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Avian influenza preparedness in Ghana: a cross-sectional assessment of knowledge, attitudes, and practices among residents of Nsawam-Adoagyiri Municipality, Eastern Region

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Abstract

Background Avian influenza (AI) represents a persistent threat to public health, food security, and livelihoods in Ghana, where outbreaks of H5N1 and H9N2 have occurred. This cross-sectional study evaluated the knowledge, attitudes, and practices (KAP) related to avian influenza among residents of the Nsawam-Adoagyiri Municipality; an area characterized by intensive poultry production with the aim of delineating deficits in community-level preparedness and guiding evidence-based public health interventions.

Methods A community-based cross-sectional study was conducted from May to July 2025 using a four-stage sampling technique. We surveyed 321 adults via structured questionnaires, evaluating socio-demographics and KAP related to AI. Scale reliability was assessed using KR-20 (knowledge) and Cronbach's alpha (attitudes/practices), with construct validity examined through exploratory factor analysis. Scores were categorized using modified Bloom's taxonomy (≥ 70% indicating good knowledge, positive attitudes, or safe practices). Data were analyzed in STATA 17 using descriptive statistics, chi-square tests, and multivariable logistic regression.

Results Most respondents demonstrated good knowledge of AI (81.6%; 95% CI: 77.0–85.5) and positive attitudes toward prevention (74.5%; 95% CI: 69.4–78.9). However, only 26.2% (95% CI: 21.6–31.3) reported adherence to recommended preventive practices. Poultry ownership was significantly associated with positive attitudes ($\chi^2 = 10.44$, $p = 0.001$) and better practices ($\chi^2 = 10.30$, $p = 0.001$). Female participants and those with lower educational attainment

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had significantly lower knowledge and attitude scores. Strong correlations were observed between knowledge, attitudes, and practices (all $p < 0.001$), underscoring their interdependence.

Conclusion While awareness and positive perceptions of AI are high in Nsawam-Adoagyiri, a substantial knowledge-practice gap remains. Community-level interventions including hands-on training, access to affordable protective equipment, and strengthened One Health collaboration are urgently needed to translate awareness into actionable biosafety behaviours and reduce outbreak risk.

Keywords Avian Influenza, Ghana, Knowledge, Attitude, Zoonosis, One Health, Low-resource setting, Nsawam-Adoagyiri

Background

Avian influenza, a highly contagious viral disease, poses a significant threat to global public health, food security, and the livelihoods of those in the poultry industry [1]. Avian influenza, caused by influenza A viruses, primarily affects wild and domestic birds but can also infect mammals, including humans [2, 3]. Wild waterfowl, such as ducks and geese, often show no clinical signs, while poultry can experience significant outbreaks [3]. Avian influenza viruses are generally species-specific. However, subtypes H5, H7, and H9 have resulted in sporadic human infections through direct contact with infected birds, with H5N1 particularly exhibiting high mortality rates of 60% [4]. Several subtypes, particularly H5N1, H7N9, H7N3, H7N7, and H9N2, pose zoonotic risks and have been linked to severe human infections [3]. The H9N2 subtype, endemic in certain poultry populations, raises concerns due to its potential of transmitting to mammals (including pigs, cats, horses, dogs, and ferrets) through minor amino acid changes in the HA segment [3, 5]. Migratory birds play a key role in the virus's long-distance spread, highlighting the need for international surveillance [2]. These transmission dynamics underscore avian influenza's significance as a zoonotic threat, emphasizing the need for interdisciplinary research and collaborative prevention efforts.

Ghana has faced significant outbreaks of avian influenza, specifically H5N1 and H9N2 subtypes. The H5N1 outbreaks occurred in two waves between 2007 and 2017, resulting in severe economic repercussions for the poultry sector, with mortality rates reaching 100% [6]. The H9N2 subtype was first identified in Ghanaian among layer hens in 2017–2018. Whole genome analysis indicated that the viruses belong to the G1-lineage, clustering with strains from North and West Africa [7]. Continued circulation of H9N2 was confirmed through surveillance from 2017 to 2019. This detected the virus in 11 avian species from backyard poultry. Phylogenetic analysis suggested the virus's importation from North Africa and Burkina Faso [8]. However, Ghana reported its first human case of H9N2 in 2024, one of 19 new human avian influenza cases globally from June to September 2024 [9].

These outbreaks have caused significant economic losses for poultry farmers, highlighting the need for improved surveillance and outbreak preparedness. The findings reveal Ghana's vulnerability to avian influenza subtypes zoonotic diseases. Study on knowledge, attitudes, and practices (KAP) concerning avian influenza among poultry workers in the Ashanti Region shows inadequate knowledge regarding disease recognition, prevention, and control practices [10]. Similarly, pig farmers in Greater Accra showed poor awareness, with over 60% lacking understanding of influenza A virus transmission. However, 60% of these farmers showed moderate compliance with biosafety measures [11]. Active surveillance in Greater Accra found an overall influenza A prevalence of 7.7%, with live bird markets having the highest rates at 13.5%, compared to backyard (1.4%) and commercial poultry (2.4%) [12]. These results indicate ongoing circulation of the H9 virus and the need for improved monitoring and best farm hygiene practice strategies in Ghana's poultry sector.

The Nsawam-Adoagyiri Municipality in the Eastern Region of Ghana is a key area for poultry farming. Given the historical context of avian influenza in Ghana and the potential for future outbreaks, it is essential to assess the outbreak preparedness of communities in high-risk areas. A cross-sectional study evaluating the KAP of residents can provide valuable insights into their readiness to prevent and control the spread of the disease. Studies conducted in Ghana and elsewhere have shown that gaps in knowledge and inadequate best practices can hinder effective avian influenza disease prevention [6, 13].

This study assessed the KAP regarding avian influenza among residents of the Nsawam-Adoagyiri Municipality by determining the community's preparedness, identifying gaps in knowledge or unsafe practices, and providing recommendations for public health interventions and educational programs. Understanding the community's perspective will help implement strategies to enhance biosafety, promote early reporting of suspected cases, and mitigate future avian influenza outbreaks in Ghana.

Methods

Study design and setting

This was a community-based cross-sectional study conducted in the Nsawam-Adoagyiri Municipality of the Eastern Region, Ghana. The Nsawam-Adoagyiri Municipal is one of the 261 Assemblies in Ghana and part of the thirty-three Municipalities and Districts in the Eastern Region. It is located in the southeastern part of the Eastern Region between latitude 5.45°N and 5.58°N and longitude 0.07°W and 0.27°W, with Nsawam as its capital. The Municipality covers an area of approximately 175 km^2 and shares boundaries with Ga West Municipal to the south, Suhum Municipal to the north and west, and Akwapim South District to the east [14]. According to the 2021 population and housing census, the population stands at 155,597, comprising 76,417 males and 79,180 females [15]. The municipality comprises urban, peri-urban, and rural settlements with diverse socio-economic status and activities, including small to large scale poultry farming and live-bird markets. These characteristics make it suitable for assessing avian influenza-related knowledge, attitudes, and practices (KAP).

Study population and eligibility criteria

The study targeted adult residents aged ≥ 18 years who had lived in the municipality for at least six months and provided written informed consent. Excluded from the study were temporary visitors, economic migrants who stayed less than six months in the study location, the critically ill, and individuals who declined participation.

Sample size determination

The minimum required sample size was calculated using the single population proportion formula: $n = Z^2 \times p(1 - p)/d^2$ where $Z = 1.96$ (95% confidence level), $p = 0.29$ (a conservative estimate of the proportion with adequate knowledge, derived from pilot data), and $d = 0.05$ (margin of error). This yielded a minimum sample size of 316. To account for the cluster design, we applied a design effect of 1.8 (estimated from intra-cluster correlation of 0.12 from pilot data), increasing the required sample to 569. Further accounting for a 10% non-response rate gave a final target of 626. The study successfully recruited 321 participants, representing 56.4% of the target. Consequently, estimates should be interpreted with caution due to reduced precision, and all analyses incorporate survey weighting to adjust for unequal selection probabilities.

Sampling procedure

A four-stage stratified cluster sampling technique was employed to obtain a representative sample of adults in the Nsawam-Adoagyiri Municipality. This approach was selected to ensure geographic representation while maintaining operational feasibility, and all analyses appropriately account for the complex sampling design through survey weighting and cluster adjustment.

The sampling frame was constructed as follows, using the 2021 Ghana Population and Housing Census as a foundation. Stage 1: The municipality was stratified into urban, peri-urban, and rural areas based on Ghana Statistical Service classifications to ensure proportional geographic representation. Stage 2: Within each stratum, enumeration areas (EAs) were randomly selected with probability proportional to population size. Stage 3: A complete listing of all households within selected EAs was conducted. From this comprehensive list, households were randomly selected using a computer-generated random number sequence. Stage 4: Within each sampled household, one eligible adult (aged ≥ 18 years with at least six months of residency) was randomly selected using the Kish grid method to prevent selection bias.

To preserve the integrity of the random sample and minimize bias, a strict protocol for non-response was followed. Up to three contact attempts were made on different days and times. Households where no eligible respondent was contacted or where participation was declined were recorded as non-respondents; no substitutions were made.

Sampling weights were calculated as the inverse of the overall probability of selection at each stage, adjusted for household-level non-response, and post-stratified to the 2021 municipal population distribution by age and sex. All statistical analyses incorporated these weights and accounted for clustering at the EA level using survey commands in STATA 17.

Study instrument design and validation

Data were collected using a standardized questionnaire we developed based on the WHO fact sheet on avian influenza [16] and a study of workers in the Italian poultry industry [17] (supplementary file:S1). The questionnaire was meticulously adapted to the local sociocultural context through a rigorous translation and validation process.

The original English version underwent forward-back translation to ensure linguistic and conceptual equivalence. Two bilingual translators independently translated the instrument into Twi and Ewe, the predominant local languages in the study area. These versions were then back-translated into English by two different bilingual translators who had no prior exposure to the original instrument. Discrepancies between the original and back-translated versions were discussed and resolved by a panel of three experts (CYD, JPK, PF A-K) with backgrounds in medical microbiology, epidemiology, and public health, producing final consensus versions in each language.

The questionnaire comprised four sections: sociodemographic characteristics, knowledge, attitudes, and practices regarding avian influenza. Content and face validity were assessed by the same expert panel. Pretesting was conducted with 30 residents from a neighboring municipality with similar population composition to assess clarity, comprehension, and cultural relevance. Minor revisions to wording and response options were made based on pretest feedback; pretest data were excluded from the final analysis.

All six research assistants completed a two-day training session that included: (i) orientation to the study objectives and ethical procedures; (ii) detailed review of each questionnaire item with the standardized local language phrasing; (iii) role-playing exercises to practice interview techniques; and (iv) supervised practice interviews with community members not enrolled in the study. A field manual containing the agreed-upon local language phrasing for key concepts (e.g., "avian influenza," "biosecurity," "protective equipment") was provided to each interviewer to ensure consistency throughout data collection.

During face-to-face administration, interviewers used the standardized Twi or Ewe versions for respondents who preferred those languages. For the few respondents who spoke other languages, local community health volunteers were engaged as interpreters after signing confidentiality agreements. This rigorous approach ensured that informed consent was obtained accurately and that data collection remained standardized across all participants.

Data collection procedures

Data were collected from May 1 to July 30, 2025, through face-to-face interviews conducted at participants' homes or preferred locations within the community. Interviews were administered by six trained research assistants (three male, three female) who were fluent in English, Twi, and Ewe. Each interview lasted approximately 20–30 min.

Data was collected by field investigators (MK, and DEA) who: (i) conducted daily spot-checks on 10% of completed interviews; (ii) reviewed all questionnaires for completeness each evening; and (iii) held daily debriefing sessions with interviewers to address challenges and ensure protocol adherence.

Quality assurance measures included: (a) a standardized introduction script explaining the study purpose and obtaining verbal informed consent; (b) use of the pretested questionnaire with standardized local language phrasing; (c) immediate review of completed questionnaires for missing data, with follow-up visits arranged when necessary; (d) double data entry with validation checks; and (e) regular supervision meetings throughout the data collection period.

For participants who preferred Twi or Ewe, interviewers used the standardized translated versions of the questionnaire. For respondents who spoke other languages, local interpreters (community health volunteers) were engaged after signing confidentiality agreements.

Instrument reliability, validity, and scoring

The internal consistency of the KAP scales was evaluated using appropriate reliability measures. The knowledge domain (11 items) demonstrated acceptable reliability (KR-20 = 0.77), while the attitude (9 items) and practice (8 items) domains yielded Cronbach's alpha values of 0.66 and 0.55, respectively. The lower reliability of the practice scale was deemed acceptable, reflecting the limited number of items and variability in behavioural responses.

Construct validity was assessed through exploratory factor analysis, supported by a Kaiser–Meyer–Olkin (KMO) value ≥ 0.60 and a significant Bartlett's test of sphericity ($p < 0.05$).

For scoring, knowledge items were coded as 1 for correct responses and 0 for incorrect or "don't know" responses. Total knowledge scores were converted to percentages and classified using modified Bloom's taxonomy criteria as good (≥ 70%) or poor (< 70%). Attitude and practice items were rated on 5-point Likert scales, with higher scores indicating more positive attitudes and safer practices. Composite attitude and practice scores were also expressed as percentages and categorized using the same ≥ 70% threshold for positive outcomes.

Data management and analysis

Data were double-entered into Microsoft Excel and analyzed using STATA version 17 (StataCorp, College Station, TX, USA). All analyses were performed using survey commands (svy: prefix) to account for the complex sampling design, including stratification by residence type (urban/peri-urban/rural), clustering at the enumeration area (EA) level, and sampling weights.

Descriptive statistics (frequencies, percentages, means, and standard deviations) were computed for all variables. The chi-square test was used to assess associations between categorical variables. Multivariable logistic regression models were fitted to identify independent predictors of adequate knowledge, positive attitudes, and good practices. All sociodemographic variables (sex, marital status, residence, education, poultry ownership) were included in the full multivariable model regardless of bivariate significance, based on prior theoretical importance.

In a sensitivity analysis collapsing 'No formal' and 'Basic' education categories, the association between tertiary education and knowledge remained strong

Table 1 Sociodemographic characteristics of respondents

Characteristic	Frequency	Percentage (%)
Sex		
Male	145	45.2
Female	176	54.8
Marital status		
Not married	197	61.4
Married	124	38.6
Residence		
Urban	279	86.9
Rural	42	13.1
Education level		
No formal education	26	8.1
Basic	66	20.6
Secondary	110	34.3
Tertiary	119	37.1
Poultry ownership		
No	234	72.9
Yes	87	27.1

Table 2 Prevalence of knowledge, attitudes, and practices

Outcome	Proportion (%)	95% CI
Good knowledge	81.6	77.0–85.5
Positive attitude	74.5	69.4–78.9
Good practices	26.2	21.6–31.3

Table 3 Association between poultry ownership and KAP

Outcome	χ^2	*p*-value
Knowledge	3.77	0.052
Attitude	10.44	0.001
Practice	10.30	0.001

(aOR = 9.41, 95% CI: 3.89–22.77). A p-value < 0.05 was considered statistically significant.

Results

Sociodemographic characteristics

A total of 321 respondents were included in the analysis. The sample was predominantly female (54.8%), unmarried (61.4%), and urban-dwelling (86.9%). Educational attainment varied, with 37.1% having tertiary education and 8.1% having no formal education. Approximately one-quarter of respondents (27.1%) reported owning poultry (Table 1).

Overall KAP prevalence

The overall prevalence of good knowledge was 81.6% (95% CI: 77.0–85.5), while 74.5% (95% CI: 69.4–78.9) demonstrated a positive attitude. In contrast, only 26.2% (95% CI: 21.6–31.3) reported engaging in good preventive practices (Table 2).

Table 4 Multivariable logistic regression analysis of factors associated with knowledge

Variable	Crude OR (95% CI)	*p*-value	Adjusted OR (95% CI)	*p*-value
Sex				
Male	1		1	
Female	0.54 (0.31–0.96)	0.035	0.54 (0.29–0.99)	0.045
Marital status				
Not married	1		1	
Married	1.55 (0.84–2.84)	0.158	1.63 (0.85–3.12)	0.140
Residence				
Urban	1		1	
Rural	1.78 (0.67–4.73)	0.251	1.60 (0.56–4.54)	0.377
Education level				
No formal education	1		1	
Basic	2.12 (0.83–5.41)	0.116	2.18 (0.84–5.69)	0.111
Secondary	3.86 (1.55–9.59)	0.004	4.03 (1.59–10.24)	0.003
Tertiary	11.89 (4.15–34.10)	0.000	12.37 (4.24–36.09)	< 0.001

Association between poultry ownership and KAP

Poultry ownership showed a borderline association with knowledge ($\chi^2 = 3.77$, $p = 0.052$). Owners were significantly more likely than non-owners to have a positive attitude ($\chi^2 = 10.44$, $p = 0.001$) and to report good preventive practices ($\chi^2 = 10.30$, $p = 0.001$) (Table 3).

Factors associated with KAP outcomes

Results from logistic regression analyses are shown in Tables 4 (Knowledge), 5 (Attitudes), and 6 (Practices).

Knowledge

In the adjusted model, female respondents had lower odds of good knowledge than males (aOR = 0.54, 95% CI: 0.29–0.99, $p = 0.045$). Higher education was a strong independent predictor, with significantly increased odds for those with secondary (aOR = 4.03, 95% CI: 1.59–10.24, $p = 0.003$) and tertiary education (aOR = 12.37, 95% CI: 4.24–36.09, $p < 0.001$) compared to no formal education.

Attitudes

Female sex remained associated with lower odds of a positive attitude after adjustment (aOR = 0.54, 95% CI: 0.32–0.93, $p = 0.025$). Tertiary education was independently associated with higher odds (aOR = 7.39, 95% CI: 2.77–19.72, $p < 0.001$).

Table 5 Multivariable logistic regression analysis of factors associated with attitudes

Variable	Crude OR (95% CI)	*p*-value	Adjusted OR (95% CI)	*p*-value
Sex				
Male	1		1	
Female	0.55 (0.33–0.92)	0.022	0.54 (0.32–0.93)	0.025
Marital status				
Not married	1		1	
Married	1.61 (0.94–2.76)	0.081	1.63 (0.92–2.87)	0.094
Residence				
Urban	1		1	
Rural	0.96 (0.46–2.01)	0.918	0.81 (0.36–1.79)	0.596
Education level				
No formal education	1		1	
Basic	1.32 (0.53–3.29)	0.554	1.28 (0.50–3.26)	0.607
Secondary	2.18 (0.91–5.24)	0.080	2.27 (0.93–5.56)	0.072
Tertiary	6.99 (2.67–18.30)	0.000	7.39 (2.77–19.72)	< 0.001

Table 6 Multivariable logistic regression analysis of factors associated with practices

Variable	Crude OR (95% CI)	*p*-value	Adjusted OR (95% CI)	*p*-value
Sex				
Male	1		1	
Female	0.82 (0.50–1.36)	0.453	0.80 (0.48–1.34)	0.403
Marital status				
Not married	1		1	
Married	0.79 (0.47–1.32)	0.369	0.77 (0.45–1.30)	0.330
Residence				
Urban	1		1	
Rural	0.87 (0.41–1.85)	0.709	0.77 (0.35–1.66)	0.498
Education level				
No formal education	1		1	
Basic	0.82 (0.27–2.45)	0.719	0.82 (0.27–2.45)	0.716
Secondary	1.03 (0.37–2.84)	0.952	1.03 (0.37–2.83)	0.960
Tertiary	1.63 (0.60–4.37)	0.336	1.64 (0.61–4.43)	0.327

Practices

No sociodemographic factors (sex, marital status, residence, education) were significantly associated with good preventive practices in the multivariable analysis.

Awareness and disease knowledge

General awareness of avian influenza was high, with 78.5% ($n = 252$) of respondents reporting they had heard of the disease (Fig. 1). When asked to identify the causative agent, 52.6% ($n = 169$) correctly cited a virus (Fig. 2A). Common misconceptions included attributing the cause to bacteria (15.0%, $n = 48$) or being unsure (25.5%, $n = 82$). Knowledge of transmission routes was varied, with 9.0% ($n = 29$) expressing uncertainty. Most respondents correctly identified the disease as preventable (91.3%, $n = 293$; Fig. 2B) and treatable (84.4%, $n = 271$; Fig. 2C), recognized the risk of consuming undercooked poultry (90.7%, $n = 291$; Fig. 2D), and understood the possibility of asymptomatic infection (69.2%, $n = 222$).

Attitudes toward prevention

Attitudes were largely favourable across measured domains (Table 7). Strong consensus existed on key biosecurity measures: 89.4% ($n = 287$) agreed avoiding sick birds is critical, and 87.2% ($n = 280$) endorsed the use of protective gear when handling poultry. Most respondents (85.4%, $n = 274$) prioritized seeking immediate medical care for suspected symptoms. A majority perceived avian influenza as a serious community threat (62.9%, $n = 202$), acknowledged personal responsibility for disposing of dead poultry (70.1%, $n = 225$), and considered veterinary services worth the cost (71.7%, $n = 230$).

Factor structure and psychometric properties of the practices scale

Principal Component Analysis with Varimax rotation of the six practice items supported a unidimensional structure, accounting for 33.2% of the total variance (Kaiser–Meyer–Olkin measure = 0.70; Bartlett's test of sphericity: $\chi^2 = 170$, df = 15, $p < 0.001$). Four items demonstrated sufficient loadings (≥ 0.61) onto the single component. The item "avoiding contact with sick poultry birds" had a low loading (0.33), and "cooking poultry products very well before eating" loaded below the 0.30 threshold and was therefore excluded from the final scale.

The resulting 4-item unidimensional scale was used as a composite measure of preventive practices in subsequent regression analyses. Its psychometric properties are presented in Table 8. The scale demonstrated moderate internal consistency (Cronbach's $\alpha = 0.59$), with a mean score of 2.42 (SD = 0.39). Corrected item-total correlations for the retained items ranged from 0.35 to 0.40.

Bivariate associations of marital status and age with knowledge

In bivariate analysis, marital status was significantly associated with knowledge levels ($\chi^2 = 18.1$, df = 8, $p = 0.020$), with married respondents constituting a lower proportion of the 'good knowledge' category (see Supplementary

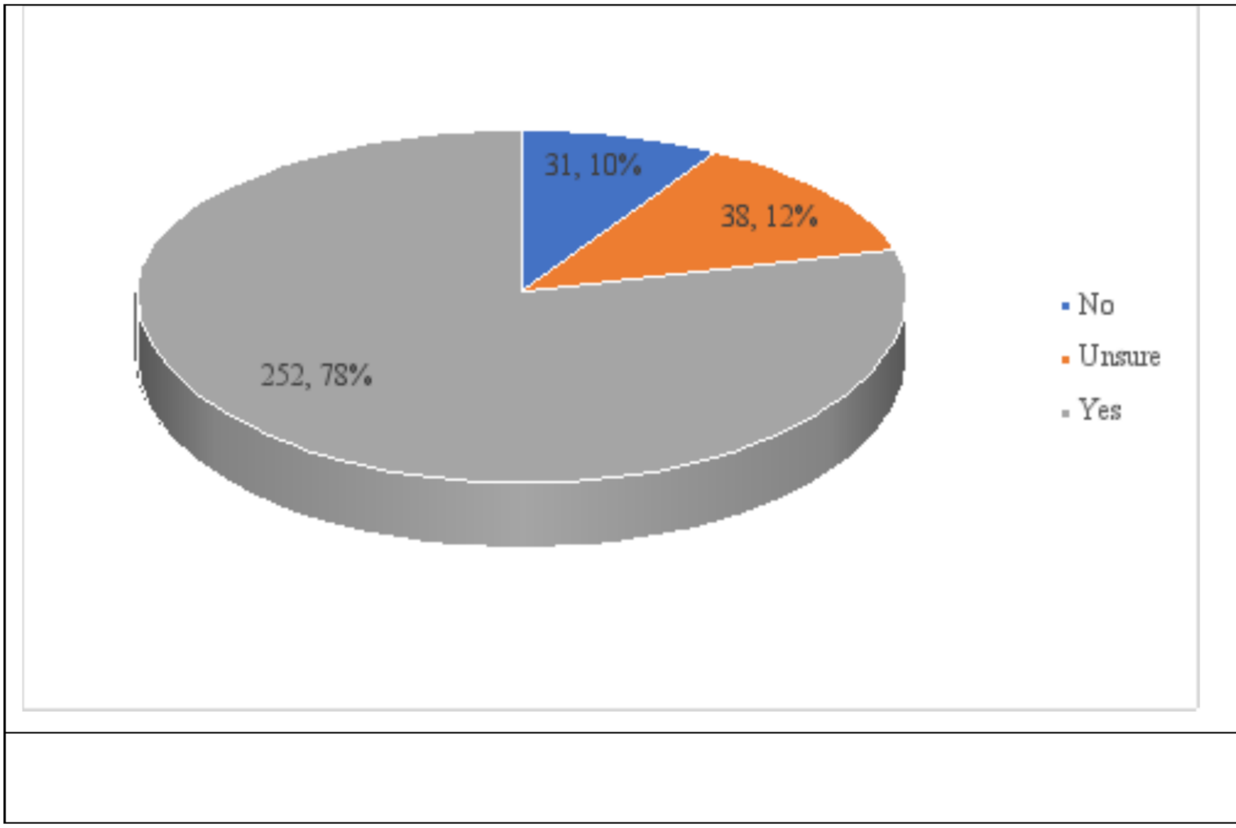

Fig. 1 Have you heard of bird flu?

Table S2). However, this association was not statistically significant in the multivariable logistic regression model after adjusting for sex, residence, and education (aOR = 1.63, 95% CI: 0.85–3.12, $p = 0.140$). No significant association was found between age group and knowledge level in bivariate analysis ($p = 0.648$).

Scale reliability detail

Item-level analysis showed that removing any of the four included items would not substantially improve the scale's reliability (range of α if item deleted: 0.47–0.63) (see Supplementary Table S1).

Discussion

This study provides a detailed assessment of the knowledge, attitudes, and preventive practices (KAP) related to avian influenza (AI) in the Nsawam-Adoagyiri Municipality, Ghana—a region with considerable poultry farming activity and historical AI outbreaks. The findings reveal a population with generally high knowledge (81.6%) and favourable attitudes (74.5%) toward AI prevention, which aligns with studies from similar socio-agrarian settings in Ghana [18], Nigeria [19], and Nepal [20]. This suggests that existing public health messaging has been relatively effective in raising awareness. However, a critical and substantial gap persists between awareness and behaviour, as only 26.2% of respondents were classified as having good preventive practices. This knowledge-practice gap is a well-documented challenge in public health interventions [21, 22] and represents a significant vulnerability in zoonotic disease preparedness.

Higher educational attainment is associated with better access to health information and greater capacity for critical appraisal of such information [23, 24], which may explain the observed knowledge differences.

A more nuanced finding is the significantly lower adjusted odds of good knowledge (aOR = 0.54, $p = 0.045$) and positive attitudes (aOR = 0.54, $p = 0.025$) among female respondents compared to males. This counterintuitive finding warrants careful interpretation within the West African context. Studies from the region provide possible explanations. In Ghana, Asare et al. [10] found that male poultry workers had greater access to agricultural extension services and veterinary officers than their female counterparts, creating gender disparities in information reception. Similarly, in Nigeria, Oyadeyi et al. [13] documented that women in poultry farming had fewer opportunities to participate in farmer training programs due to domestic responsibilities and cultural norms limiting mobility. These gendered patterns in information access may explain why women in our study,

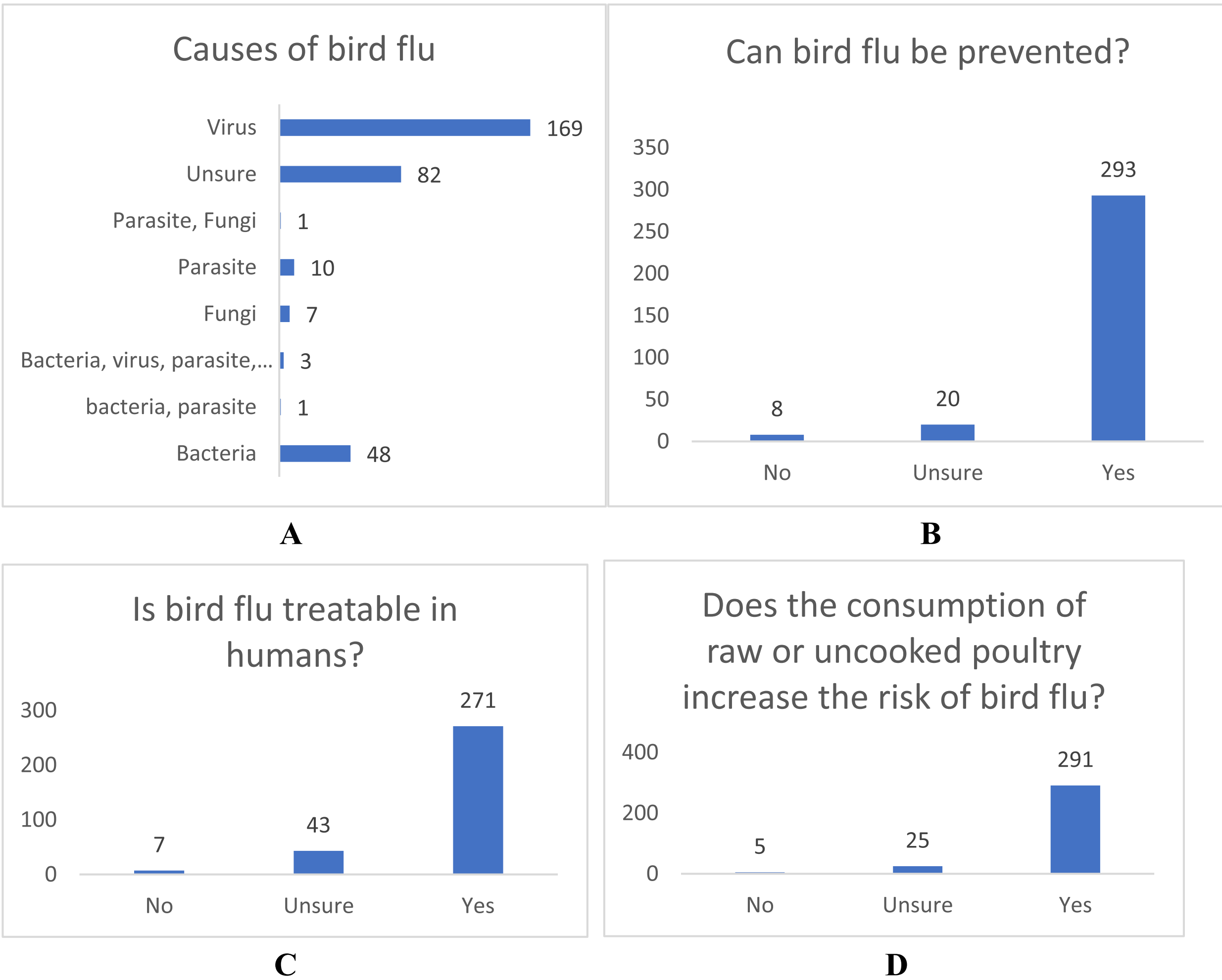

Fig. 2 Knowledge of avian influenza among residents of Nsawam-Adoagyiri Municipality. (A) Awareness of the viral causative agent; (B) Perception of the disease as preventable; (C) Perception of the disease as treatable; (D) Recognition of the risk associated with consuming undercooked poultry products

Table 7 Attitudes toward avian influenza prevention

Attitude item	Response		
	No	Yes	Unsure
Do you believe bird flu is a serious threat in your community	89(27.7)	202(62.9)	30(9.3)
Is avoiding sick birds critical for bird flu prevention?	16(5.0)	287(89.4)	18(5.6)
Do you believe it is your responsibility to dispose of dead poultry birds?	77(24.0)	225(70.1)	19(5.9)
Do you feel it is important to wear protective gear when handling sick or dead poultry birds?	21(6.5)	280(87.2)	20(6.2)
Do you think veterinary services are worth the cost?	53(16.5)	230(71.7)	38(11.8)
Do you prioritize seeking medical care immediately if you suspect bird flu symptoms?	25(7.8)	274(85.4)	22(6.9)

despite constituting 54.8% of the sample, demonstrated lower knowledge scores.

Furthermore, risk communication research from West Africa suggests that extension messaging often targets men as primary decision-makers in agriculture [11], potentially excluding women who may be responsible for daily poultry care but not included in formal training. This "information gender gap" has been documented across the region [19] and likely contributes to our findings. Additional explanations include unmeasured confounding variables such as primary occupation (direct involvement in live bird markets vs. domestic poultry care), media consumption patterns, and autonomy in health-related decision-making—factors known to differ by gender in Ghanaian communities [15]. This finding underscores the urgent need for gender-sensitive communication strategies that deliberately reach women through channels accessible to them, such as women's groups, market days, and community health volunteers,

Table 8 Psychometric properties of the avian influenza preventive practices scale

Item	Factor Loading	Uniqueness	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
Do you dispose dead poultry birds properly?	0.731	0.466	0.40	0.467
Do you wash equipment that has come into contact with dead or sick poultry birds?	0.713	0.492	0.39	0.473
Do you wear any protective clothing (e.g., gloves, masks) before handling sick or dead poultry birds?	0.641	0.590	0.36	0.530
Do you wash your hands after handling poultry birds?	0.606	0.632	0.35	0.536
Do you avoid contact with sick poultry birds?*	0.332	0.890	0.18	0.630

*This item was retained in the scale due to its face validity and theoretical importance, despite its lower statistical loading

Footnote: The item *"Do *you cook poultry products very well before eating?"* was removed from the scale due to a factor loading below 0.30

rather than relying solely on traditional extension services that may perpetuate existing disparities.

The most operationally significant finding is the strong association between poultry ownership and both positive attitudes ($p = 0.001$) and better preventive practices ($p = 0.001$). This finding is consistent with experiential learning theories [25], which propose that individuals with direct risk exposure may develop heightened risk perception and greater uptake of protective behaviours. However, given the cross-sectional design, we cannot establish that poultry ownership causally improves practices.

Importantly, no sociodemographic factors were significantly associated with good practices in the multivariable model. This powerfully indicates that the knowledge-practice gap is not merely a function of individual demographics but is driven by broader contextual and enabling factors, such as access to affordable protective equipment, the feasibility of recommended actions within existing poultry-rearing systems, economic disincentives for reporting sick birds, and deeply ingrained husbandry routines [26]. The practice scale demonstrated moderate internal consistency (α = 0.59), which, while below the conventional 0.70 threshold, is considered acceptable for exploratory research with limited items and heterogeneous behavioural constructs. The unidimensional structure supported by EFA and adequate item-total correlations (0.35–0.40) supports its use as a composite measure, albeit with results interpreted cautiously [27].

Strengths and limitations

A key methodological strength of this study is the transparent psychometric evaluation of the preventive practices scale, which confirmed a unidimensional construct and allows for clearer interpretation of the practice-related findings. The interpretation of these results must be considered within several important limitations:

1. Cross-sectional design: This captures a snapshot in time and identifies associations but cannot establish causality or temporal sequence between KAP elements.
2. Self-report and interviewer bias: Data were collected through face-to-face interviews, which may have introduced both respondent and interviewer bias. Respondents may have provided socially desirable answers, potentially inflating reports of positive attitudes and ideal practices. The discrepancy between high knowledge (81.6%) and low reported practices (26.2%) suggests that if social desirability bias occurred, it did not uniformly inflate all responses; nevertheless, the true prevalence of good practices may be even lower than reported. Interviewer variability was minimized through standardized training and use of a field manual, but some residual bias cannot be excluded.
3. Measurement limitations: The 4-item preventive practices scale demonstrated moderate internal consistency (Cronbach's α = 0.59), indicating some measurement error. While acceptable for exploratory research with limited items, this may have attenuated associations with predictor variables and contributed to the null findings for sociodemographic factors in the practices model. Furthermore, the exclusion of the item regarding "thorough cooking of poultry" from the final scale, while statistically justified, omits a critical, globally recommended food safety practice from the composite measure.
4. Seasonal effects: Data collection occurred from May to July, which coincides with the major rainy season in Ghana. Seasonal factors may influence

risk perception in two potential directions: (i) increased respiratory illnesses during rainy seasons might heighten general concern about influenza-like diseases; or (ii) reduced poultry farming activity during wet months might decrease salience of avian-specific risks. Our cross-sectional design cannot assess seasonal variation, and findings may not generalize to other times of year.

5. Unmeasured confounding: The associations involving gender and the null findings for sociodemographic predictors of practice may be influenced by unmeasured contextual, economic, or psychosocial confounders not captured in this survey, such as primary occupation, media access, or household decision-making autonomy.

Public health implications and recommendations

The persistent knowledge-practice gap underscores that informational campaigns alone are insufficient. Based on our findings, we propose differentiated interventions across two-time horizons:

Short-term Interventions (6–18 months):

1. Targeted skills-based training for poultry owners: Leverage the positive disposition of poultry owners (= 0.001) through hands-on workshops delivered via existing farmers' cooperatives. Training should focus on correct PPE use, safe carcass disposal, and equipment disinfection, with demonstration and return-demonstration methods.
2. Gender-sensitive community messaging: Develop and disseminate context-appropriate information through channels accessible to women, including: (i) community health worker home visits; (ii) radio dramas in local languages during times when women are likely listening; (iii) discussions at women's group meetings and market days.
3. Subsidized protective equipment pilot: Partner with district assemblies and NGOs to pilot a subsidy scheme for essential protective gear (gloves, boots, masks) targeted at smallholder poultry farmers, with monitoring to assess uptake and practice change.
4. Simplified reporting mechanisms: Establish community-based syndromic reporting systems using mobile technology (e.g., SMS hotlines, simple reporting apps) that trigger rapid veterinary response, reducing economic disincentives for reporting sick birds.

Long-term Interventions (2–5 years):

1. Structural enabling environment: Advocate for policy changes that (i) establish permanent compensation mechanisms for poultry culling during outbreaks; (ii) integrate biosecurity training into agricultural extension curricula; (iii) mandate inclusion of women in all farmer training programs.
2. One Health institutionalization: Formalize cross-sectoral collaboration through: (i) permanent joint district-level risk communication teams (public health, veterinary services, agriculture extension); (ii) annual joint simulation exercises for outbreak response; (iii) shared surveillance data platforms accessible to all sectors.
3. Research capacity strengthening: Support longitudinal and mixed-methods studies to elucidate causal pathways to behaviour change, validate measurement tools for preventive practices, and evaluate intervention effectiveness.
4. Local production of protective equipment: Explore partnerships with local manufacturers to produce affordable, culturally acceptable protective gear, reducing dependency on imported supplies and improving sustained access.

Conclusion

In conclusion, this study confirms a solid foundational awareness of avian influenza in the Nsawam-Adoagyiri Municipality. However, the stark disparity between high knowledge/attitude scores and low preventive practice prevalence reveals a critical barrier to community protection. To mitigate zoonotic risk, public health action must evolve from raising awareness to actively enabling behavioural change. This necessitates targeted, practical interventions for high-risk groups, the removal of structural barriers to safe practice, and the institutionalization of a functional, locally-adapted One Health framework.

Abbreviations

AI	Avian Influenza
EAs	Enumeration Areas
FAO	Food and Agriculture Organization
KAP	Knowledge, Attitudes, and Practices
KR-20	Kuder–Richardson Formula 20
PPS	Probability Proportional to Size
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Authors' contributions

CYD Conceived and designed the study; MK, and DEA participated in the field Investigations and data collection; SQS and CYD analyzed, interpreted/visualized the data; CYD, SQS, DN JANB, DAT, GSA, GAA, drafted the manuscript; CYD, IEE, JPK, SKA, AS, JOA, NKTDD, PBT-Q, GBK, IA and PF-A helped to revise the manuscript. All authors read and approved the final manuscript.

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Data availability

The dataset, survey instrument, and analysis code supporting this study have been deposited in the Zenodo repository and are publicly available. The persistent digital identifier (DOI) is:

Declarations

Ethics approval and consent to participate

Ethics approval was obtained from the Institutional Review Board of Central University, Accra (Protocol No. CUIRB/39/05/25), and the study was conducted in accordance with the principles of the Helsinki Declaration. Verbal informed consent was obtained from all participants prior to data collection. The consent script was read aloud in the participant's preferred language. For literate participants, verbal consent was documented by the interviewer. For non-literate participants, verbal consent was witnessed and documented with a thumbprint. This procedure was approved by the IRB (Protocol No. CUIRB/39/05/25). Confidentiality was ensured through anonymized data collection and secure storage using unique identification numbers and password-protected files.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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