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Knowledge and perception of small-scale farmers on highly pathogenic avian influenza prevention

Nguyen Hoang Qui*, Nguyen Thi Anh Thu

Department of Animal Science and Veterinary Medicine, School of Agriculture and Aquaculture, Tra Vinh University, Tra Vinh city, Vietnam

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***Correspondence:**

Corresponding author: Nguyen Hoang Qui
E-mail address: nhqui@tvu.edu.vn,

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ABSTRACT

Knowledge and perception of poultry farmers is one of key factors to improve disease prevention practice. By collecting data from small-scale poultry farmers, this study aimed to determine the knowledge and perception of farmers towards highly pathogenic avian influenza (HPAI) prevention practice and analyse the effect of social profiles, farmer's raising behaviours on knowledge and perception of farmers. The study applied purposive sampling method to select 159 respondents in Tra Vinh Province and use multiple regression analysis to analyze data. The results showed that farmers were mostly more than 40 years old and not completed high school yet. Farmers have raised poultry under traditional methods with some feed and water from natural sources. Farmers keep cleaning and disinfect their farm frequently. The study recorded that farmer had a good knowledge and perception towards HPAI. There were some factors significantly affect the knowledge and perception of farmers including gender, training, income, poultry species, water source. Particularly, when farmers were male, joined in HPAI prevention training activities and not use water from natural source, their knowledge significantly increased. Besides, the increase in one unit of gender, income, poultry species, water source significantly increased the perception of poultry farmers. Other variables had no significant effect. It can be concluded that gender, training, income, poultry species, water source could be used to improve farmer's knowledge and perception towards HPAI prevention practice.

Introduction

Currently, there is a global challenge posed by the creation and dissemination of numerous perilous infectious diseases, with zoonotic diseases accounting for around 70% of infections acquired by the community (Özlü *et al*., 2021). Besides, the current status of the pandemic in chicken industry remains intricate, with diseases not yet fully under control (Hafez and Attia, 2020). Consequently, the elevated cost of veterinary pharmaceuticals persists, leading to diminished efficiency in animal production.

According to a study conducted by Delabouglise *et al*. (2019), birds infected with avian flu may display various clinical symptoms such as lethargy, fatigue, digestive issues (including diarrhoea, flatulence, and abnormal faecal colour), respiratory problems (such as difficulty breathing and increased respiratory sounds), sudden death, swollen crop, wing paralysis, loss of appetite, cyanosis, and upper-respiratory tract symptoms (such as a runny nose). On the other hand, Whelan *et al*. (2021) found that highly pathogenic avian influenza (HPAI) in birds can manifest as coughing, decreased appetite, nonspecific neurological signs, and/or sudden mortality. The avian species that are the most susceptible, including chicken, turkey, and quail, exhibit pronounced clinical manifestations as a result of HPAI. Over the past few decades, the prevalence of HPAI viruses in domesticated poultry has escalated, leading to elevated mortality rates and the occurrence of outbreaks that have been associated with substantial economic repercussions (Kim *et al*., 2023). Vietnam is among the developing countries that have been affected by HPAI, as stated by Özlü *et al*. (2021). According to a study conducted by Delabouglise *et al*. (2019), it was observed that an average of 2.5% of chicken in small-scale flocks in the Mekong delta region experienced mortality on a weekly basis. The prevalence of disease burdens in small-scale poultry farms in the region can be attributed to the low hygiene and biosecurity standards that are commonly observed in these establishments (Van *et al*., 2020). Moreover, in regions where there is a prominent practice of domestic chicken production, the highly pathogenic avian influenza (HPAI) virus is consistently present, as noted by Khaw *et al*. (2021). The presence of a diverse range of poultry species, including ducks, in live bird markets, coupled with inadequate sanitary conditions, the practice of storing poultry in floor pens rather than cages, and the presence of at least one wholesaler engaged in trading within these markets, significantly heightens the likelihood of the presence of avian influenza virus-infected poultry and/or environments contaminated with avian influenza virus (Sealy *et al*., 2019; Wang *et al*., 2018).

Zoonotic diseases are the primary form of infection transmission occurring within the population. The broadcast of information and the implementation of behavioural training are essential components in the efforts to prevent and control zoonotic diseases. These measures are designed to reduce the occurrence and transmission of such diseases (Çakmur *et al*., 2015). The impact of an outbreak on farmers' behaviours is still not well understood (Delabouglise *et al*., 2020). Therefore, the attitude and behaviour of farmers towards HPAI may play a significant role in forecasting their perceived importance. According to a study conducted by Whelan *et al*. (2021), the biosecurity guidelines implemented may not align with the management strategies employed by small-scale farms in Vietnam. Additionally, the perceived threat of zoonotic diseases and the adoption of preventive measures are influenced by factors such as gender and the accessibility of information, as highlighted by Win *et al*. (2021). Whelan *et al*. (2021) have identified certain deficiencies in the implementation of water management strategies as a means of biosecurity against HPAI, which may be exacerbated by the influence of peers and media. Like their counterparts in other developing countries, smallholder farmers in Vietnam utilize several strategies to avoid and manage illnesses. The effective management and mitigation of prevalent and re-

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curring diseases in the smallholder poultry value chain necessitates the consideration of both biological and environmental factors, as well as the enhancement of the socioeconomic practices exhibited by producers, merchants, and consumers (Sealy *et al*., 2019). According to the research conducted by Delabouglise *et al*. (2020), there exists a positive correlation between the educational attainment, enterprise size, and monthly income of cattle producers, and their level of knowledge, attitude, and practices pertaining to zoonotic diseases. According to Guntoro *et al*. (2023), social profiles play a significant role in influencing farmers' practices related to zoonotic diseases. In the study conducted by Qui *et al*. (2021); Qui *et al*. (2024a) and Qui *et al*. (2024b), the focus was on examining the profiles of farmers and their sources of knowledge pertaining to the practice of disease prevention among farmers.

However, most of the published studies on poultry pathogens in the Mekong Delta region have cantered on the detection and characterization of HPAI virus. Most of the research to date focuses on a singular etiological agent, and a broader panel of pathogens must be investigated to prioritize disease control strategies. Besides, the public may have a low level of knowledge about breeding and husbandry practices. The knowledge and perception of local farmers on the risk of zoonotic diseases has not been widely observed (Win *et al*., 2021). The study's objectives were to determine farmers' knowledge and perceptions about HPAI, thus, analyse the effect of social economic status and raising characteristics on knowledge and perception of farmers.

Materials and methods

Location

The research was carried out in Tra Vinh province, located in the Mekong Delta region of Vietnam. The province was chosen due to its status as the most vibrant region for chicken production operations among small-scale farmers. Furthermore, it has been noted that these places exhibit an augmented susceptibility to HPAI as a result of inadequate knowledge and preventive measures pertaining to the disease.

Data collection

The data was obtained through the administration of a questionnaire to a sample of 159 farmers throughout the period spanning from February to April 2023. The researchers employed the purposive sampling method for the selection of participants. The compilation of participants was gathered by government officials specializing in veterinary matters. The respondents were selected basing on two criteria (1) engaging in poultry farming at the time of the survey, and (2) having a minimum of 20 poultry heads (3) possessing a minimum of three years of experience in poultry farming and have been involved in trading or producing chickens throughout the HPAI pandemic were chosen. These individuals were picked as they possess valuable insights into accessing information regarding prevention techniques and addressing challenges on their farms. The survey instrument was initially developed in Vietnamese, the native language, and subsequently translated into English (Qui *et al*., 2021). Prior to commencing the response, participants were provided with a comprehensive overview of the questionnaire's contents. It was explicitly communicated that respondents possessed the agency to decline providing any information that they deemed sensitive or personally identifying in nature. The study encompassed four distinct sections that focused on the following aspects: social profiles, rising behaviours, knowledge, and perception of farmers on the prevention practices of HPAI. In the initial phase, pertinent demographic information pertaining to farmers' social profiles was documented, encompassing variables such as age, gender, educational background, occupation, familial composition, labour involvement, training, and income levels. The subsequent segment encompasses the chicken species, the quantity of poultry, sources of feed and water, methods of disposal, and the frequency of disinfection application. The next step was an examination of farmers' knowledge, when participants were presented with a series of eight questions aimed at assessing their understanding of HPAI prevention practices. The fourth segment was a series of nine questions aimed at assessing farmers' perceptions of the practice of preventing HPAI. The recorded variable definitions can be seen in Table 1.

All responses to inquiries regarding consciousness and cognition were documented without any interference. The Likert scale was employed to gather data on the extent to which farmers responded to the questions (Sullivan and Artino, 2013). The Likert scale was utilized in this research, employing five levels of magnitude: strongly agree (SA), agree (A), undecided (UD), disagree (D), and strongly disagree (SD), which were assigned point values ranging from 1 to 5, respectively. As previously stated, the selection of research locations was determined by considering the poultry population and the level of agricultural engagement among

Table 1. Operational definitions.

	Operational definitions	Variable type
	Categories	
Sex	1 if male; 0 if female	Dummy
Age	1 if < 40 years old; 2 if ≥ 40 years old	Categorical
Occupation	1 if horticulture; 2 if livestock husbandry; 3 if small business; 4 if officer	Categorical
Education	1 if not completed high school yet; 2 if completed high school; 3 if bachelor	Categorical
Labour	1 if ≤ 3 people working at farm; 2 if > 3 people working at farm	Categorical
Family member	1 if < 4 members; 2 if ≥ 4 members	Categorical
Income	The amount of income	Continuous variable
Training	1 if yes; 0 if no	Dummy
Poultry species	1 if chicken; 2 if duck	
Poultry number	1 if < 30 heads; 2 if 30-100 heads; 3 if more than 100 heads	Categorical
Water sources	1 if natural water; 2 if tap water; 3 if others	
Feed sources	1 if commercial feed; 2 if agriculture by-products; 3 if wasted food from meals; 4 if mixed	Categorical
Disposal method	1 if no disposal method; 2 if used as fertilizer	Categorical
Disinfectant frequency	1 if once a week; 2 if once a month; 3 if more than a month	Categorical
Knowledge	Likert scale	Continuous variable
Perception	Likert scale	Continuous variable

farmers. This approach was adopted to ensure that the collected data accurately reflects the overall position of the province. The study was assessed the reliability and validity of the data to ascertain the accuracy and consistency of the number of responses. Based on the results of Cronbach's alpha statistical analysis, the obtained reliability coefficient was 0.930, indicating a high level of reliability for all items pertaining to farmers' knowledge and perception. Additionally, the validity assessment revealed significant and strong correlations (ranging from 0.344 to 0.825) for all items. The presence of multicollinearity among the independent variables was assessed using correlation analysis, with particular emphasis on the variables related to knowledge and perception. The findings indicated that there was no evidence of multicollinearity among the variables.

Data analysis

The data were analysed using descriptive analysis and multiple regression analysis with the Statistical Package for the Social Sciences (IBM SPSS) 26.0 (IBM Corp, Armonk, NY, USA).

The Likert scale was constructed using five scales and the maximum score attained by farmers in terms of their understanding on HPAI was 40, while the minimum score recorded was 8. The largest and lowest scores for the perception towards HPAI were identical.

Logistic regression can be employed to analyse a singular dependent variable alongside multiple independent variables. Logistic regression is a statistical method that seeks to predict the value of a singular dependent variable by utilizing independent variables with known values. According to Moore *et al*. (2006), the influence of each predictor value is determined by assigning weights to them, which reflect their overall significance. This study employed multiple logistic regression analysis to examine the relationship (Lind *et al*., 2018) between social profiles and various raising characteristics, such as age, gender, occupation, education, family size, labour, training, income, farm cleaning routine, and faces disposal. The dependent variables of this study were the knowledge of farmers towards HPAI prevention practices (Y1) and the perception of farmers towards HPAI prevention practices (Y2). A statistic is deemed significant when its corresponding $p < 0.05$ or $p < 0.01$. The formulation is in Equation (1):

$$Y(Y_1/Y_2)=\log(p/(1-p))=a+b_1 X_1+b_2 X_2+...+ b_n X_n \quad (1)$$

where Y is the dependent variable, Y_1 is the knowledge score of farmers towards HPAI prevention practice, Y_2 is the perception score of farmers towards HPAI prevention practice. The independent variables are X_1 (age), X_2 (gender), X_3 (occupation), X_4 (education), X_5 (family member), X_6 (labour), X_7 (training), X_8 (income), X_9 (faces disposal), X_{10} (the number of poultry at farm), X_{11} (disinfectant frequency), X12 (poultry species), X_{13} (feed source), X_{14} (water source). Regression analysis is used to optimize the prediction of the dependent variable Y_1/Y_2 by utilizing a set of independent variables and determining the appropriate weights for each variable ($a, b_1,...,b_n$).

Results

Social profiles of poultry farmers in survey area

Table 2 shows that farmers mostly were more than 40 years old who were working at farm or joining farming activities as their main job. Male farmers were predominant than female farmers with 67% in total. Farmers did not complete their high school accounted for high proportion with almost 80% of farmers. Besides, farmer's family in the survey was less than 3 people made up approximately 50%. Besides, labours from family members were less than 3 people accounted for 84.3% while their average income was approximately 55$ per month only. The study recorded that more than a half of farmers in the study did not join in training activities, accounting for 53.5%.

Table 2. Social profiles of poultry farmers.

No	Variables	Categories	Results	
			Frequency	%
1	Age	< 40 years old	38	23.9
		≥ 40 years old	121	76.1
2	Gender	Female	52	32.7
		Male	107	67.3
3	Occupation	Horticulture	57	35.8
		Livestock husbandry	84	52.8
		Small business	13	8.2
		Officer	5	3.1
4	Education	Unfinished high school	127	79.9
		high school	24	15.1
		Bachelor	8	5
5	Income	USD	55.31 USD	
6	Family	< 4 members	72	45.3
		≥ 4 members	87	54.7
7	Labour	≤ 3 labours	134	84.3
		> 3 labours	25	15.7
8	Training	No	85	53.5
		Yes	74	46.5

Poultry raising characteristics in survey area

At poultry farms, farmers mostly raised chickens with 76.1% of total poultry (Table 3). Ducks were recorded of 23.9% while no other poultry was confirmed. The study also recorded that the number of chickens was less than 100 heads accounting for almost 90% of surveyed farms in which 30-100 heads per farm was 73.6%. As traditional farming practice, poultry farmers giving agricultural by-products for their bids with 30.8%. The combination of commercial feed with other kinds of feed such as wasted food after meal, by-products were dominant, confirming by more than 50% of farmers. Additionally, farmers raised their birds with tap water accounting for 65%. The study also recorded that there are some farmers had used natural water for their birds. Cleaning and disinfectant routine were done once a week with 66% of farmers. Moreover, farmers used faeces as fertilizer accounting for 57.9% total of respondents.

Table 3. Poultry raising behaviour of farmers.

No	Variables	Categories	Results	
			Frequency	%
1	Poultry species	Chickens	121	76.1
		Ducks	38	23.9
2	The number of poultry	30-Jan	24	15.1
		31-100	117	73.6
		> 100	18	11.3
3	Feed sources	Commercial feed	11	6.9
		Agricultural by-products	49	30.8
		Wasted meals	11	6.9
		Mixed feed	88	55.3
4	Water sources	Natural water	30	18.9
		Tap water	104	65.4
		Others	25	15.7
5	Disinfectant	Once a week	105	66
		Once a month	12	7.5
		> One month	42	26.4
6	Disposal	No disposal method	67	42.1
		Used as fertilizer	92	57.9

Knowledge of farmers towards HPAI prevention practice

Figure 1 shows that the farmers mostly provided correct answers to eight questions (strongly agree and agree were determined as correct answers). Almost 99% of the respondents understood HPAI and the danger it poses to the poultry industry and human health. The term zoonosis was incomprehensible for approximately 8% of respondents, and only 2.5% of the farmers were unaware that HPAI can cause death in poultry and humans. Farmers knew well about the source of virus and disease symptoms (1.9% misunderstood the symptoms of the disease). Besides, farmers can also recognize some common symptom of HPAI disease, only 5% farmers did a wrong answer. As a normal method to prevent diseases, farmers seek the help of a veterinarian in cases of diseases. Cleaning and disinfecting equipment in the farms were used to prevent poultry diseases. Notably, the farmers were confused regarding the treatment for HPAI, with more than 34% of respondents wrongly confirming that antibiotics can be used to treat HPAI.

Perception of farmers towards HPAI prevention practice

The high perception of farmers toward HPAI prevention practice was confirmed (Figure 2). The key method to controlling the disease (all-in, all-out) was misconducted by some respondents (3.8%). However, farmers possess good perception on how to control people's access to their farms. The birds can still come into contact with wild animals, which may introduce diseases to the farms. As small-farm owners, some farmers did not focus on securing an animal health checking certificate when selling their animals (around 5%). HPAI can transmit from animals to human via the atmosphere but 4.4% of respondents confirmed not using masks in their farms, and 4.4% were undecided about their answer. In addition, the farmers confirmed that they did not sell animals to the market and declare when their birds manifest disease symptoms, approximately 99%.

Effect of social profiles and raising characteristics on knowledge and perception of farmers

Table 4 recorded that there were several factors affecting the knowledge of farmers towards HPAI prevention practice. Particularly, the knowledge was significantly affected by gender, training, water source. These variables statistically significantly predicted knowledge of farmers towards HPAI prevention practice, $F(12, 146) = 6.218$, $p < 0.000$, $R^2 = 0.338$. For farmer's knowledge, one unit increase in gender, changing from female to male (0 to 1) is expected an increase of 0.171 in log odds of being higher in the score of farmer knowledge, all other variables kept constant. As similar trend, one unit increase in training from not join in training to join in training (0 to 1) and one unit change in water source

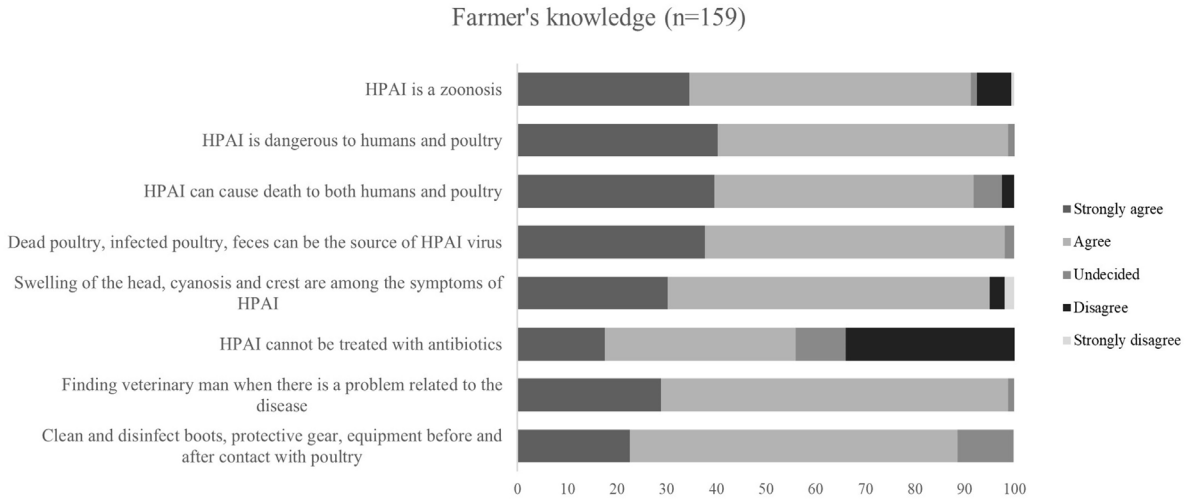

Figure 1. The knowledge of farmers towards HPAI prevention practices.

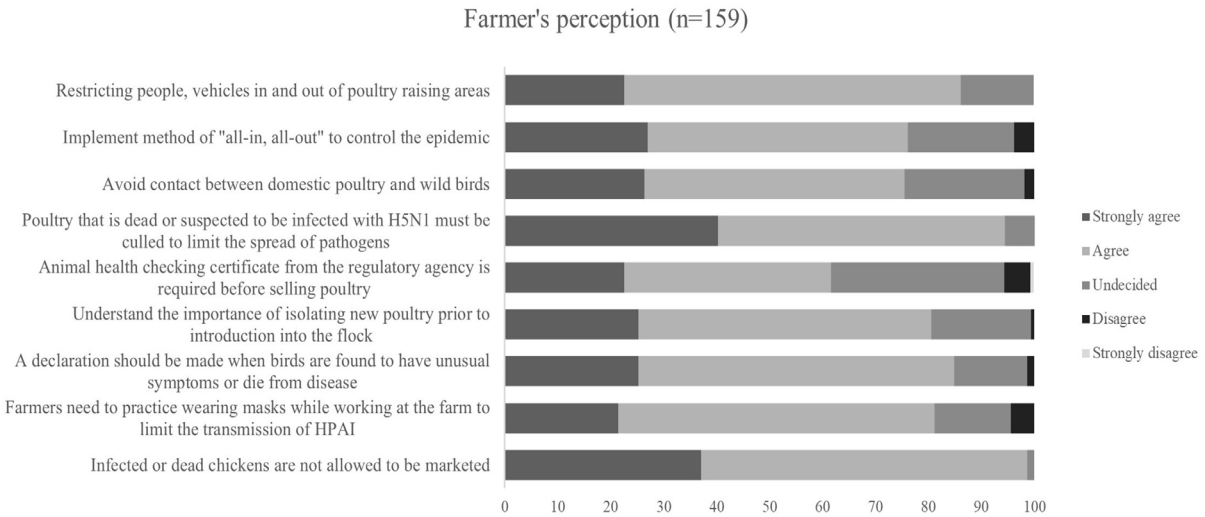

Figure 2. The perception of farmers towards HPAI prevention practice.

from natural water to other sources (from 1 to 3) is expected an increase of 0.161 and 0.352 respectively in log odds of being higher in score of farmer knowledge, all other variables kept constant. Basing on the results of regression analysis, the equation of regression could be seen as below:
Y_1= "2.861 + (0.171 x gender) + (0.161 x training) + (0.352 x water source"

Table 4. Factors affecting the knowledge of farmers.

Criteria	Multiple regression analysis results			
	B	Std. Error	t	Sig.
Age	-0.02	0.09	-0.18	0.86
Gender	0.171*	0.08	2.21	0.03
Occupation	0.00	0.06	0.04	0.97
Education	0.07	0.08	0.92	0.36
Family	-0.02	0.08	-0.25	0.80
Labour	-0.10	0.10	-0.93	0.36
Training	0.161*	0.08	2.09	0.04
Income (USD)	0.00	0.00	1.11	0.27
Poultry species	0.08	0.09	0.95	0.34
Poultry number	0.07	0.09	0.79	0.43
Feed source	0.07	0.04	1.96	0.05
Water source	0.352**	0.07	5.23	0
Constant	2.86	0.34	8.50	0

Table 5 shows that there were several factors affecting the perception of farmers towards HPAI prevention practice. Particularly, gender, poultry species, income, water source significantly affected perception of farmers. These variables statistically significantly predicted perception of farmers towards HPAI prevention practice, $F(12, 146) = 9.923$, $p < 0.000$, $R^2 = 0.449$. Particularly, one unit increase in gender (from 0 to 1 or from female to male) is expected a 0.163 increase in log odds of being higher perception of farmers towards HPAI prevention practice. One unit increase in water source from 1 to 3 resulted in a 0.261-unit change in log odds of higher farmer's perception. Similarly, one unit increase in income is expected a 0.001 unit increase in farmer's perception, all other variables kept constant. In contrast, a decrease in one unit of poultry species from ducks to chickens (2 to 1) increased in log odds of being higher perception of farmers. "The equation of regression analysis could be seen as below:
Y_2= 3.562 + (0.163 x gender) + (0.001 x income) – (0.233 x poultry species) + (0.261 x water source)".

Table 5. Factors affecting the perception of farmers.

Criteria	Multiple regression analysis results			
	B	Std. Error	t	Sig.
Age	-0.08	0.09	-0.89	0.37
Gender	0.163*	0.07	2.19	0.03
Occupation	-0.03	0.05	-0.58	0.57
Education	0.09	0.08	1.22	0.22
Family	0.09	0.07	1.19	0.24
Labour	-0.03	0.1	-0.30	0.77
Training	0.14	0.07	1.86	0.06
Income (USD)	0.001*	0.00	2.02	0.05
Poultry species	-0.233**	0.08	-2.87	0.01
Poultry number	0.10	0.08	1.25	0.21
Feed source	-0.06	0.03	-1.66	0.10
Water source	0.261**	0.07	4.05	0
Constant	3.56	0.32	11.02	0

Discussion

The prevalence and challenges associated with the management of significant animal diseases have prompted a shift in attention towards animal health and its interconnectedness with prevention practice (Alarcón *et al*., 2021). Knowledge and perception of farmers are influenced by various factors, such as their socioeconomic backgrounds and management strategies, which might potentially impact the spread of HPAI. Furthermore, a comprehension of production processes plays a pivotal role in influencing farmers' use of disease prevention measures. According to Guntoro *et al*. (2023), a thorough analysis of social characteristics is necessary to ascertain suitable agricultural techniques. In order to effectively implement this method, it is important to possess a thorough comprehension of veterinary epidemiology, encompassing an knowledge of disease transmission mechanisms, the factors contributing to individuals' susceptibility to diseases, and the preventive measures that can be employed (Robertson, 2020).

To control disease outbreak, farmers should have high knowledge and high perception of the targeted disease and to mitigate the spread of HPAI, it is imperative for poultry farmers, merchants to exhibit a comprehensive understanding, appropriate attitudes, and adherence to optimal procedures (Hinjoy *et al*., 2023). According to Espinosa *et al*. (2020), enhancing the control over meat production and decreasing self-consumption can serve as a supplementary risk management strategy, effectively reducing the likelihood of contracting infections from animals. The favorable outcomes were attributed to the farmers' level of knowledge on HPAI and their view of effective preventive measures against HPAI. The concept of prevention entails the implementation of measures aimed at interrupting the transmission pathways through which the virus can propagate (Wang and Hu, 2023). Access to the animal farm is strictly prohibited for individuals not affiliated with the facility, while personnel are required to undergo disinfection and protective measures upon entry and exit. In order to enhance the biosecurity measures, it is imperative to implement disinfection protocols for both materials and vehicles entering the farm (Wang and Hu, 2023). Additionally, farmers tended to overlook certain indicators, such as the practice of all-in all-out in trading poultry. It was also mentioned previously, when introducing new breeding from external sources, it is essential to establish a designated isolation and observation period prior to their integration into the existing population. This practice aims to facilitate the adoption of a population management strategy known as "all-in and all-out" which further strengthens the biosecurity barrier (Wang and Hu, 2023).. The finding was consistent with previous research of Hinjoy *et al*. (2023) which showed that the transmission of HPAI in people and poultry flocks is significantly influenced by the sale of unwell or deceased birds with unexplained causes. This risk factor is particularly relevant in live poultry marketplaces. While the poultry farmers examined in this study demonstrated a commendable level of knowledge and perception regarding the prevention and management of HPAI, it was observed that certain farmers exhibited confusion regarding antibiotic treatment. This confusion could potentially be attributed to their limited educational background, as they had only completed primary and secondary schooling without pursuing further education in animal science or veterinary fields. Furthermore, the omission of a technical examination pertaining to HPAI resulted in a limited comprehension of the associated circumstances and therapeutic approaches. According to the research conducted by Guntoro *et al*. (2023), individuals with a lower level of education in the agricultural sector exhibit a decreased likelihood of possessing knowledge regarding animal disease control methods. Hence, it is imperative to enhance risk communication pertaining to HPAI among relevant stakeholders, including authorities, the poultry industry, and the general public. This approach should be complemented by reinforcing HPAI surveillance, prevention, and control measures.

In order to effectively address the requirements associated with the implementation of biosecurity measures, it is imperative for farmers to

possess a comprehensive understanding of diverse infectious diseases and possess the capability to effectively apply biosecurity protocols. Consequently, the measures are readily implementable as required (Dione *et al*., 2020). This study observed that gender had an impact on both the knowledge and perception of farmers, which aligns with the findings of previous studies conducted by Guntoro *et al*. (2023) and Qui *et al*. (2021). While it has been shown that males tend to have stronger control over larger animals, and women have more control over smaller animals like chickens and small ruminants (Ransom *et al*., 2017), the findings of this study indicate that men possessed a higher level of knowledge in the context of HPAI prevention compared to women. According to Qui and Linh (2023) and Qui *et al*. (2024b), male farmers tend to have more leisure time compared to their female counterparts due to their limited involvement in family chores. This surplus of free time enables male farmers to engage in interactions with extension officers, facilitating the exchange of information pertaining to disease prevention in the agricultural context. According to Alqahtani *et al*. (2021), males engage in various occupational activities, such as livestock breeding, which increases their likelihood of interacting with animals or associating with those who possess some level of knowledge in this domain. Moreover, it is worth noting that within the familial context, men have primary business-related obligations. Consequently, they are compelled to undertake proactive measures in epidemic prevention to mitigate any financial effects (Wang and Hu, 2023).

Training is an effective approach for enhancing farmers' knowledge. The acquisition of knowledge pertaining to risk factors plays a crucial role in formulating recommendations aimed at managing disease outbreaks (Robertson, 2020). Subsequently, this knowledge is integrated into disease prevention practice programs specifically designed for the livestock species. Li *et al*. (2020) assert that extension agencies facilitate the organization of training programs aimed at instructing farmers on the effective utilization of approaches to mitigate performance uncertainty. There was a greater emphasis on injury prevention training (with animals) compared to disease prevention training. The study conducted by Palomares Velosa *et al*. (2021) revealed that the workers' attitudes towards zoonotic disease risks were evident in their views. Specifically, the respondents were more inclined to report injuries compared to infectious diseases. In addition, the acquisition of knowledge and skills by farmers through experiential learning within their own community or through observation and training provided by various organizations is crucial. This is because it enhances the effectiveness and efficiency of farmers by fostering a deeper comprehension of prevention practices (Aderemi *et al*., 2023).

The decision-making process is conventionally assumed to be primarily influenced by factors pertaining to financial costs. This study examines the potential influence of income on farmers' perceptions towards the prevention of HPAI. In another study, Zhang *et al*. (2017) demonstrated that implementing biosecurity measures or disease preventive practices, such as refraining from selling sick or culled animals, can mitigate the financial income. Their perceived income may affect the prevention methods. Moreover, increased income provides individuals with greater opportunities to engage in preventive measures, such as accessing information on disease prevention or investing in infrastructure to safeguard their farm operations against diseases. The presence of poverty, lack of cost for fencing stuff and renting staff for controlling disease were identified as a significant obstacle in the enhancement of prevention practice measures (Wolff *et al*., 2019).

Prevention practice was not a priority in backyard poultry farming for poultry species. The differential levels of knowledge and perception between chicken farmers and duck farmers may be attributed to the significant effect of this matter. Qui & Tho (2023) and Qui *et al*. (2024b) contend that the poultry industry is primarily acknowledged for its production of chicken. The chicken farming community in Vietnam exhibit a higher degree of knowledge-sharing compared to other poultry farming communities. The utilization of this method for dissemination has the potential to enhance public relations pertaining to the prevention of avian influenza, so facilitating a comprehension of the disease among poultry farmers and fostering a heightened perception of danger (Hinjoy *et al*., 2023). In case of water, the utilization of water in agricultural practices has had an impact on the perception and understanding of farmers towards the prevention of HPAI. As previously stated, the excretion of viruses primarily takes place through the oropharyngeal and cloacal pathways, leading to transmission not only through direct contact with infected hosts but also indirectly through the contamination of surface waters (Rohani *et al*., 2009). Additionally, farmers face limitations in their ability to recognize diseases that might be transmitted through water sources. This behaviour may heighten the potential for disease transmission due to the potential survival of viruses or virus spores in these water sources. Moreover, a significant segment of the global populace resides in rural areas, whereby certain resources are commonly shared. For instance, the mitigation strategy of minimizing direct contact among distinct herds at watering stations necessitates the willingness and modification of behaviour by many individuals (Wolff *et al*., 2019). The practice of duck farming, which often entails the rearing and containment of ducks in unconfined aquatic environments. This method of farming poses a potential hazard as it allows for the potential intermingling of wild waterfowl with domesticated ducks, hence facilitating the transmission of influenza viruses (Sealy *et al*., 2019). Therefore, it is possible for feed and water supplies to serve as vectors for disease transmission. Upon perceiving this knowledge, farmers may be inclined to abstain from utilizing tap water.

No significant correlations were found between age, occupation, education, labour, family members, feeding practices, and farmers' knowledge of and perception towards HPAI prevention practices. In contrast to the research conducted by Ngoshe *et al*. (2022), which demonstrated that older farmers, despite their lower educational attainment, exhibited greater knowledge regarding animal diseases and implemented more effective practices in relation to the prevention and management of zoonotic diseases compared to younger farmers, our study findings suggest that age did not significantly influence farmers' knowledge and perception of HPAI prevention practices. Elderly farmers may underestimate the impact of diseases and place a higher degree of trust in their prior experiences. Besides, this study did not record any effects of neither education nor family member on knowledge and perception of farmers. The observed findings could potentially be linked to a deficiency in educational attainment within agricultural communities. Furthermore, the observed feeding behaviour aligns with the findings of Linh *et al*. (2022), indicating that farmers employ local feed sources or agricultural by-products from their nearby surroundings in their farming practices. According to Linh *et al*. (2022), the availability of natural feed throughout the year significantly influences both the quantity and quality of feed. Nevertheless, the feeding behaviour did not have an impact on the knowledge and perception of farmers. The findings of this study were in opposition to the research conducted by Rohani *et al*. (2009). There are no effects of these factors on the knowledge and perception of disease prevention practice because beside these factors, various factors including individuals' personal backgrounds, past experiences, availability of information sources, social surroundings, and individual interpretations (Hinjoy *et al*., 2023), farmers' emotional states, and normative views (Doidge *et al*., 2021), can significantly influence farmer's knowledge and perception and should be examined in the same model.

Conclusion

The study reveals that most farmers, mostly male and over 40 years old and earn less income from poultry farming activities who raise chickens without proper training for HPAI prevention. Farmers still use agricultural by-products, tap water for their poultry. Besides, cleaning and disinfectant routines was also applied in farms with faeces as fertilizer. A total of 99% of farmers understand HPAI's dangers, but only 2.5% are aware of its potential. Factors affecting farmers' knowledge and perception include

gender, training, income, poultry species and water source. Increases in gender, training, and water source significantly increase farmers' knowledge, while a decrease in poultry species also increases their perception of HPAI prevention.

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Conflict of interest

The authors declare that they have no conflict of interest.

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