%)		4 (100%)	0 (0%)	0 (0%)	
330	4 (100%)	0 (0%)	0 (0%)		4 (100%)	0 (0%)	0 (0%)	
360	2 (100%)	0 (0%)	0 (0%)		2 (100%)	0 (0%)	0 (0%)	
397	1 (100%)	0 (0%)	0 (0%)		1 (100%)	0 (0%)	0 (0%)	
420	1 (100%)	0 (0%)	0 (0%)		1 (100%)	0 (0%)	0 (0%)	
445	1 (100%)	0 (0%)	0 (0%)		1 (100%)	0 (0%)	0 (0%)	
600+	4 (100%)	0 (0%)	0 (0%)		4 (100%)	0 (0%)	0 (0%)	
<b>Times visited health facility last 6 month</b>								
None	8757 (86%)	1,395 (14%)	0 (0%)		9756 (96%)	368 (3.6%)	28 (0.3%)	
1	1672 (79%)	436 (21%)	1 (<0.1%)		1977 (94%)	126 (6.0%)	6 (0.3%)	
2	886 (79%)	236 (21%)	0 (0%)		1050 (94%)	69 (6.1%)	3 (0.3%)	
3	464 (74%)	160 (26%)	0 (0%)		566 (91%)	57 (9.1%)	1 (0.2%)	
4	252 (76%)	80 (24%)	0 (0%)		311 (94%)	21 (6.3%)	0 (0%)	
5	173 (75%)	58 (25%)	0 (0%)		215 (93%)	16 (6.9%)	0 (0%)	
6	224 (78%)	65 (22%)	0 (0%)		267 (92%)	20 (6.9%)	2 (0.7%)	
7	33 (70%)	14 (30%)	0 (0%)		44 (94%)	3 (6.4%)	0 (0%)	
8	29 (67%)	14 (33%)	0 (0%)		41 (95%)	2 (4.7%)	0 (0%)	
9	7 (70%)	3 (30%)	0 (0%)		10 (100%)	0 (0%)	0 (0%)	
10	21 (75%)	7 (25%)	0 (0%)		24 (86%)	4 (14%)	0 (0%)	
11	3 (75%)	1 (25%)	0 (0%)		4 (100%)	0 (0%)	0 (0%)	
12	6 (67%)	3 (33%)	0 (0%)		7 (78%)	1 (11%)	1 (11%)	
14	2 (67%)	1 (33%)	0 (0%)		3 (100%)	0 (0%)	0 (0%)	
15	2 (100%)	0 (0%)	0 (0%)		1 (50%)	1 (50%)	0 (0%)	
20	4 (67%)	2 (33%)	0 (0%)		5 (83%)	1 (17%)	0 (0%)	
95	0 (0%)	1 (100%)	0 (0%)		0 (0%)	1 (100%)	0 (0%)	
Don't know	1 (50%)	1 (50%)	0 (0%)		2 (100%)	0 (0%)	0 (0%)	
Out of pocket payments for consultation	686 (76%)	211 (24%)	0 (0%)	0.8	834 (93%)	63 (7.0%)	0 (0%)	0.4
Unknown	9411	1546	0		10,520	405	32	
Covered by health Insurance	11,291 (83%)	2367 (17%)	1 (<0.1%)	<0.001	12,959 (95%)	664 (4.9%)	36 (0.3%)	<0.001
Heard family planning on TV last few months	4640 (76%)	1444 (24%)	0 (0%)	<0.001	5640 (93%)	438 (7.2%)	6 (<0.1%)	<0.001
Heard family planning in newspaper/magazine last few months	410 (68%)	194 (32%)	0 (0%)	<0.001	528 (87%)	76 (13%)	0 (0%)	<0.001
Heard family planning by text messages on mobile phone	627 (68%)	293 (32%)	0 (0%)	<0.001	824 (90%)	95 (10%)	1 (0.1%)	<0.001

<sup>1</sup>n (%); <sup>2</sup>Pearson's Chi-squared test; Fisher's exact test.

Over 90% of women aged 15 - 19 years had not been screened for either breast or cervical cancer. The majority of women who underwent breast cancer screenings were in the 30 - 34 age group, while 7.2% of women aged 45 - 49 were the most tested for cervical cancer. A higher proportion of women in urban areas participated in screening compared to those in rural areas, with 21% screened for breast cancer and 6.3% for cervical cancer.

The Greater Accra, Eastern, and Western Regions had the highest percentages of women screened for breast cancer, at 24%, 23%, and 23% respectively. In contrast, the Northern, Volta, and Eastern Regions had higher rates of cervical cancer screenings, with 6.7%, 6.6%, and 6.4% respectively.

The study also indicated that women with higher education levels were more likely to be screened for both cancers—48% were screened for breast cancer and 17% for cervical cancer. Women from the wealthiest households were more frequently examined for both types of cancer: 35% of these women were screened for breast cancer, and 11% for cervical cancer.

Among the sample, the majority identified as Christians, with Anglicans having the highest percentage of breast cancer screenings at 25%. Additionally, 7.7% of Catholics were tested for cervical cancer, representing the highest percentage among this group.

Furthermore, 22% of women who underwent breast cancer screenings were visited by fieldworkers (Community Health Officers), while 6.5% of those tested for cervical cancer received similar visits. Lastly, 17% of women covered by the National Health Insurance Scheme were screened for breast cancer, and 4.9% were screened for cervical cancer (see [Table 1](#)).

More so, the relationship between breast cancer screening and cervical cancer testing is illustrated in [Table 2](#). Out of 15,014 samples, 457 (3%) were tested for both breast and cervical cancer [17].

**Table 2.** Association between breast cancer examination and cervical cancer testing among reproductive-age women in Ghana, GDHS 2022.

	Cervical cancer testing		Total	P-value <sup>1</sup>
	No	Yes		
<b>Breast cancer examination</b>				<b>&lt;0.001***</b>
No	12,303	233	12,536	
Yes	2020	457	2477	
Unknown	1	0	1	
<b>Total</b>	14,324	690	15,014	

<sup>1</sup> \*p < 0.05; \*\*p < 0.01; \*\*\*p < 0.001.

### 3.1. Bivariate Association between Breast Cancer Examination and Cervical Cancer Testing, and Independent Variables

The overall prevalence rate for breast cancer examinations among reproductive-age women in Ghana was 16.5%, while the rate for cervical cancer was 4.6%. Using Pearson's Chi-Square and Fisher's exact test analyses, significant differences were

observed in several factors: place of residence (<0.001), combined wealth index (<0.001), visits by fieldworkers (<0.001), out-of-pocket payments (0.8 for breast cancer and 0.4 for cervical cancer), coverage by National Health Insurance (<0.001), and exposure to family planning information via television (<0.001), newspapers/magazines (<0.001), and text messages on mobile phones (<0.001) (**Table 1**).

Additionally, a similar study by Anaba *et al.* (2024) found that the uptake of these screening exercises was influenced by various factors classified as predisposing (such as age, education, and contraceptive use), enabling (including wealth index, place of residence, region, health insurance, frequent use of mass media, and barriers to accessing healthcare), and need-related factors (such as visits by fieldworkers and testing for HIV) [12].

This study specifically addressed the enabling and need factors identified by Anaba *et al.* (2024). Key issues that could be tackled through the implementation of Community-based Health Planning and Services (CHPS) in Ghana include place of residence, region, health insurance, health promotion, accessibility to healthcare, home visits by fieldworkers, and HIV testing. The CHPS program is an effective strategy for overcoming challenges related to accessing quality and cost-effective healthcare, as it delivers services directly to community members by organizing them into clusters [14].

### 3.2. Predicting Clusters of Non-Screened Reproductive-Age Women

The Hot spot analysis (Getis-Ord GI\*)

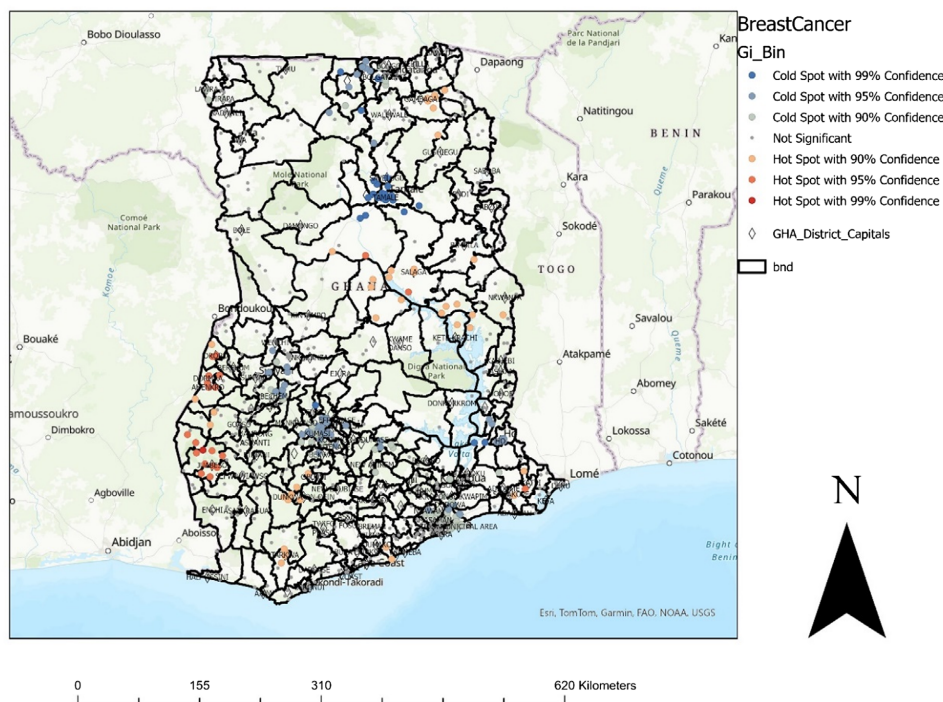
The clusters with blue spots indicated cold spots, with deeper colors representing a higher confidence interval ranging from 90% to 99%. Hot spots for non-screened women at risk of breast cancer included Salaga, Gushegu, Gambaga, Kete Krachi, Drobo, Dormaa Ahenkro, Juaboso, and Duankwa Offin. In contrast, Bolga, Savelugu, Tamale, Kumasi, Ho, and Dodowa were identified as cold spots for non-screened reproductive-age women regarding breast cancer (see **Figure 1**).

Additionally, many areas in the northern and middle sectors of the country were identified as hot spots for non-screened reproductive-age women at risk of cervical cancer. These hot spots included Tumu, Bawku, Gambaga, Salaga, Bimbila, Nkwanta, Kwame Danso, and Kete Krachi. Meanwhile, most clusters in the southern regions, such as Bono, Western North, Western, Central, Eastern, and Greater Accra, were classified as cold spots for cervical cancer (see **Figure 2**).

The histograms produced for both cancers were skewed to the left, indicating that the medians were higher than the means. For non-screened breast cancer, the median was 97, while, cervical cancer was 95, the median was 85, and the mean was 83 (see **Figure 3** & **Figure 4**).

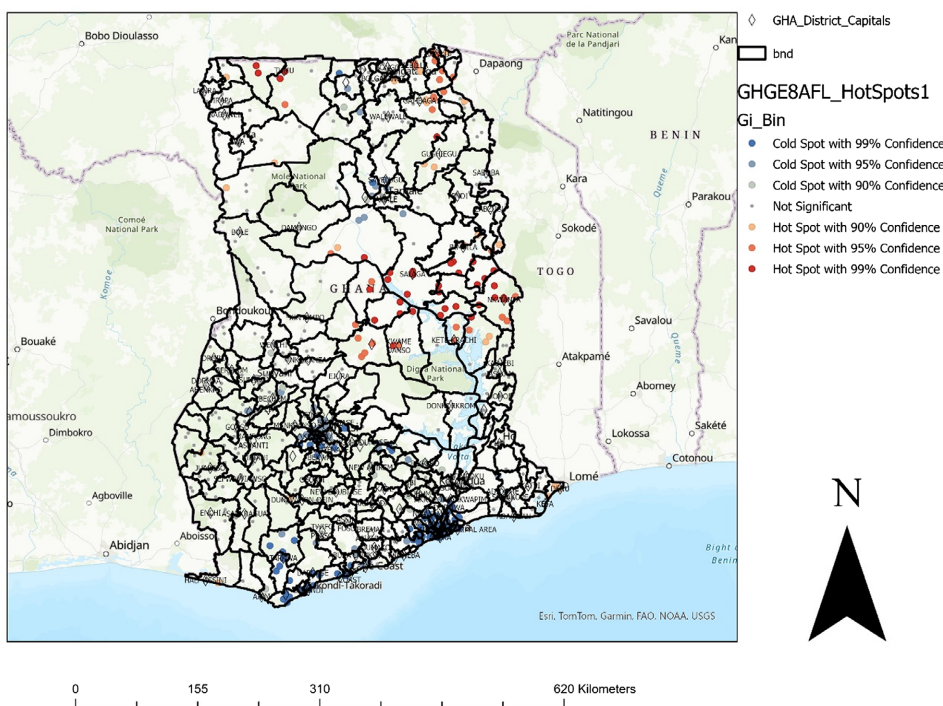
The x-axis represents the z-scores, indicating the intensity of the clustering. Positive z-scores represent areas with high values, while negative z-scores represent areas with low values. The z-score near zero indicates no significant clustering, whereas, the y-axis represents the frequency. More so, the skewed distribution indicates the significance of the clustering [15] [16] (see **Figure 3** and **Figure 4**).

**Hot Spot Analysis Map Showing Percentage of Reproductive-Aged (15-49years) Women Who Had not been Screened for Breast Cancer in Ghana, GDHS 2022**

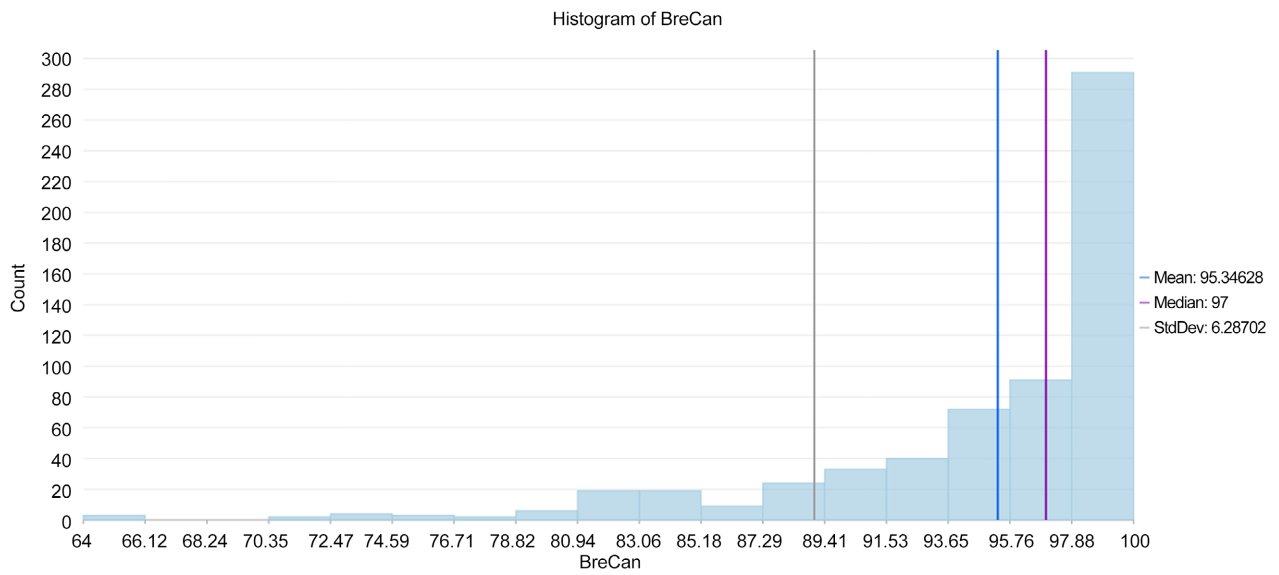


**Figure 1.** Hot spot analysis (Getis-Ord GI\*) showing the distribution of non-screened reproductive-age women for Breast Cancer in Ghana, GDHS 2022.

**Hot Spot Analysis Map Showing Percentage of Reproductive-Aged (15-49years) Women Who Had not been Screened for Cervical Cancer in Ghana, GDHS 2022**

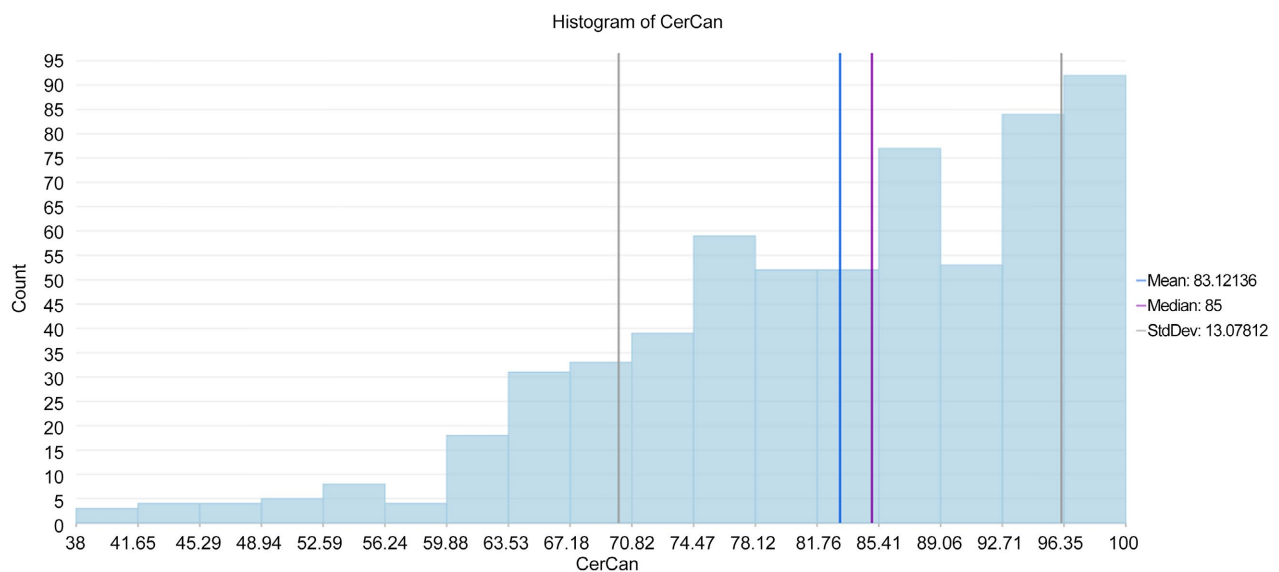


**Figure 2.** Hot spot analysis (Getis-Ord GI\*) showing the distribution of non-screened reproductive-age women for Cervical Cancer in Ghana, GDHS 2022.



**Figure 3.** Histogram showing the distribution of the percentage of non-screened reproductive-age women for breast cancer, GDHS 2022.

BerCan: Percentage not screened for breast cancer.

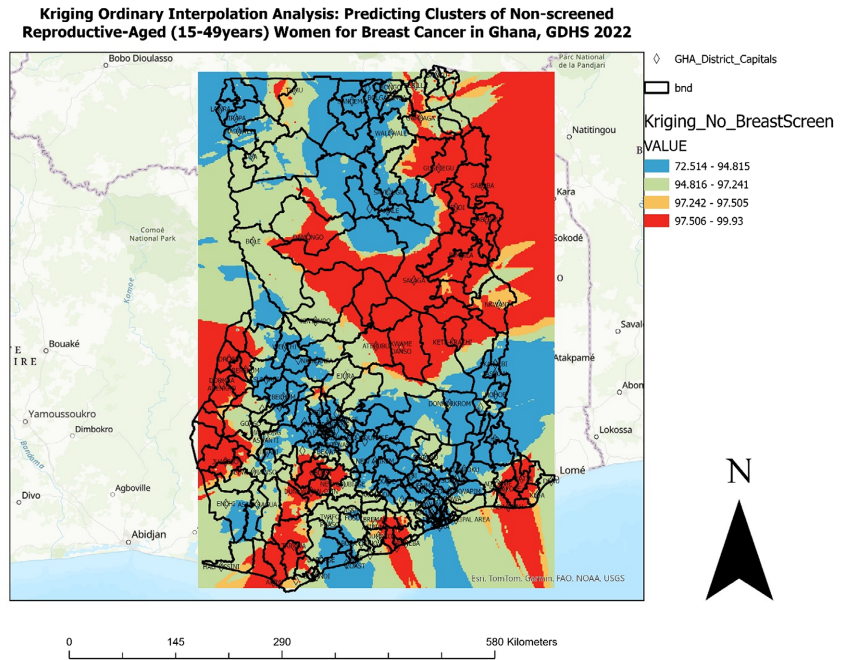


**Figure 4.** Histogram showing the distribution of the percentage of non-screened reproductive-age women for cervical cancer, GDHS 2022. CerCan: Percentage not screened for cervical cancer.

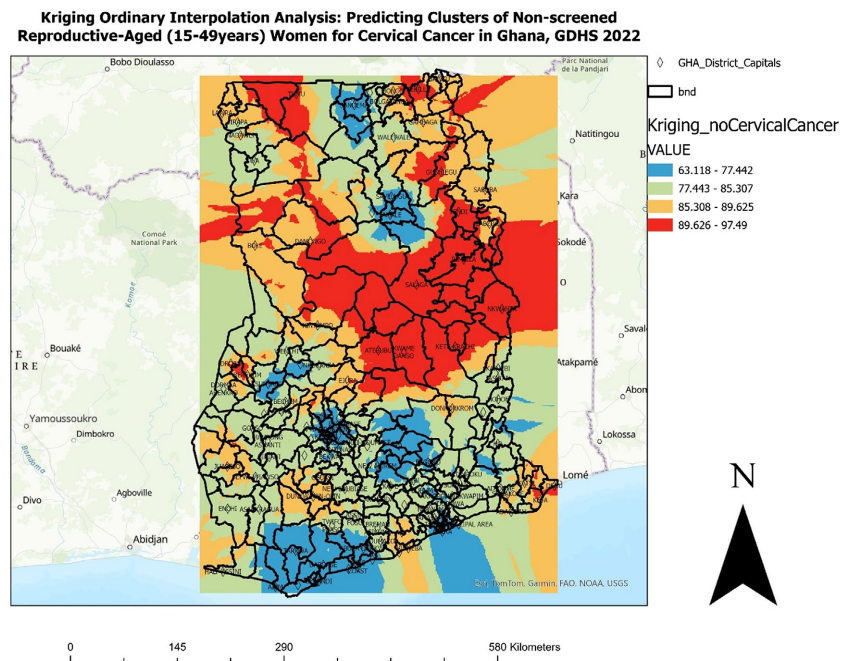
### 3.3. The Kriging Ordinary Interpolation Analysis

The raster output of the Kriging analysis is represented in four colors: blue, green, orange, and red, each indicating levels of predicted clusters. While non-screened women are distributed throughout the country, the analysis shows that clusters in the red zones have the highest predicted values of non-screened women for breast cancer. These red zone clusters include areas around Gambaga, Kete Krachi, Kwame Danso, and Damango in the northern part of the country, as well as Drobu,

Dorma Ahenkro, and Juaboso in the Bono and Western North regions. Other areas such as Obuasi, Tarkwa, Axim, Winneba, and Keta also fall within the red zone. It was predicted that non-screened reproductive-age women for breast cancer are densely concentrated in these clusters (see **Figure 5**).



**Figure 5.** Kriging ordinary interpolation: predicting clusters of non-screened reproductive-age women (15 - 49 years) for breast cancer in Ghana, GDHS 2022.



**Figure 6.** Kriging ordinary interpolation: predicting clusters of non-screened reproductive-age women (15 - 49 years) for cervical cancer in Ghana, GDHS 2022.

In contrast, the northern sector of the country has many clusters with a significant number of women who have not been screened for cervical cancer (see **Figure 6**). Notably, clusters such as Kwame Danso, Salaga, Kete Krachi, Nkanta, and Gushegu feature women who have not been screened for both types of cancer (see **Figure 5** and **Figure 6**).

## 4. Discussion

This study explored the factors influencing breast and cervical cancer screening uptake and identified clusters of non-screened reproductive-age women in Ghana. According to the Ghana Statistical Service's 2022 Demographic and Health Survey, the prevalence of screening is notably low, with only 5% of women undergoing cervical cancer tests and 18% receiving breast cancer examinations. These results align with similar findings from other Sub-Saharan African countries, where breast cancer examination rates stand at 9.73% in Nigeria, 9.73% in Lesotho, and just 0.9% in Tanzania [2] [12].

Our analysis revealed a strong association between the availability of breast cancer and cervical cancer screening services [17] [18]. Levano *et al.* indicated that conducting both screening programs simultaneously might not necessarily boost participation. Instead, they emphasised the importance of raising awareness, addressing financial barriers, and enhancing community outreach services [17]. Anaba *et al.* recognised these factors as essential drivers for increasing screening efforts [12].

These findings highlight the need to overcome barriers to accessing healthcare, which is crucial for improving cancer screening services [12]—a key component of the Community-Based Health Planning and Services (CHPS) initiative. The Ghana Health Service has employed a strategy to address these public health challenges by assigning Community Health Officers to provide healthcare within specific clusters or zones.

### 4.1. Predicting Clusters of Non-Screened Reproductive-Age Women

This study highlights the locations of reproductive-age women who have not been screened for tailored health interventions. The distribution of these women is left-skewed, suggesting that many areas show high levels of hot spots, while only a few locations exhibit cold spots. This means that most areas have high hot spot values, indicating a significant need for public health interventions focused on breast and cervical screening.

Notably, these hot spots are primarily found in the northern region of the country, which lacks large health facilities offering screening services. In contrast, the southern region is home to three publicly funded tertiary hospitals that manage hospital-based cancer registries: Komfo Anokye Teaching Hospital (KATH) in Kumasi, Cape Coast Teaching Hospital, and Korle Bu Teaching Hospital (KBTH) in Accra. The presence of these facilities in the southern region could explain why

there are fewer cold spot clusters compared to the north [19].

A study conducted by Schoenhals *et al.* (2023) also found that being within 75 km of health facilities significantly increases the likelihood of early cancer detection [20]. Therefore, there is a need to empower other health facilities and Community Health Officers assigned to these northern zones to provide breast and cervical cancer screening in order to enhance the early detection rates in Ghana.

#### **4.2. Integration of Breast Cancer and Cervical Cancers Screening, and CHPS Implementation**

The Ghana Health Service utilizes the Community-based Health Planning and Services (CHPS) as a foundation to implement Primary Health Care (PHC) to achieve Universal Health Coverage (UHC) [13] [14]. The services offered through this platform include immunization, family planning (FP), antenatal care (ANC), treatment of minor illnesses, disease surveillance, school health services, and home visits by community health officers (CHOs) [13] [14]. Midwives and nurses conduct home visits, providing antenatal care services and follow-ups [21]. They could be specially trained to perform breast cancer screening and keep detailed records [22]. Furthermore, physician assistants could provide cervical cancer screenings at primary healthcare facilities within each cluster. Community Health Officers (CHOs) could play a vital role in boosting the uptake of breast and cervical cancer screenings [12].

A scoping review by O'Donovan *et al.* highlighted the crucial role community health workers play in cervical cancer screening in low- and middle-income countries (LMICs). Their efforts focus on education, outreach, awareness programs, and referring clients to nearby health facilities. The review concluded that community-based approaches to screening are effective and recommended further in-depth contextual studies [9] [22].

Moreover, a study conducted by Prof. Yaw Adu-Sarkodie and colleagues reported that approximately 7.9 million GHS (5.3 million USD) is needed to scale up cervical cancer screening at the national level. This estimate is based on an assumption of 70% coverage, screening every five years, and that 2.63% of screened women will require treatment with cryotherapy [23]. The study emphasized that the number of women screened per provider and treated per facility is a crucial factor in determining the costs of visual inspection with acetic acid (VIA) and cryotherapy before scaling up cervical cancer testing [23].

Integrating breast cancer examinations and cervical cancer testing by the same service providers in health facilities that are closer to community members could be a cost-effective solution, possibly offered at a subsidized fee or even for free.

#### **4.3. Implications for Policymakers and Implementers**

We observed a correlation between breast cancer examinations and cervical cancer testing among women of reproductive age. Women who receive breast cancer screenings are more likely to also participate in cervical cancer testing. This finding

suggests that integrating both programs could enhance the number of women engaging in these vital screenings.

Additionally, the distribution of women who have not been screened is consistent across the country; however, they are particularly concentrated in the northern and middle belts of Ghana. Policymakers should create an enabling environment for healthcare providers to combine these services in these areas.

Breast and cervical cancer screening, along with other public health initiatives, should prioritize the hotspots identified in this study. We believe that increasing the uptake of these screening services could be achieved cost-effectively through the implementation of Community-based Health Planning and Services (CHPS), with a focus on the identified hotspots for cancer screening activities, provided the necessary resources are available.

## 5. Limitations of the Study

There was a possibility of recall bias since women were asked to remember previous events in their lives. The findings cannot be generalized for all women, since this study focused on women aged 15 - 49 in Ghana.

Psychosocial factors such as perceived risk and fear of diagnosis could influence screening behaviors but were not captured by captured in DHS dataset. Moreover, the availability of transportation to health facilities and appointment scheduling were not captured in the dataset.

## 6. Conclusions

Our investigation found that the rate of breast and cervical cancer screening is low in Ghana. Reproductive-age women who have not yet been screened for these serious cancers are primarily concentrated in the northern and middle sectors of the county. This is in contrast to those in the southern sector, where the three publicly funded tertiary hospitals designated hospital-based screening services are located.

The study also suggests that integrating these screening efforts with other health initiatives—such as family planning education and home visits by Community Health Officers—could significantly increase the percentage of women who undergo screening. By focusing public health interventions on these identified high-risk areas, there is potential to boost participation in screening activities.

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## Disclosure

### Authors' Contributions

C.K.A: Conceptualized, formal analysis, investigation, methodology, software, validation, visualization, writing original draft. R.S.M: Methodology and writing review. C.A: Conceptualized, project administration, supervision, writing review

and editing. J.T: Formal analysis, validation and visualization. All authors reviewed and approved the manuscripts.

### Availability of Data and Materials

The Ghana Demographic and Health Survey 2022 is publicly available online and can be downloaded from this site:

[https://WWW.dhsprogram.com/data/dataset\\_admin/login\\_main.cfm](https://WWW.dhsprogram.com/data/dataset_admin/login_main.cfm).

### Declarations

#### Ethical Approval and Consent to Participate

We used the Ghana Demographic and Health Survey 2022, for this study. Approval was sought from DHS to use this dataset for this investigation. The KR file of the Ghana Demographic and Health Survey which is publicly available ([https://WWW.dhsprogram.com/data/dataset\\_admin/login\\_main.cfm](https://WWW.dhsprogram.com/data/dataset_admin/login_main.cfm)) was approved for download on 17th June 2024, numbered 204745. No ethical approval and consent to participate was required.

#### Conflicts of Interest

The authors declare no conflicts of interest.

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