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Socioeconomic Factors and Geographic Patterns Influencing Sanitation Access among Older Adults in Ghana

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Abstract

The right to sanitation is a core human right vital for maintaining health and preserving dignity; however, insufficient access continues to pose a major problem around the world. This issue particularly adversely affects susceptible groups, including elderly individuals. The present research examines the geographical patterns and socioeconomic factors associated with sanitation access for older persons in Ghana. Data were drawn from the 2021 Population and Housing Census, with Moran's I, Getis-Ord Gi* hotspot analysis, and Anselin Local Moran's I cluster and outlier techniques applied to evaluate spatial patterns in sanitation access. Logistic regression was utilized to identify predictors of sanitation access. Results revealed notable variations across regions and districts in Ghana regarding sanitation availability for the elderly. Factors at the individual level, including gender, age group, marital situation, educational background, urban/rural location, religious affiliation, possession of household items, and presence of disabilities, played a key role in determining access to sanitation. In particular, the multivariable logistic regression showed that women exhibited greater likelihood of having sanitation access compared to men (AOR: 1.054, CI 1.023, 1.087, p-value < 0.001). Similarly, individuals aged 80 and older demonstrated increased odds relative to the 60–69 age category (AOR: 1.171, CI 1.129, 1.214, p-value < 0.001). Furthermore, persons who were separated or divorced (AOR: 1.374, CI 1.263, 1.494, p-value < 0.001), widowed (AOR: 1.143, CI 1.059, 1.234, p-value < 0.001), or single (AOR: 1.208, CI 1.077, 1.354, p-value < 0.001) showed higher probabilities of sanitation access than those in informal cohabitation arrangements. Moreover, individuals with any history of school attendance had markedly elevated odds compared to those without (AOR: 2.749, CI 2.662, 2.838, p-value < 0.001). These results underscore the importance of comprehensive strategies that account for geographic differences and personal characteristics to successfully tackle inequalities in sanitation provision.

Keywords: Socioeconomic factors, Geographic patterns, Sanitation access, Ghana

Introduction

Sanitation access represents not only a fundamental human right but also a critical factor influencing survival [1, 2]. Deficient water, sanitation, and hygiene (WASH) infrastructure contributes substantially to global morbidity and mortality as a major underlying cause [3]. Evidence demonstrates that enhanced sanitation facilities can lower diarrheal incidence by 25%, and improved hygiene practices can decrease it by an additional 30% [4]. Nevertheless, despite such proven advantages, millions continue to face poor sanitation and hygiene conditions, disproportionately impacting at-risk groups like children and the elderly in resource-limited settings [2]. According to the Joint Monitoring Programme (JMP), in 2022 approximately 3.4 billion individuals lacked safely managed sanitation services, comprising 1.9 billion with basic provision, 570 million with shared or limited options, 545 million using substandard facilities, and 419 million engaging in open defecation [2].

In Ghana, although basic drinking water reaches 87.7% of the population, basic sanitation coverage stands at just

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25.3% for improved latrines [5]. Moreover, the 2021 Population and Housing Census reported that 17.7% of households practice open defecation in areas like beaches, fields, or drains [5]. This affects over 5 million people and generates roughly 1,300 tonnes of human waste daily, leading to risks including water-related illnesses, undernutrition, and pollution [6]. While inadequate sanitation affects people of all ages, genders, and socioeconomic backgrounds, its consequences are amplified for older persons due to age-related physical limitations (e.g., reduced vision/hearing, sarcopenia, osteoporosis, and mobility restrictions) that complicate traveling distances, assuming squatting positions, or managing incontinence [7].

Worldwide, around 900 million people aged 60 and over make up about 13% of the total population [7]. Life expectancy is rising, with projections indicating that by 2050 one in six individuals (1.5 billion) will be 65 or older, including 426 million octogenarians and beyond [8]. In Ghana, the elderly population (60+) has grown nearly tenfold over six decades, from approximately 200,000 (213,477) in 1960 to nearly 2 million (1,991,736) in 2021 [5], with forecasts suggesting around 6 million by 2050 [5, 9]. This demographic shift is anticipated to bring considerable burdens.

Aging is linked to physiological declines (such as muscle atrophy, bone loss, and impaired mobility) as well as psychological issues (including depression, anxiety, and cognitive impairment), often stemming from social isolation, immune weakening, and rising chronic conditions [10]. The Global Humanitarian Overview [11] notes that about half of older adults worldwide experience functional limitations affecting daily independence. Such disabilities profoundly hinder sanitation facility use (here defined as availability of toilet amenities), given challenges with basic tasks like vision, hearing, ambulation, or posture maintenance, thereby threatening health and quality of life. Notably, Gyasi, Simiyu, and Bagayoko [12] linked chronic illnesses (e.g., hypertension, diabetes, arthritis, Alzheimer's) in the elderly to reliance on poor sanitation. In Benin, Gaffan *et al*. [13] analyzed Demographic and Health Survey data and identified wealthier households, those led by adults ≥30 years, females, and highly educated heads as more prone to basic individual or combined WASH access. A Kenyan study in two informal urban areas by [14] associated WASH improvements with location, wealth level, head's age, poverty, ethnicity, tenure, and food security. In Nigeria, Abubakar [15] found sanitation type correlated with household size, head's gender, water source, room count, and electricity availability.

Despite this evidence, factors shaping sanitation access specifically for Ghanaian older adults remain underexplored. Accordingly, this study addresses two key questions: a) how is sanitation access spatially distributed among Ghana's elderly? and b) which socioeconomic elements predict such access? The analysis thus explores geographic patterns and socioeconomic influences on sanitation services for older Ghanaians. Insights into these predictors can guide targeted policies to mitigate illness and death linked to poor sanitation. While definitions of old age differ between high- and low-income nations [16], here older adults denote those aged 60 and above [17]. Drawing from limited prior research, we posited that socioeconomic variables like age, gender, and marital status would affect sanitation access in this group.

Theoretical and conceptual framework

Sanitation access plays a vital role in promoting public health and preserving human dignity. The WHO/UNICEF Joint Monitoring Programme defines sanitation access in terms of toilet facilities situated within the dwelling, compound, plot, or without usage restrictions [18]. Building on this WHO/UNICEF Joint Monitoring Programme definition, the present research defines sanitation access as utilizing any toilet facility apart from open defecation. This part positions the research within a theoretical context. Existing literature lacks a unified theory to account for the study's emphasis. Consequently, the research combines several theoretical approaches to examine the ways in which geographic patterns and socioeconomic elements affect sanitation access for elderly individuals. The theoretical basis incorporates principles from environmental health, theories of spatial inequality, and the social determinants of health approach, highlighting the connections among socioeconomic aspects.

The field of environmental health investigates how environmental conditions can adversely impact health and overall welfare [19]. It draws from multiple fields to explore the relationships between environmental hazards and health results. Various environmental elements, including inadequate air quality, restricted sanitation availability, and contaminated water sources, harm people's health and welfare [20–22]. Research has illustrated how environmental health enhances

comprehension of the connections between human health and the environment. Although personal choices and additional elements contribute to health and welfare, environmental health views sanitation as an environmental factor that engages with physical and social settings to influence health results. For this research, environmental health emphasizes sanitation's essential function in protecting community health. Among elderly persons, insufficient sanitation access poses greater risks owing to their weakened immune systems and higher vulnerability to diseases transmitted through water.

Theories of spatial inequality address geographical variations in availability of resources and amenities, such as sanitation [23, 24]. They suggest that systemic imbalances in distributing infrastructure and amenities produce varying access patterns across areas. In Ghana, pronounced differences exist between rural and urban settings as well as between northern and southern regions, where urban and southern zones typically feature superior sanitation systems relative to rural and northern areas [25]. This perspective stresses the importance of geographic location in comprehending disparities in sanitation access for elderly individuals. Additionally, the social determinants of health approach underscores how socioeconomic and demographic elements shape health and welfare [26, 27]. The World Health Organisation popularized this approach in 2010 by describing how social, economic, and political processes sort individuals by socioeconomic position and thereby affect their health outcomes [26]. Important elements like income level, educational attainment, social networks, and housing conditions determine people's capacity to obtain and sustain sanitation systems [15, 28, 29]. Elderly persons in Ghana frequently face financial reliance from retirement or scarce income sources, potentially limiting their sanitation facility access or upkeep expenses. This approach offers a perspective for examining how wider socioeconomic situations combine with personal factors to impact sanitation access.

Drawing from the outlined theories, the conceptual framework for this research centers on the connections between geographic patterns and socioeconomic elements in explaining sanitation access for elderly individuals. For instance, nearness to sanitation systems might relate to location, whereas the capacity to use them frequently hinges on socioeconomic aspects like cost and knowledge. Notably, the geographic disparities examined here occur at the district scale, concentrating on elderly persons lacking sanitation access. The socioeconomic elements include educational attainment, sex, work situation, presence of disabilities, and related factors. This combined approach highlights the importance of tackling both aspects together, since strategies targeting only one might not eliminate deeper imbalances. Moreover, this framework offers an organized method for exploring the factors influencing sanitation access, informing the study's methods and examination.

Materials and Methods

Data sources

The information used in this research comes from the 2021 Population and Housing Census (PHC) carried out by the Ghana Statistical Service. Ghana conducts the PHC at consistent intervals, usually every decade, to count residents and housing units and structures nationwide. Specifically, the census supplies demographic, social, and economic details. It aims to support national planning, allocate resources, and track advancement in development. This research examines sanitation facility access for individuals aged 60 years and above. The census information suits this research as it offers comprehensive details on how demographic and social traits intersect to affect sanitation access for elderly persons in Ghana. According to the 2021 PHC data gathering guide, questions on water and sanitation applied to households. To align with the focus on elderly groups, the dataset was filtered to include only those aged 60 and older residing in occupied homes. Overall, 198,278 elderly persons qualified, with information drawn from the complete dataset for analysis.

Definition of variables and measurement

Dependent variable

The primary outcome variable in this research was access to sanitation. Sanitation was defined operationally as the availability of toilet facilities for older adults within or near their housing unit. This variable was binary, where individuals with access to toilet facilities were assigned a code of 1, and those without were coded as 0.

Independent variables

The choice of predictor variables was guided by prior studies [12, 30]. Accordingly, the regression models incorporated demographic, socioeconomic, and disability-related predictors that could vary over time.

Among the sociodemographic factors subject to change, the analysis included age groups (60–69 years, 70–79 years, and 80 years or older), marital status (informal union or cohabitation; formally married; separated or divorced; widowed; and single/never married), educational background (no schooling ever, currently attending or previously attended), and religious denomination (Orthodox, Pentecostal/Charismatic, other Christian groups, Islam, Traditional religion, no religion, and other categories), possession of a radio or stereo set (yes or no), ownership of a digital television (yes or no), and ownership of an analogue television (yes or no). Furthermore, demographic characteristics specific to the period were examined, such as gender (male or female) and place of residence (urban or rural). Concerning factors related to health and disability, the study incorporated issues with vision, hearing difficulties, physical disabilities, and speech impairments. Each of these was measured on a binary scale (no difficulty or some difficulty).

Data analysis

Analyses were carried out using SPSS version 23.0 (IBM SPSS Statistics), considering results statistically significant at $p < 0.05$. Descriptive statistics were applied to summarize the variables across the full sample through frequencies and percentages. In addition, crosstabulations combined with chi-square tests were performed to assess relationships between the outcome variable and the predictors. The factors influencing sanitation access were investigated through multivariable logistic regression models. Initially, unadjusted regression analyses were conducted to examine the simple bivariate relationships between the selected demographic, socioeconomic, and disability-related variables and sanitation access among older adults. Equation 1 describes the unadjusted binary logistic regression model used to identify the factors associated with sanitation access in this population.

$$\text{logit}(p) = \beta_0 + \beta_1 X_1 \quad (1)$$

where:

- logit(p) = the log-odds of the probability p of the outcome occurring.
- β_0 = the intercept of the model.
- β_1 = the coefficient for the predictor variable X_1.
- X_1 = demographic, socioeconomic and disability-related factors

Subsequently, we evaluated the adjusted relationships by entering all predictors that reached statistical significance during the unadjusted stage into the model. It is important to mention that a correlation matrix was generated for the independent variables to assess multicollinearity. The outcomes confirmed the absence of multicollinearity, given that the correlation coefficients were between 0 and 0.4, indicating only mild interconnections among the predictors [31]. All analyses utilized the full dataset. The logistic regression outcomes are presented as odds ratios (OR) along with their corresponding 95% confidence intervals (CI). Equation 2 depicts the adjusted binary logistic regression model employed to evaluate the factors associated with sanitation access in older adults.

$$\text{logit}(p) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k \quad (2)$$

where:

- logit(p) = the log-odds of the probability p of the outcome occurring.
- β_0 = the intercept of the model.
- $\beta_1,\beta_2,\ldots,\beta_k$ = are the coefficients for the predictor variables $X_1,X_2,\ldots,X_k$.
- X_1, X_2, …,X_k= demographic, socioeconomic and disability-related factors

Furthermore, spatial examinations were carried out employing ArcGIS version 10.5. Specifically, the percentages of elderly individuals with access to toilet facilities were calculated for each district. These calculated percentages were then joined to the district shapefile to facilitate various spatial examinations. The first step in the spatial examination involved assessing the geographic distribution of sanitation access among elderly persons in Ghana through the application of Moran's I spatial autocorrelation tool. The null hypothesis underlying this tool assumes that the distribution of a feature, such as sanitation access, is spatially random. Accordingly, the tool determines whether the observed pattern is random, clustered, or dispersed. Moran's I spatial autocorrelation was selected because it offers a reliable statistical approach for interpreting geographic patterns in sanitation access among Ghana's older population. Although the spatial autocorrelation results reveal the overall geographic pattern of sanitation access, they do not indicate the intensity of access across districts. To address this, hotspot analysis was performed using the Getis-Ord Gi* statistic. This geographic statistical method classifies districts into hotspots, cold spots, or random areas based

on confidence levels ranging from 90% to 99%, by evaluating neighbouring units. Districts exhibiting significantly higher concentrations of the phenomenon are identified as hotspots, while those with lower concentrations are classified as cold spots. The Anselin Local Moran's I tool for cluster and outlier detection was applied to identify anomalies in the geographic distribution of sanitation facility access. This outlier analysis highlights potential atypical districts that might appear overly generalized when using the Getis-Ord Gi* hotspot tool. Findings from the spatial examinations are illustrated through maps and figures.

To minimize potential biases in the spatial examinations, aggregation was performed at the district level, as the dataset contained district identifiers rather than precise geographic coordinates for individual respondents. District-level aggregation has been employed in comparable research and allows for reliable comparisons across studies. Nevertheless, we recognize that this aggregation choice may have affected the results.

Results and Discussion

Sample characteristics

The profile of the study participants is summarized in **Table 1**. The majority were women (56.7%), and more than half (55.6%) belonged to the 60–69 age category. Around 53.0% lived in urban settings, while 36.5% identified with Orthodox religious denominations. Half of the elderly participants were currently married (50.8%), and 33.7% were widowed. Nearly half (49.6%) had never received formal education. Notably, a proportion of respondents indicated some degree of disability: 22.7% in vision, 10.7% in hearing, 25.8% in physical mobility, and 4.5% in speech. Regarding ownership of household media assets, approximately 55.2% possessed a radio or stereo, 31.0% had a digital television, and 29.0% owned an analogue television.

Table 1. Characteristics of the study sample

Variable	Percent (%)	Frequency	Without Toilet Facility (%)	With Toilet Facility (%)	p-value
Sex					< 0.001
Male	43.3	85,863	19.5	80.5	
Female	56.7	112,415	20.2	79.8	
Age group					< 0.001
60–69 years	55.6	110,182	17.5	82.5	
70–79 years	27.4	54,427	22.1	77.9	
80 years and older	17.0	33,669	24.1	75.9	
Type of residence					< 0.001
Urban	52.5	104,019	9.1	90.9	
Rural	47.5	94,259	31.9	68.1	
Religion					< 0.001
Orthodox	36.5	72,407	11.0	89.0	
Pentecostal/Charismatic	22.9	45,321	12.1	87.9	
Other Christian	10.8	21,318	13.8	86.2	
Islam	15.7	31,100	35.7	64.3	
Traditionalist	7.2	14,333	59.5	40.5	
No religion	5.9	11,736	26.0	74.0	
Other	1.0	2,063	16.1	83.9	
Marital status					< 0.001
Informal/cohabiting	2.9	5,738	20.4	79.6	
Married	50.8	100,643	21.3	78.7	
Separated/divorced	10.4	20,597	13.5	86.5	
Widowed	33.7	66,729	19.9	80.1	

Never married	2.3	4,571	15.9	84.1	
Education					< 0.001
Never attended school	49.6	98,356	32.2	67.8	
Ever attended school	50.4	99,922	7.8	92.2	
Vision impairment					< 0.001
No difficulty	77.3	153,196	19.5	80.5	
Some difficulty	22.7	45,082	21.2	78.8	
Hearing impairment					< 0.001
No difficulty	89.3	176,973	19.2	80.8	
Some difficulty	10.7	21,305	25.8	74.2	
Physical mobility					< 0.001
No difficulty	74.2	147,144	19.7	80.3	
Some difficulty	25.8	51,134	20.6	79.4	
Speech impairment					< 0.001
No difficulty	94.5	187,332	19.7	80.3	
Some difficulty	4.5	8,883	23.0	77.0	
Owns radio/stereo					< 0.001
Yes	55.2	109,421	15.3	84.7	
No	44.8	88,857	25.5	74.5	
Owns digital TV					< 0.001
Yes	31.2	61,947	6.0	94.0	
No	68.8	136,331	26.2	73.8	
Owns analogue TV					< 0.001
Yes	28.8	57,098	12.9	87.1	
No	71.2	141,180	22.7	77.3	

Availability of toilet facilities

The patterns of toilet facility usage among elderly individuals in Ghana indicate considerable differences in sanitation options **(Table 2)**. The most frequently utilized facilities by these older adults were private household toilets (59.7%) followed by public toilets (20.4%). Notably, 19.9% of the participants had no access to any form of toilet facility—a figure exceeding the national average of 17.7%—highlighting substantial gaps in sanitation provision and infrastructure for this age group.

Table 2. Type of toilet facility

Type of toilet facility	Percent	Frequency
Household toilet	59.7	118,304
Public toilet	20.4	40,530
No toilet facility	19.9	39,444
Total	100.0	198,278

Spatial pattern of access to sanitation among older adults in Ghana

As illustrated in **Figure 1**, the computed z-score of 20.51 exceeds the critical value of 2.58, demonstrating statistically significant spatial clustering of sanitation access among older adults in Ghana at the 99% confidence level; consequently, sanitation access is neither randomly distributed nor spatially dispersed, but rather concentrated in specific districts, with the confidence threshold indicating only a 1% probability that this observed pattern is due to chance.

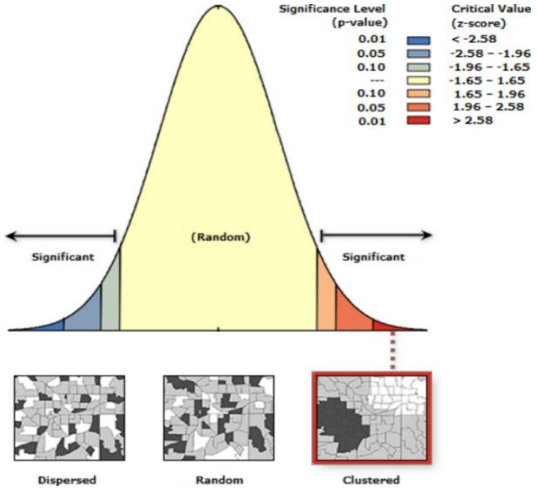

Figure 1. Spatial configuration of sanitation availability among older persons

Spatial concentration of sanitation access among older persons in Ghana

An examination at the district scale reveals pronounced regional contrasts in sanitation availability for older adults across Ghana. Districts located predominantly in the southern and central zones—such as Upper West Akim, Atiwa West, Gomoa East, Accra Metropolitan Area, and Kumasi Metropolitan Area—demonstrate comparatively widespread access, illustrated by blue-toned shading in **Figure 2**. Conversely, a clustering of districts characterized by restricted sanitation access among older adults is evident in the northeastern part of the country, with additional pockets of similar disadvantage observed in portions of the southeastern region, as indicated by red-toned shading.

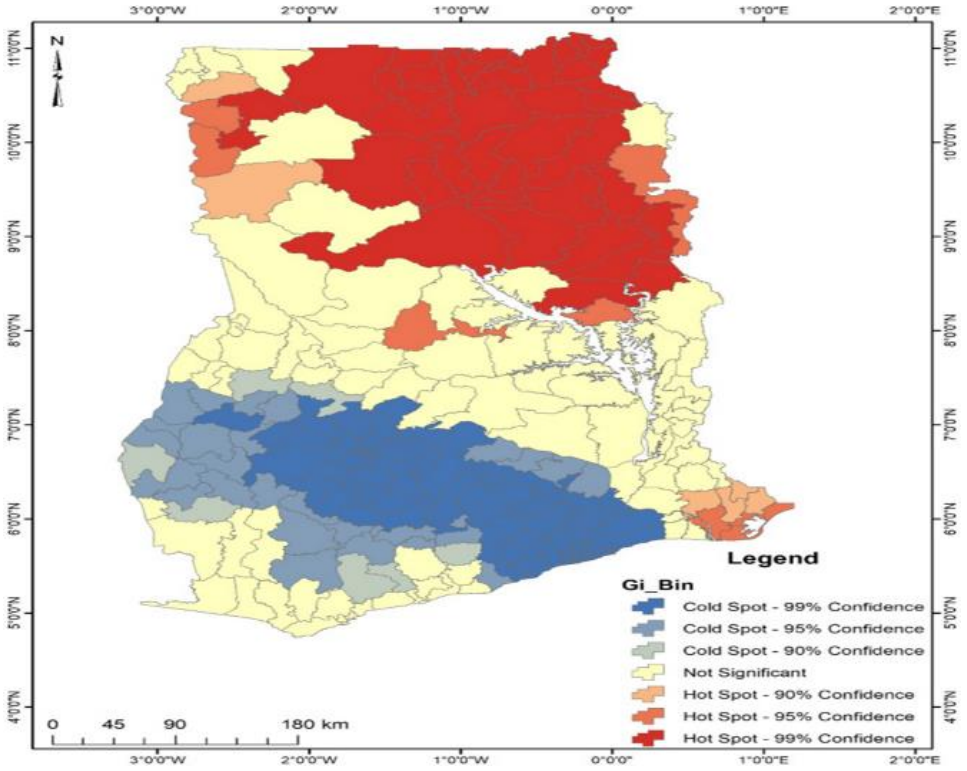

Figure 2. Spatial hotspots of sanitation access among older adults

Spatial clusters and anomalies in sanitation access among older adults in Ghana

As illustrated in **Figure 3**, several districts exhibit atypical patterns of sanitation access when compared with adjacent districts. Districts depicted in blue represent areas where older adults experience relatively fewer limitations in sanitation access despite being located next to districts with a higher prevalence of limited access. In contrast, districts shown in red indicate locations with a high share of older adults facing sanitation constraints, even though they are bordered by districts where such limitations are less common.

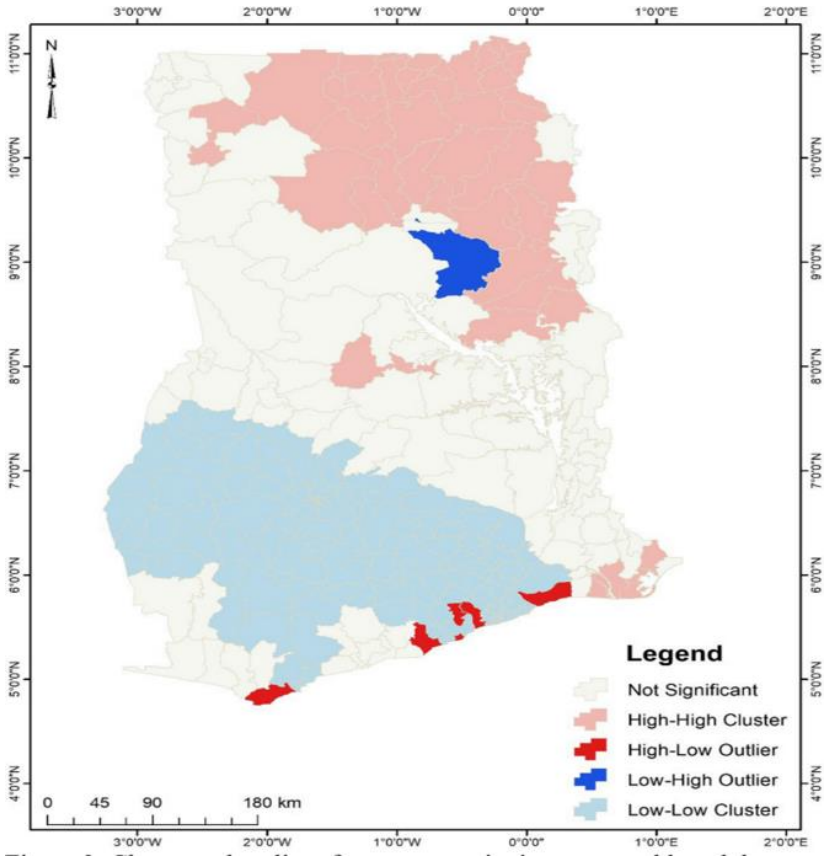

Figure 3. Spatial clustering and outlier patterns of sanitation access among older adults

Factors influencing sanitation access among older adults in Ghana

The adjusted logistic regression analysis included 198,278 older adults and yielded an R^2 value of 0.23, indicating that approximately 23% of the variation in sanitation access was accounted for by the explanatory variables. The model diagnostics—specifically the likelihood ratio Chi-square statistic (45,988.07), the associated p-value (0.000), and the log-likelihood value (−75,930.71)—collectively demonstrate that the model is statistically robust, explains a meaningful proportion of variability, and exhibits an acceptable overall fit. The determinants associated with sanitation access among older adults are detailed in **Table 3**. Findings from the unadjusted analyses showed that each independent variable was a significant predictor of sanitation access, suggesting that demographic characteristics, socioeconomic conditions, and disability-related factors each independently contribute to shaping sanitation access among the older population.

Table 3. Determinants of access to sanitation facilities among older adults in Ghana

Variable	Category/Reference	Adjusted Odds Ratio (AOR)	95% Confidence Interval	Crude Odds Ratio (COR)	95% Confidence Interval
Sex	Reference: Male				
	Female	1.054**	[1.023, 1.087]	0.958**	[0.937, 0.980]
Locality	Reference: Urban				
	Rural	0.348**	[0.338, 0.358]	0.213**	[0.208, 0.218]
Age Group	Reference: 60–69 years (early old)				
	70–79 years (middle old)	0.997	[0.968, 1.028]	0.748**	[0.729, 0.767]

	80 years and older (oldest old)	1.171**	[1.129, 1.214]	0.668**	[0.648, 0.687]
Religion	Reference: Orthodox Christian				
	Pentecostal/Charismatic	0.963	[0.927, 1.002]	0.899**	[0.867, 0.933]
	Other Christian	0.893**	[0.851, 0.937]	0.774**	[0.740, 0.810]
	Islam	0.287**	[0.277, 0.299]	0.224**	[0.217, 0.231]
	Traditionalist	0.226**	[0.217, 0.237]	0.085**	[0.081, 0.088]
	No religion	0.583**	[0.554, 0.614]	0.352**	[0.336, 0.369]
	Other	0.780**	[0.687, 0.887]	0.647**	[0.574, 0.729]
Marital Status	Reference: Informal union/living together				
	Married	0.967	[0.898, 1.040]	0.945	[0.885, 1.009]
	Separated/Divorced	1.374**	[1.263, 1.494]	1.644**	[1.524, 1.773]
	Widowed	1.143**	[1.059, 1.234]	1.028	[0.962, 1.099]
	Never married	1.208**	[1.077, 1.354]	1.350**	[1.219, 1.495]
School Attendance	Reference: Never attended school				
	Currently attending or attended in the past	2.749**	[2.662, 2.838]	5.659**	[5.509, 5.812]
Disability – Sight	Reference: No difficulty				
	Has difficulty	0.999	[0.965, 1.034]	0.900**	[0.878, 0.924]
Disability – Hearing	Reference: No difficulty				
	Has difficulty	0.882**	[0.843, 0.923]	0.684**	[0.662, 0.707]
Disability – Physical	Reference: No difficulty				
	Has difficulty	1.124**	[1.087, 1.163]	0.946**	[0.922, 0.970]
Disability – Speech	Reference: No difficulty				
	Has difficulty	1.072*	[1.011, 1.138]	0.824**	[0.787, 0.862]
Ownership of Radio/Stereo	Reference: Yes (owns)				
	No (does not own)	0.713**	[0.695, 0.732]	0.582**	[0.517, 0.540]
Ownership of Digital TV	Reference: Yes (owns)				
	No (does not own)	0.344**	[0.331, 0.358]	0.181**	[0.175, 0.187]
Ownership of Analogue TV	Reference: Yes (owns)				
	No (does not own)	0.608**	[0.589, 0.628]	0.503**	[0.489, 0.517]

*p < 0.05, **p < 0.001

The multivariable logistic regression analysis revealed that older adult women in Ghana exhibited greater likelihood of having access to sanitation facilities compared to men (adjusted odds ratio [AOR] = 1.054, 95% CI: 1.023–1.087, p < 0.001). Individuals aged 80 years and above also showed increased odds of sanitation access relative to those aged 60–69 years (AOR = 1.171, 95% CI: 1.129–1.214, p < 0.001). Furthermore, older adults who were separated or divorced (AOR = 1.374, 95% CI: 1.263–1.494, p < 0.001), widowed (AOR = 1.143, 95% CI: 1.059–1.234, p < 0.001), or never married (AOR = 1.208, 95% CI: 1.077–1.354, p < 0.001) demonstrated higher probabilities of sanitation access than those in informal cohabiting relationships.

Conversely, older adults residing in rural areas had substantially reduced odds of sanitation access in comparison with urban dwellers (AOR = 0.348, 95% CI: 0.338–0.358, p < 0.001). Adherents of religions other than Orthodox Christianity generally displayed lower odds: this included other Christian denominations (AOR = 0.893, 95% CI: 0.851–0.937, p < 0.001), Muslims (AOR = 0.287, 95% CI: 0.277–0.299, p < 0.001), Traditionalists (AOR = 0.226, 95% CI: 0.217–0.237, p < 0.001), those with no religious affiliation (AOR = 0.583, 95% CI: 0.554–0.614, p < 0.001), and followers of other unspecified religions (AOR = 0.780, 95% CI: 0.687–0.887, p < 0.001).

Lack of ownership of household assets was associated with diminished sanitation access: older adults without a radio or stereo (AOR = 0.713, 95% CI: 0.695–0.732, p < 0.001), without a digital television (AOR = 0.344, 95% CI: 0.331–0.358, p < 0.001), or without an analogue television (AOR = 0.608, 95% CI: 0.589–0.628, p < 0.001) were considerably less likely to have sanitation facilities than owners of these items. Regarding disabilities, individuals experiencing hearing difficulties had lower odds of sanitation access (AOR = 0.882, 95% CI: 0.843–0.923, p < 0.001). In contrast, those with speech difficulties (AOR = 1.072, 95% CI: 1.011–1.138, p < 0.05) or physical mobility challenges (AOR = 1.124, 95% CI: 1.087–1.163, p < 0.001) showed elevated odds compared to those without such impairments.

This research examines the spatial patterns and individual-level factors influencing sanitation access among older adults in Ghana, combining geospatial methods with socioeconomic analysis. The 2021 Population and Housing Census indicates that 17.7% of Ghanaian households have limited sanitation access, often resulting in open defecation [5]. Yet, data specific to older adults show that approximately 20% experience limited or no sanitation access, surpassing the national household average documented by the GSS [5]. Research by Simiyu *et al*. [30] and Gyasi *et al*. [12] demonstrates that older adults facing sanitation limitations are at greater risk of experiencing major depressive episodes and chronic illnesses. Restricted sanitation access carries profound consequences for the overall well-being of older adults. Geospatial analyses were employed to map these patterns, aiding in evidence-based policy development and research.

The geospatial evaluation explored variations in sanitation access for older adults across Ghana's districts. Moran's I statistic indicated non-random clustering rather than uniform distribution. This clustering reveals geographic inequalities, with some districts showing greater availability of sanitation infrastructure and others facing severe shortages. Specifically, Getis-Ord Gi* hotspot analysis pinpointed districts with elevated sanitation access among older adults, concentrated mainly in south-central Ghana, alongside areas of restricted access, notably in northeastern and certain southeastern districts. These geographic differences emphasize the need to incorporate regional specificities and contextual factors into sanitation strategies and programs. Additionally, Anselin Local Moran's I cluster and outlier analysis detected districts exhibiting unique patterns relative to neighbors, identifying zones of relative advantage or disadvantage. These results align with Belay *et al*. [28] in Ethiopia, which reported clustered spatial patterns in sanitation access. However, Belay *et al*. [28] focused on the broader adult population rather than older adults specifically, complicating direct comparisons while still offering useful contextual insights. Such geospatial insights equip decision-makers to prioritize resource distribution and targeted initiatives in high-need areas.

Beyond geospatial patterns, the analysis identified key individual factors shaping sanitation access. Gender was a prominent influence, with women exhibiting greater likelihood of access compared to men. This pattern may stem from sociocultural norms in Africa that prioritize dignified toilet facilities for women to safeguard their privacy and respect [20, 32]. Men, conversely, often accept open urination or defecation. Age also mattered, as those aged 80 and above had elevated access probabilities relative to younger cohorts. This likely reflects adaptations for the very old, who face mobility challenges with standard facilities and thus require tailored supportive setups for daily functioning.

Other factors included marital status, educational attainment, and economic position, where separated/divorced, widowed, or never-married individuals, as well as those with advanced education, displayed increased access likelihood. Marital partnerships facilitate resource pooling that can support better sanitation infrastructure [33, 34], unlike for those lacking such bonds. Higher education and wealth enable investment in quality facilities [35], consistent with the observed patterns favoring educated and affluent older adults. Rural dwelling, however, correlated with reduced access odds versus urban settings, reflecting infrastructural gaps in rural Ghana [36].

Religious affiliation influenced outcomes, with some groups showing diminished access relative to others. Household asset ownership and certain disabilities, especially hearing-related, also significantly affected access. Both personal and contextual elements substantially shape sanitation availability. For example, Belay *et al*. [28] and Mariwah, Amo-Adjei, and Anima [37] highlight how age, education, marital status, residence type, and geographic region drive sanitation access. Variations tied to location, gender, marital ties, wealth, and education can widen health disparities—unfair and preventable differences in outcomes arising from social structures [38].

Study strengths encompass the use of a large, representative national dataset, comprehensive variable inclusion, and pioneering focus on socioeconomic and health drivers of sanitation access in older adults within low- and middle-income settings. Limitations persist, however. The cross-sectional design precludes inferences of causality or temporality in relationships between sanitation access and predictors. Future research would gain from longitudinal approaches to clarify directional influences on late-life sanitation predictors. Data relied on self-reports, introducing potential social desirability or recall biases despite their standard use in social studies. Sampling focused on community-residing older adults, limiting applicability to institutional populations. District-level geospatial work may encounter the modifiable areal unit problem from data aggregation. Lastly, the binary sex categorization overlooked gender's fluid dimensions, roles, and identities.

Implications for policy and practice

The results of this study emphasize the necessity for geographically customized policies to tackle inequalities in sanitation access among older adults in Ghana. Geospatial analyses identified concentrations of restricted access in particular districts, especially in the northeastern and southeastern areas, underscoring the pressing need for focused resource distribution and infrastructure enhancement. Decision-makers should focus on these neglected regions, incorporating sanitation upgrades into larger rural development initiatives. Moreover, the pronounced urban-rural gap in sanitation access highlights the critical role of rural infrastructure investment, guaranteeing that rural communities obtain sufficient assistance for building and sustaining sanitation facilities. Utilizing geospatial information can support informed policy choices, enabling precise targeting of interventions to areas of greatest need.

This research further illuminates how socioeconomic, gender, and health-related factors influence sanitation access. Interventions should aim to support at-risk populations, such as older adults and those with disabilities, through the creation of age-appropriate and disability-inclusive facilities that prioritize safety, privacy, and ease of use. In addition, linking sanitation enhancements to existing health initiatives could mitigate the negative health effects associated with poor sanitation, including chronic diseases and depressive disorders. Promoting community-driven strategies is essential to build local commitment and long-term viability, complemented by robust monitoring and evaluation frameworks to assess advancements and adjust programs accordingly. By confronting these issues, Ghana can advance fair sanitation provision, enhance health status, and diminish social and geographic disparities among its older population.

Conclusion

This research aimed to evaluate the geographic patterns and predictors of sanitation access among older adults in Ghana. From the geospatial assessments, it is evident that restricted access (absence of toilet facilities) to sanitation among older adults is clustered in certain districts, predominantly in the northeastern and southeastern parts of the country. The results also highlight the intricate relationships among demographic, socioeconomic, and other factors that determine sanitation access in this age group. Critically, the study found that a larger share of older adults engage in open defecation compared to the national household average, demanding targeted action given their vulnerabilities—such as reduced physical strength for traveling distances or squatting. Overall, this investigation exposed the extent of sanitation limitations faced by older adults and employed spatial methods to pinpoint priority zones for improvement. Thus, efforts to reduce sanitation disparities through policy and practice must adopt comprehensive strategies. These should account for individual factors like sex, age, religion, and marital status, while emphasizing focused actions to achieve universal sanitation coverage across regions and subgroups, ensuring inclusivity. Drawing on the geospatial findings, governments, non-governmental organizations, and donors ought to direct additional resources toward older adults in identified hotspot districts to bolster their sanitation access. Communities themselves can contribute by assisting older members via community-led total sanitation programs. Future investigations could explore older adults' access to public sanitation facilities.

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