An epidemiological survey of avian influenza knowledge and practices among poultry farm workers in Indonesia

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Abstract

Background.

Avian influenza (AI), especially the highly pathogenic form, poses a serious threat to global public health. Awareness and protective behaviours among the ~~general public~~public, ~~as well as~~particularly the high-risk populations, are essential for prevention and control. The purpose of this study is to determine the AI knowledge and practices of poultry farm workers in Indonesia.

Methods.

This online cross-sectional study included 200 men and women, aged from 18 to 50 years ~~, aged <20–50 years~~, who work~~ing~~ on poultry farms in Indonesia. ~~It used a~~A pre-designed standardised questionnaire containing six demographic questions, 14 questions on knowledge, and seven questions for practices, was used. The questionnaire was distributed via the WhatsApp and email platforms. Data were analysed using the~~The~~ Chi-square and Fisher Exact tests ~~were used to analyse the data~~.

Results.

The findings depicted that more than two-thirds ~~half~~ (67%) of the respondents ~~had~~ have heard of AI. Their primary sources of information were health workers (36%) and TV (34%). A majority of

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the participants (91.33%) ~~had~~ have good knowledge regarding AI as a contagious infection, ~~that is~~ transmitt~~ed~~able from birds to other birds, animals, or humans. ~~transmits between animals to animals and birds to birds~~. A total of 76.8% of the respondents believe that poultry workers and veterinarians were at high risk of contracting AI infection. On average (74.2%), the participants believe that using ~~face masks~~facemasks and washing hands with soap and water is a good practice to prevent AI infections. Moreover, 78.5% of the respondents believe that properly disposing of the dead birds can also prevent these infections from occurring or spreading. The study participants had a substantial relationship between their level of knowledge and their practices (p = 0.009).

Conclusions.

The study ~~revealed~~ concluded that the poultry workers ~~had~~ have ~~a~~ good knowledge regarding AI infection, transmission, and risk variables, which was reflected in their practices during the survey. ~~how they dealt with AI infection.~~ Health workers and television were the main sources of information on AI. ~~Primary sources of information regarding AI were health workers and TV~~. The level of knowledge and practices had a significant relationship among respondents.

Keywords: avian influenza, farmworkers, knowledge, practices, public health, Indonesia.

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Introduction

Avian influenza (AI), commonly known as '~~bird~~ Bird Flu' is a highly contagious viral infection belonging to the family 'Orthomyxoviridae'. It has the potential to ~~harm~~ infect both birds and humans. The strains of this virus can present themselves in a variety of ways, depending on their virulence (OIE, 2020). The first case of the ~~AI~~ highly pathogenic avian influenza H5N1 strain~~virus~~ (HPAI H5N1) in a human was recorded in Hong Kong in 1997 (Yuen et al., 1998), and it was thought that the live bird markets contributed to this outbreak (WHO 2007). ~~-~~Individuals who engage in the poultry industry or who interact directly with poultry may be more susceptible to AI than the general public, and thus may function as a route for the transmission of AI into the general population (Huang et al., 2015). According to a report published by the World Health Organization on March 16, 2017, a total of 858 documented cases have resulted in 453 deaths in 16 countries since 2003 (WHO, 2017). Human deaths ~~cases~~ in developing countries such as China were at 100% in 2003, but have since dropped to 50% in 2010. In Egypt, the rate of human deaths peaked at 56% in 2003 and then dipped to 45% ~~in~~by 2010. Since 2005, HPAI H5N1 has been found in a number of other Asian countries, including Afghanistan, Bangladesh, India, Myanmar, Pakistan, and most recently Bhutan and Nepal (Timilsina & Mahat, 2018). ~~The WHO recorded 430 highly pathogenic AI (HPAI) H5N1 related deaths in 16 countries as of March 20, 2015, with a 55% case fatality rate (WHO, 2015). Even human around the globe have been infected by type A viruses of the same in recent years (WHO, 2011).~~ Highly pathogenic avian influenza subtype H5N1 has been endemic to poultry in Indonesia since 2003 and continues to cause ~~substantial~~ significant social and economic losses for both the poultry industry and backyard farms (Sumiarto & Arifin, 2008, WHO, 2011).

Poultry producers and the industry are suffering significant social and economic consequences (Basuno, Yusdja, & Ilham, 2010; Rushton, Viscarra, Bleich, & McLeod, 2005. As a result, Indonesia has the highest human death rate for HPAI H5N1 in the world~~.). Due to this, Indonesia has the world's highest human fatality rate for HPAI H5N1~~. From the first outbreak in August 2003 to May 2015, 199 (human) AI cases were confirmed in Indonesia ~~by~~using laboratory testing. ~~In fact, 199 (human) AI cases were confirmed in Indonesia through laboratory testing from the first outbreak in 2003 to May 2015.~~ Of these, 165 were fatal. These cases have been documented in Bali, Sulawesi, Sumatra, Lombok and Java Island, with a majority of these being recorded in the latter (WHO, 2015, Kurscheid et al., 2015). The Indonesian government has taken several measures to avoid HPAIV, which has resulted in a decrease in disease outbreaks in poultry since 2012 (FAO, 2012) and a significant decline in human H5N1 infections since 2013 (WHO, 2017). ~~In this regard~~Morris ~~and Jackson~~ et al., (2005) identified a number of factors that either directly or indirectly help in the spread of highly pathogenic avian influenza virus , ~~Morris and Jackson discovered a number of factors that contribute to the direct and indirect propagation of the HPAI virus~~ throughout Asia. ~~.(Morris et al., 2005).~~ These ~~risk~~ factors were: risky handling and farming activities ~~like~~including the~~,~~ rearing of mixed-species poultry or in a free-range environment in rural or urban locations, using of ~~infec~~contaminated vehicles and bird cages to transport live birds, and insufficient/absence of biosecurity practices at live bird markets (LBMs). Human infections have been associated with the handling of dead or sick poultry in H5N1-affected areas, ~~revealing~~an indication that H5N1 illness in humans is spread primarily through infected birds (Neupane et al.,

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2012). ~~First, mixed and free-range poultry production poses a high danger of AI infections in both rural and urban areas. Second, infected trucks and bird cages are used to transport live birds, and third, there are no biosecurity controls in place at live bird market places (LBMs) (McLeod et al., 2009). From this, it is evident that pandemics of human influenza have happened before and will probably happen again (Kumar et al.,2013).~~ Due to these~~is~~ observations, the knowledge of AI among poultry farm workers and other poultry industry stakeholders is vital for AI prevention and control ~~management~~ in poultry and humans. ~~Human infections have been associated with the handling of dead or sick poultry in H5N1-affected areas, revealing that H5N1 illness in humans is spread primarily through infected birds (Neupane et al., 2012).~~

The data on the importance of knowledge in the context of ~~a pandemic~~ the influenza outbreak has been less overwhelming. While some studies have discovered the benefits of protective behaviours (Eastwood et al., 2009; Liao et al., 2011), others have not (Van der Weerd et al., 2011). According to a prior study by MacMahon et al. (~~-~~2008), poultry workers who are exposed to infected birds, poultry products, virus-contaminated objects, or environments have an occupational risk of infection with these viruses. Moreover, it was found that poultry workers at risk of AI virus exposure include those operating in various poultry production systems or sectors, including poultry farmers and their staff, etc (Leonard, 2009). However, from these studies, it was found that poultry farm workers are the most susceptible to AI infections if they are exposed to infected birds, or virus-contaminated environments or materials. ~~Moreover, it was seen that AI knowledge was acceptable but poorly associated with real biosecurity procedures, according to a cross-sectional research of poultry workers' knowledge, attitudes and chicken handling practices in India (Kumar et al., 2013).~~ Several epidemiological studies have been published to assess the risk factors for H5N1 infection in humans, especially when there is contact with poultry and poultry products (Zhou et al., 2009; Van kerkhove et al., 2011; Van kerkhove et al., 2013). ~~It was foundseen that~~ ~~e~~Exposure to ~~this~~ AI virus has been linked to contact with contaminated poultry blood, bodily fluids during food preparations, and working with poultry in markets or farms (Radwan et al., 2011).

In a study conducted in Kathmandu, Nepal, 38.7% of the butchers in the country had some knowledge while 44.6% had good practices regarding inappropriate preventive behaviours related to AI. However, none of the respondents showed sufficient knowledge or proper behaviour (Paudel, Acharya, & Adhikari, 2013). ~~Human death cases in developing countries such as China were at 100% in 2003, but have since dropped to 50% in 2010. In Egypt, the rate of human deaths peaked at 56% in 2003 and then dipped to 45% in 2010. Since 2005, a number of other Asian countries, including Afghanistan, Bangladesh, India, Myanmar, Pakistan and, most recently, Bhutan and Nepal, have recorded cases of H5N1 (Timilsina & Mahat, 2018).~~ Previous studies among poultry farm workers in Italy, Nigeria, and China revealed that HPAI~~high~~ knowledge ~~of pathology~~ was considerably higher with educational attainment and among those who ~~was~~ were perceived as being more susceptible to this infection (Abbate et al., 2006; Fasina et al. 2009; Yu et al., 2013). An earlier study conducted in Indonesia among small-scale poultry farmers indicated that those with a greater understanding of HPAI symptoms are more likely to implement good practices regarding the handling of poultry and poultry products and are more concerned about disease transmission risks (Tiongco et al.,~~ Narrod, Kobayashi, Scott, & Nuryartono,~~ 2011). Moreover, it appears that urban poultry workers and consumers are more knowledgeable about HPAI than their rural counterparts (Barennes et al., 2007; Fasina et al., 2009). These findings are not surprising, considering poultry workers' and dealers' poor levels of education ~~levels~~ (Alders et al., 2009). In

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fact, in certain countries, there are no sufficient acceptable facilities. The poultry workers and traders are not involved in disease control~~regulation~~ and surveillance ~~programs monitoring~~, which are~~is~~ usually done by government organizations (Alders et al., 2009; Azhar et al., 2010).

In some countries, the impact of HPAI, information sources, and education initiatives (e.g., mass media, training, and community mobilization activities) on the knowledge of poultry workers or villagers have been explored. ~~The impact of HPAI, sources of information and education programs (e.g., mass media, training and community monitoring programs) on poultry workers' or villagers' knowledge has been studied in some countries~~ (Azhar et al., 2010; Barennes et al., 2007; Kurscheid et al., 2015; Manabe et al., 2011; Neupane et al., 2012; Yu et al., 2013). The primary source of HPAI information in Nigeria, Laos, and Vietnam was TV (Barennes et al., 2007; Fasina et al., 2009; Manabe et al., 2011) whereas radio was more essential in Nepal (Neupane et al., 2012). Similarly, previous studies conducted in Indonesia revealed that in the mass media, television is the primary source of AI information (Tiongco ~~, Narrod, Kobayashi, Scott, & Nuryartono~~et al., 2011; Kurscheid et al., 2015). ~~AI viruses pose a significant danger to food security because the poultry industry is one of the most popular sources of animal protein in the world, owing to its accessibility, nutritional content and lack of cultural limitations (Sinclair, 2019).~~ Good public awareness and safe practices regarding specific diseases or infections are critical for the ~~a successful pandemic control~~ prevention and successful control of outbreaks ~~prevention~~ (Dishman, Stallknecht, & Cole, 2010; Van Nhu et al., 2020).

In light of the above~~is~~, the main objectives of ~~the~~ this study ~~are~~ were to 1) determine the levels of knowledge and preventive practices among Indonesian poultry farm workers regarding AI, and 2) identify the factors related to the knowledge and practice of AI preventive behaviours, such as sociodemographic traits and media usage.

The study's findings are expected to help policymakers enhance AI knowledge and preventative practices among poultry farm workers through educational initiatives (seminars, workshops) on the same.

Materials & methods

Ethical considerations

The present study's protocol was reviewed and approved by the Animal Care and Use Committee, Faculty of the Veterinary Medicine, University of Airlangga, Surabaya under the approval letter No: 2.KE.096.07.2021. Participants were given verbal information about the study's aims, purpose, and structure, as well as assurances of confidentiality.

Study area ~~and~~

The current cross-sectional study was carried out in five different provinces: Banten, Jawa Barat, Jawa Tengah, Jawa Timur, and Lampung of Indonesia (Figure-1).

Study population

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This is a descriptive cross-sectional online survey conducted through a pre-designed questionnaire, which ~~targeting~~ targeted Indonesian ~~people who work on~~ poultry farms workers in the different provinces (Banten, Jawa Barat, Jawa Tengah, Jawa Timur, and Lampung) of Indonesia (Figure ~~1~~1). The selected provinces were located on Java Island which represents 60% of the humans and 70% of the poultry ~~Because of the significant number of major commercial farms in these provinces, they were chosen~~ (layer, broiler, breeder, and backyard) population of Indonesia (Sumiarto & Arifin, 2008). In comparison to other Indonesian islands, this island was more affected by avian influenza infection due to the high density of poultry and human population.~~The majority of outbreaks were reported in these provinces, such as the first AI outbreak in Indonesia, which occurred in Central Java and Banten.~~

The majority ~~125(62.5%)~~ of respondents 125 (62.5%) were from East Java province, ~~because of~~of the region that is characteristic with ~~the~~ high density of poultry and human population in ~~the area~~Indonesia. ~~Of these, a majority of the respondents were from the East Java province since it has more resources for data collection, besides hosting a large number of poultry farms~~. The inclusion criteria was based on, all people (employee or farm owner), working ~~on at~~ in big commercial poultry farms (broiler, breeder~~e~~, and layer~~),~~ and backyard~~)~~ poultry farms~~: as an employee or farm owner~~. The questionnaire was initially written in English but was translated into the native language of the region (Bahasa Indonesia) to improve respondent accuracy, reduce margins of error, and avoid confusion among respondents. The questionnaire was created using Google Forms, which can be accessed by clicking on a link; the investigators disseminated it via social media, such as WhatsApp, and electronic media, such as email. The aim of the study was concisely ~~brief~~explained ~~by~~prior to obtaining an informed consent from each of the study participants, before each participant fill~~ing~~s out the study questionnaire.

The Raosoft online calculator was used to calculate the sample size (Raosoft, 2015). The Raosoft online calculator is specifically intended for population surveys to calculate sample size and determine how many replies are required to achieve the desired confidence level with the margin of error (usually 5 percent). As a result, it is strongly suggested that it be employed in such a study while taking into account the population size. The overall number of poultry farm workers in Indonesia was~~is~~ estimated to be around 12 million (Ferlito & Respatiadi, 2019). We did not~~don't~~ know the precise population of poultry farm workers in the study provinces, ~~so we'll assume there~~but took an informed estimates of ~~are~~approximately 20,000 poultry farm workers ~~there~~. As a result, a minimum sample size of 377 was necessary to meet a 95 percent confidence level and a 5 percent margin of error. ~~However~~In total, we ~~have~~ sent the questionnaire to 450 people in order to have a good response rate.

The author used a number of Whatsapp groups belonging to local veterinary doctors~~' Whatsapp groups~~ to ~~find~~identify commercial and backyard poultry farms that already had contact information so that the study questionnaire could be sent to them.

~~Hence, we opted to distribute questionnaires among poultry farms that had prior contact information with the respondent. The authors used veterinary doctor' groups to recognize potential farm managers and poultry farms that are significant in size and recognize commercial outlets.~~ In

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this context, it is important to note that small-scale production farms were excluded from the study. The investigators kept track of veterinary doctors' ~~those~~ groups ~~-~~and reminded them regularly through WhatsApp and email as per the convenience of the respondents. The authors intended to reach as many outlets as possible to get reasonable and sufficient responses. Therefore, ~~author~~ an online questionnaire was forwarded to approximately 450 participants: of these, 210 respondents filled the forms out completely (46% response rate). Following this, the questionnaires were fully sent out for responses between August 11, 2021 to October 10, 2021. In the end, there were found to be only 10 incomplete questionnaires, and these were removed from the final analysis.

Questionnaire Validation

A pilot study was conducted in the aforementioned provinces for two reasons: to ensure that the questionnaires were comprehensive and to ensure the respondents were ~~available to~~ willing to participate in the study. The questions were written in both languages (English and Indonesian Bahasa). We proceeded and broadly distributed the survey after correcting any errors and responding to minor suggestions concerning the language of the questions.

Data collection tools

The data collection tools were adopted from previously published questionnaires for a study on Italian poultry workers and some modifications were done to be relevant to the local situation. ~~with modifications from previously published questionnaires for a study on Italian poultry workers~~ (Abbate, 2006) as well as the WHO fact sheet on AI (Organisation, 2011). The questionnaire comprised 27 items and was divided into three sections. The first part comprised six questions that investigated demographic variables and general information, including gender, age, residence, religion, level of education, and working status. There were 14 multiple choice questions in the second section with the options 'yes'/'no'/'don't know'. The question 'Have you heard of avian influenza?' (yes/no) was used to assess public awareness of the disease, while the question 'sources of information' with options such as radio, TV, newspapers, health workers, and friends were used to estimate the main sources of AI-related information among the participants. Furthermore, the participants were asked questions about the mode of transmission, and vehicles of transmission with the options 'yes'/'no'/'don't know'. A question about whether certain professional groups like poultry workers, butchers or veterinarians were at risk ~~for~~ of contracting AI was used to assess perceptions of professional risk ('yes'/'no'/'don't know'). A question was also posed to the participants regarding their frequency of ~~following~~ complying with the use of~~the~~ protective measures when dealing with poultry, which was taken from a previously published article by Neupane et al (2012);~~-~~such as hand~~-~~washing with soap and water, using face masks, boots/boot covers, protective body clothes and contact with bird cages ~~contact~~, consulting with doctors when feeling influenza-like symptoms and properly disposing of dead birds ('always/'sometimes/'never').

Data management

The knowledge scores were determined as follows: one for 'yes'and zero for 'no' and 'don't know'. Meanwhile, the preventive/control practices were graded as follows: one for 'always' (positive practices) and zero for 'sometimes' and 'never'. These scores were then converted into categorical

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variables: 'High' (scores greater than 80%), 'Moderate' (50–80%), and 'Low' (below 50%) (Islam et al., 2017).

Data analysis

The primary author imported the acquired data into Statistical Package for Social Sciences (SPSS) version 25.0. The typing errors were discovered and rectified. Owing to the nature of the study, descriptive statistics ~~was~~ were conducted~~used~~. To demonstrate the strength of the relationship between the knowledge and practice scores, correlation analysis was used. Pearson's Chi-square (X^2) test or Fisher's exact test (if applicable) were used to analyse the relationship between different variables, with $p \leq 0.05$ being considered statistically significant.

Results

A total of 200 farm workers from five provinces of ~~[~~Banten (n = 15), Jawa Barat (n = 15), Jawa Tengah (n = 30), Jawa Timur (n = 125), and Lampung (n = 15)~~] with different proportions have~~ participated in this study (Figure-1). The overall response rate was 46%.

Socio-demographic background

Both male and female farmers worked on the poultry farms were considered ~~for~~ in the present study. Most (59.5%, n = 119), of the respondents were males, ~~(59.5%, n = 119),~~ whereas 40.5% (n = 81) were females. Seventy-four percent (74%; (n = 148) of the respondents were ~~of the~~ in the aged range~~s~~ 31–50, 25% (n = 50) were ~~aged~~ in the range ~~from~~ 20–30 years, while a very small proportion (1%, n = 2) were~~as~~ under the age of 20 years. Of the 200 respondents, 55.5% (n = 111) resided in ~~at~~ rural areas, ~~while~~ and 93.5% (n = 187) practiced Islam. A majority (97.2%, n = 195) of the respondents had completed primary school while only 2.5 % (n = 5) ~~had~~ did not. On the other hand, more than half (59%, n = 118) of the participants were paid employees (Table 1).

Awareness and sources of information on AI

Out of 200 respondents, 67% (n = 134) had heard about AI, with ~~. Even though they got to knew know about it from~~ various sources of awareness, including the ~~a the majority of farm workers learnt ed about the disease through~~ health workers (36%), ~~followed by~~ TV (34%), friends (14.5%), and newspapers (14%). Only 1.5% have learn~~t~~ed about it from the radio (Table 2).

Mode of transmission

A high~~er~~ percentage (83.5%~~;~~) ~~n = 167)~~ of the participants were aware that AI was~~is~~ a contagious infection that affects all birds. 95% believed that AI ~~i~~was transmissible from animal-to-animal, while only 67.5% believed that it was~~is~~ transmissible from animal-to-human, ~~which tells us about~~ an indication of its zoonotic nature. A small proportion (20.5%) stated that it could ~~an~~not be transmitted from human to human. In addition to this, 50% of the participants stated that touching uncooked poultry and eggs could~~an~~ also contribute to spreading AI. Ninety–five percent ~~95% (n = 190)and 91 % (n = 182)~~ claimed that poultry and ninety–one percent alleged that other birds were the main sources of AI transmission (Table 2).

Risk groups and practices

An average of 76.75% of the respondents thought that poultry workers and veterinarians were~~are~~ more likely to cont~~r~~act AI infection ~~than~~ compared to butchers. In response to questions about the participants' practices, 51% stated that they always wore separate clothes while working on the

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farm. The most common practices were hand cleaning with soap and water (83.5%), appropriately disposing of deceased birds (78.5%), and using a face mask (65%). Other forms of personal protection, such as consulting with doctors when feeling influenza-~~-~~like symptoms and wearing boots or boot covers, appeared to be less common. Overall, the study's findings demonstrate that the participants had a strong knowledge of the suitable practices in dealing with AI infections (Table 2).

Awareness and demographic characteristics

Table 3 depicts the association between participant awareness and demographic characteristics. Based on their *p*-value (> 0.05), none of the variables had a significant relationship with AI awareness. It implies that respondents' awareness regarding AI was~~is~~ independent of their demographics.

Level of knowledge and practices

Table 4 shows that higher levels of knowledge were statistically significant to the participants' residence and employment status (*p*-value <0.05). Gender, age, religion, and educational status, on the other hand, did not show significant association with ~~have no relationship with~~ knowledge because their *p*-values are not statistically significant (> 0.05).

Practices and demographic variables

Table 5 reveals that good practices were associated with gender, residence, and employment status. Other variables, such as age, religion, and educational status, did not show any significant association ~~do not have a statistically significant relationship~~ with the practice because their *p*-values are not statistically significant (> 0.05).

Figure 2 depicts the relationship of respondents with AI knowledge and biosecurity practices, which were~~are~~ statistically significant (*p*-value≤ 0.009).

Discussion

The goal of the present epidemiological survey was to determine the level of AI awareness and practice among the Indonesian poultry farm workers.

AI is a zoonotic disease mainly affecting birds and other mammals including humans. The disease is still endemic in Indonesia (Pusch & Suarez, 2018; Wibawa et al., 2014). The pan zoonosis of AI in domestic birds is a key risk factor, as it increases the chances of mutations and genetic re-assortment (Trampuz, Prabhu, Smith, & Baddour, 2004).~~(AvianInfluenza, 2011).~~ To the best of our knowledge, this is the first cross-sectional survey ~~epidemiological investigation~~ of AI among poultry farm workers in Indonesia. According to the results, most of the respondents had good knowledge and practices about AI.

Our findings revealed crucial information about the knowledge level of people who were known to be at high risk of AI infection. A majority of them were aware that AI is a contagious infection that affects all birds, while more than sixty percent said that they had heard of it. This is an important aspect ~~in~~ of AI control as it might be due to the information and experiences gathered from the numerous AI epidemics that have occurred in Indonesia, particularly on Java Island~~, explaining why the participants were well educated on it~~. Our findings are in line with those of other studies conducted in Ghana and Bangladesh, which showed that 63.5% of the respondents

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were aware of AI (Asare et al., 2021; Islam et al., 2017). A previous study conducted in Italy by Abbate et al. (2006) found that 64% of poultry workers correctly identified AI as a contagious infection caused by a virus that can affect all species of birds. Our results also concur with those of a study conducted in Pokhara, Nepal, in which 75% of participants correctly identified avian flu (Timilsina & Mahat, 2018). This could be due to the fact that the authors surveyed a population with a high level of education.

According to our findings, a majority of the respondents were aware that AI can be transmitted from animal-to-animal and animal-to-human, while only twenty percent stated that it couldan be transmitted from human-to-human. This is in line with the previous studies conducted in Italy, India, Nepal, and Bangladesh (Ezeh et al., 2017; Kumar et al., 2013; Lambrou et al., 2020; Sarker et al., 2016~~).~~

Data on the assessment of risk factors revealed that ninety to ninety-~~five percent~~(90 – 95%) of participants said that poultry and other birds were the vehicles of AI transmission while ~~seventy-five to seventy (9%)ni~~74.5% and 79%~~ne percent~~ believed that veterinarians and poultry workers respectively were high-risk groups of getting AI infection~~ed~~. This is similar to the findings ~~of~~ from a previous study, which was conducted in Baghdad, in which a majority of participants stated that poultry and wild birds were~~are~~ the primary vehicles of AI transmission. ~~but i~~However, our result was higher than~~n contrast to~~ the findings of a previous study in Indonesia, which found that only 58 % of participants believed that diseased birds might transmit HPAI (Kurscheid et al., 2015)~~.~~ Other categories, such as at-risk populations (veterinarians, poultry workers), elicited mixed responses, which contrasted with our findings (Al-Sarray, 2018). Direct contact with infected birds have been identified as the primary risk factor for AI transmission among humans in various studies. A cohort study of poultry workers in Hong Kong found that exposure to chicken increased the risk of AI infection among poultry workers and veterinarians (Bridges et al., 2002). A previous study in China that evaluated the knowledge and practices in urban and rural areas regarding "~~K~~knowledge, attitude, and practices" of AI found that poultry workers and veterinarians were at a higher risk of contracting AI (Xiang et al., 2010). All these findings concur with what we found from the present survey. Our findings on AI transmission were quite similar to those reported in a previous study conducted in Indonesia, which revealed the respondents had a good understanding of AI transmission (Hunter et al., 2014).

In the survey, it was also clear that the main sources of information for respondents were~~as~~ mass media, ~~specifically~~ health workers, followed by TV and radio. These findings are in line with the results of earlier studies con~~u~~acted among Cambodian and Nigerian poultry workers where ~~the~~ TV and radio were important sources of AI awareness (Fatiregun & Saani, 2008; Khun et al., 2012). A comparable study conducted in Nepal revealed that TV and newspapers were the important sources of campaigns regarding AI knowledge and awareness (Neupane et al., 2012). Our results were consistent with those of Hunter et al. (2014) and Tiongco et al. (2011), who said that TV was the main source of AI-related information in Indonesia. In the current investigation, the demographic characteristics did not affect AI awareness. This might be due to the endemicity of AI in Indonesia. In contrast, a previous study in Ghana found that age, marital status, residency, educational level, and years of job experience all have a substantial impact on awareness (Asare et al., 2021). In

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contrast, a study that was done in Indonesia in the past showed that the level of education has a significant effect on the level of awareness regarding AI (Tiongco et al. 2011). According to the findings of the present survey, 42% of respondents had a high level of knowledge while 25% had a moderate level of understanding (Figure 2) of AI illnesses in birds, the source of virus transmission, and other risk categories.

In contrast, the study in Ghana indicated that 87.5% of respondents had little understanding of the pathogenesis of AI, symptoms in diseased birds, and the source of virus transmission (Asare et al., 2021). Our findings are consistent with the previous H5N1 surveys conducted in China, Laos, and Italy (Abbate, 2006; Di Giuseppe et al., 2008; Xiang et al., 2010). According to our findings, a majority of the participants followed biosecurity and biosafety practices like hand washing, disposing of dead birds, and using ~~face masks~~facemasks, while 45–50% of respondents used separate clothes and boots cover when dealing with poultry. A comparable study conducted by Neupane et al. (2012) in Nepal discovered that 40% of the participants practiced personal preventative behaviours such as hand washing and sanitizing surfaces and utensils. In a prior study in Indonesia, 40% of participants were found to be aware of properly disposing of sick and deceased birds to reduce the risk of virus transmission (Kurscheid et al.,2015). To avoid AI infection, 51% wore face masks, whereas less than 40% wore special boots or protective body clothes while working on the farm. In the current study, 44.5% of the respondents showed high adherence to these practices, while only 20% did not, which contrasted with the findings of a prior study conducted in Ghana, where only 4.3% showed strong adherence (Asare et al., 2021). Previous studies in Nepal and Nigeria found similar results, with 59.3% of the people adhering to these practices highly (Neupane et al., 2012; Perry et al., 2011). Our findings are intended to assist decision-makers in improving AI control and prevention strategies among poultry farm workers through education initiatives (workshops, seminars, etc.) on the same.

Limitations of the study

The major limitations ~~here can be~~in this study were attributed to the sampling method used and the~~se~~ regions covered, as these findings cannot be extrapolated to all of Indonesia. This is because we did not have enough social resources to cover more Indonesian provinces. Furthermore, because this is an online survey, respondents' interpretations of certain questions were susceptible to variations. Only the socio-demographic, knowledge, and behaviour characteristics were examined as influencing factors to avoid having too many items in the questionnaire and, thereby, inadvertently causing a long response time. Moreover, the study would be feasible only for people who had smartphones, used WhatsApp, had email IDs, and worked on commercial farms. Additional assessments, based on all elements of the knowledge and practices related to AI, would be necessary to ascertain the true degree of knowledge and practices among local farm workers. We had a lot of problems collecting data because our survey was conducted online. For the distribution of the study questionnaire, we chose WhatsApp and email as our modes of communication. Compared to other research methodologies, most respondents are less likely to stay completely engaged for a survey lasting more than 8-10 minutes, which is why we have a low

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response rate. We requested the respondents to complete the survey questionnaire several times, although a majority of them did not.

Conclusion

The study's findings demonstrated that poultry farm workers had good knowledge, which was reflected in their practices. The level of knowledge and practices was found to have a significant relationship. The primary sources of information about AI were health workers and TV. In addition, veterinarians and poultry workers were at a higher risk of getting avian influenza infection as compared to butchers. Furthermore, farm owners and workers in rural areas were shown to have a better degree of AI knowledge than those in urban areas. However, because of the high risk of infection, Indonesian poultry farm employees must increase their knowledge and practice of AI even more. The findings of the current study may help to improve avian influenza policies and targeted management strategies in controlling and eradicating the disease in Indonesia.

~~However, there is still a need to further improve Indonesian poultry farm workers' knowledge and practice ofAI. Doing this will enhance the working effieiency of poultry farm owners/workers. Moreover, staying up-to-date with the latest knowledge is vital in combating propaganda such as false information. Moreover, it will help in adopting formal or standard practices regarding AI. In this regard, the local government, farm managers and poultry workers must be more actively involved in designing and implementing education and awareness programs, regulatory measures and incentive mechanisms~~.

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Commented [FF(62]: I will rather think that this study focus more on awareness. Knowledge is another level which is deeper. For example, knowledge will get the farmers to know the specific cause, know transmission patterns, knows risk of introduction, and such things.

Acknowledgments

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