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RESEARCH ARTICLE

Possible Route of Transmission of Highly Pathogenic Avian Influenza Virus Type H5N1 in Family Poultry at Rural Bangladesh

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ABSTRACT

Highly pathogenic avian influenza virus type H5N1 represents one of the major causes of morbidity and mortality of poultry in both developed and developing countries. However, little is known about the transmission of this virus in developing countries that usually raise poultry as family-based farming. The study was conducted at 10 of total 64 administrative districts of Bangladesh that experienced H5N1 virus outbreaks since 2007. Trained field workers visited 30 rural families at each district to check family poultry management system. The collected data were transcribed and coded according to the standardized mutual performance of the field workers. Approximately two-third of farmers (67%) were rearing only chickens and remaining (33%) both chickens and ducks. Most of the farmers provided night shelter to their birds inside their living room (24%) or close proximate (69%). Usually ducks were scavenged in water land (58.6%) or paddy field (18.2%). The majority of owners (93%) also shared the same water land with migratory/wild birds for their daily necessity. The marketing system of poultry was characterized by comprehensive interactions among family poultry and commercial birds for prolonged duration. Unsold or newly bought birds were brought back to farmer's house in almost all instances (97.8%). Findings from this study indicated that interactions of domestic chickens and ducks with their owners (through contaminated agricultural and fisheries tools or clothing) are partially, if not solely, responsible for wide spread transmission of Avian influenza virus type H5N1.

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INTRODUCTION

The highly pathogenic avian influenza (H5N1) virus has been detected in Asia, Europe and Africa that possess health risk to poultry and human. Since 2003, infection with H5N1 virus has caused natural death or killing of over 300 million poultry. Also, 330 human beings have died of this infection (World Bank, 2008; WHO, 2011). In addition, the impact of H5N1 virus on food security and providence of nutrition in developing countries is tremendous because main bulk of their populations depend on eggs and poultry meat as only reliable source of protein (Burgos and Burgos, 2007; Gueye, 2007; Sonaiya, 2007; Das *et al.*, 2008).

Bangladesh, an Asian country with more than 150 million people, has experienced outbreaks of H5N1 virus since 2007 (Biswas *et al*, 2008). Official and conservative estimates indicated that over 1.8 million birds have already died or killed due to H5N1 virus infection (MFL, 2011; OIE, 2011). A single human infection by H5N1 virus has also been reported in Bangladesh (ICDDR'B, 2008; Brooks *et al.*, 2009).

In contrast to developed countries that are mainly rearing industrialized poultry, family poultry represents one of the most important sub-sectors of livestock of Bangladesh. Studies have shown that about 80-90% of rural households keep poultry (Dolberg, 2008; Das *et al*., 2008), and family poultry is raised by about 90% of total population of Bangladesh (Dolberg, 2008). These poultry

contribute the protein need of the country and also represents a sustainable source of income of villagers.

The infection of H5N1 virus has shown the susceptibility of family poultry population of Bangladesh to destruction and distortion in a short span of time. Although the rural poultry handlers are interested to know about possible steps to block transmission of similar outbreaks of infectious diseases, almost no study has been conducted at Bangladesh to address their queries. It is true that studies have been conducted in mainly developed countries about possible blocking of transmission cycle of infections agents (Sims *et al*., 2005; Ellis *et al*., 2006; Khan *et al.*, 2009; Martin *et al.*, 2010; Cecchinato *et al.*, 2011). However, raising of family poultry is endowed with specific features in each developing country on the basis of their socio-economic and cultural heritages.

Therefore, this survey was conducted at 10 of 64 districts of Bangladesh that were mainly affected by H5N1 virus infection since 2007. The salient features of this study were pooled to develop insights about family poultry management systems, particularly those related with transmission of H5N1 virus infection.

MATERIALS AND METHODS

The study was performed based on qualitative and quantitative survey. We employed ten field workers with basic backgrounds of poultry management and conducted observational survey. These persons were trained about our study objectives; (1) nature of poultry rearing at family levels, (2) interactions of poultry with other birds, (3) close observation of poultry marketing and (4) management of unsold birds.

The survey was undertaken at 10 of 64 districts of Bangladesh (Fig.1) based on their demographic variations in terms of H5N1 virus outbreaks. In each district, 30 households were randomly selected to observe the family poultry management system and related issues. They also visited at least 5 poultry markets in each district. They discussed with family poultry farmers and took interview to develop insights about family poultry management system at rural Bangladesh. Poultry marketing and livestock-crop mixed cultivation system (rice-duck) were also checked in each district as this have been reported to play an important role in the introducing and spreading of H5N1 virus in some countries (Gilbert *et al*., 2006; 2008; Sims, 2007; Cecchi *et al.*, 2008; Hop and Saatkamp, 2010; Chantong and Kaneene, 2011; Henning *et al*., 2011). The collected information were transcribed and coded according to the standardized mutual performance of the surveyors.

RESULTS

Table 1 shows the base line information about flock size and purpose of family poultry. Approximately, two-third of farmers (67%) were rearing only chickens and remaining (33%) both chickens and ducks. Depending on the socio economic condition, there was wide variation with regard to the number of birds per family. The flock size ranged from 4 to 23 (average flock size 10±0.28) was observed at the survey areas (Table 1). Among the farmers, 7%, 12% and 81% were rearing birds for the source of protein, income and income plus protein, respectively.

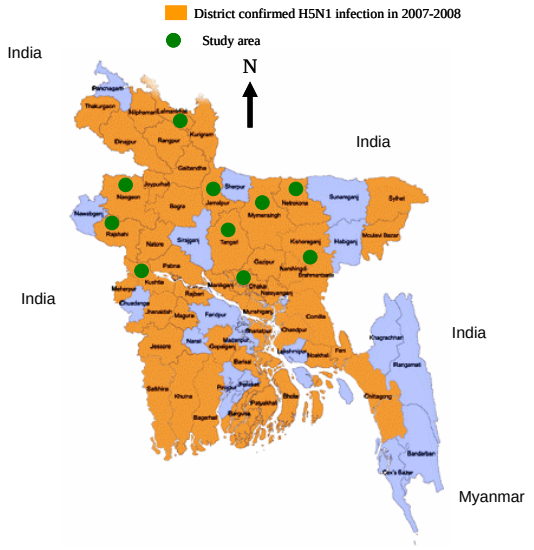

Fig. 1. Districts (administrative area) of Bangladesh selected for this study. The green circle indicated study area.

Table 1: Flock size and purpose of family poultry rearing

	No. of family (Total 300)	%
Types of birds		
Chicken	201	67.0
Chicken and duck	99	33.0
Number of birds		
≤ 5	21	7.0
6-10	182	60.7
11-15	75	25.0
≥ 16	22	7.3
Purpose of rearing		
Income	36	12
Source of protein	21	7
Income plus source of protein	243	81

The family members of rural farmers shared their bed room with the poultry. At night, the poultry were kept in a cage and put under their bed (24%) or an attachment (69%) where there was no biosecurity. This practice was observed in most of the farmer houses (93%) (Table 2). Some times, chickens and ducks were kept in the same cage. In others, there may be separate cages for chickens and ducks. Approximately three-quarters of farmers provided food to their birds on a daily basis that occurred inside the room or on verandas (Table 2).

During feeding of birds, no discrimination was made between healthy and sick birds. Most of the farmers (93.7%) gave food to them together. Usually, the children took part in poultry feeding. Also, the birds took food from the plates of the children at different times.

A large number of rural farmers (about 90%) were also using their living room for hatching of eggs. They sporadically put eggs under broody chickens or ducks and used them as hatcheries. Checking of hatching eggs and physical examination, feeding, cleaning droppings of broody birds occurred at unhygienic condition with no hand wash practices.

During day time, the chickens moved freely in the homestead areas of the farmers and nearby crop lands.

About 58.6% of farmers thought their ducks were mainly scavenging in the nearby ponds, rivers, lakes or other low lying areas of rural Bangladesh. Many migratory birds come to these areas in the winter season and about 15% farmers thought that there interactions among their ducks with migratory ones (Table 2 and 4). In addition, the rural farmers and their family members (92.3%) including female and children also used these watery areas for fishing, bathing, bathing of other domestic animals or other agricultural/aquacultural activities. Thus, rural life style favored an intimate contact among poultry, human and migratory birds. Another potential important place of interaction between chickens, domestic ducks and migratory birds was provided by mixed farming like chicken-duck-rice production system. About 18% farmers were practicing this farming system to allow the ducks to move freely in rice fields as pest controller (Table 2).

In the market, live birds were sold at minimal hygienic condition. The family poultry were put in close proximity of birds from commercial farms. The unsold or newly bought birds were brought back to framer's house or commercial farms at all instances (97.8%). It is a natural practice at rural Bangladesh to slaughter healthy or sick poultry and migratory/wild birds at their home with minimal hygienic condition within close proximity to the other birds and family members (Table 3). After the bird's throat is slit, it thrashes and its blood sprinkles all over the courtyard. The blood is not washed away, nor are the remains of the bird properly disposed off. Instead, almost all farmers (98%) were thrown away the uneatable portions of the birds to open place where wild birds, other poultry, dogs or cats may eat or children play with it.

DISCUSSION

Due to wide-spread outbreaks of H5N1 virus in early 21st century, some countries have banned family poultry farming to reduce infection (BBC News, 2007). However, considering the economical and social structures of comparatively improvised people of resource-restricted countries, it seems that this option would not contribute to prevent and control of avian influenza in Bangladesh. Rather, the effect may be counterproductive. On the contrary, attention should be given to find out ways and means to restrict or block infection of family poultry by H5N1 virus infection. In fact, public health approach to materialize this has not been well explored.

To draw a possible road map to block future infection of family poultry population by H5N1 virus or other similar infectious agent, it is needed to develop insights about ongoing practices of family poultry management at rural area. This study revealed that risks of H5N1 virus infection may increases at family poultry due to environmental, agro-ecological, physical, social and cultural factors. Avian influenza virus mostly spreads by direct contact with infected birds or contaminated feces, feeds, water, equipment, and clothing. Proper maintaining of bio-security measures at family poultry production level might be useful for stopping the spread of viruses. However, results from this study indicated that biosecurity, in its true sense, is neither possible nor feasible in almost all branches of family poultry production in Bangladesh.

We assume that migratory birds might be responsible to initial introduction of H5N1 virus into Bangladesh because the H5N1 virus isolates from domestic chicken

Table 2: General management of family poultry

	No. of family (Total 300)	%
Place of night shelter		
Inside the owner's living room	72	24.0
Close proximate to owner living room with no or minimal attachment	207	69.0
Separate place from owner house	21	7.0
Times to provide foods		
One time per day	197	65.7
Two times per day	21	7.0
Not regularly	82	27.3
Feeding systems		
Provide feed separately to healthy and sick birds	19	6.3
Provide feed together to healthy and sick birds	281	93.7
Chicken scavenging system		
Scavenge around homestead area	132	44.0
Scavenge around homestead area and nearby crop fields	168	56.0
Duck scavenging system (out of 99 farmers)		
Scavenge around homestead area	0	0.0
Scavenge around homestead area and nearby crop fields	8	8.1
Scavenge nearby ponds, river and wet land area	58	58.6
Scavenge paddy field as weed and pest controller	18	18.2
Scavenge long distance and interact with migratory birds	15	15.1

Table 3: Poultry marketing and slaughtering systems

	No. of family (Total 300)	%
Live bird marketing system		
Marketing at home	21	7.0
Marketing at local market within vicinity	279	93.0
Unsold or newly bought poultry are back to home and keep in same box/sheds with other birds	293	97.8
Place to slaughter		
In side home	253	84.3
Outside home	47	15.7
Method to dispose of feathers and uneatable portion after slaughtering		
Buried in soil	5	1.7
Through to home garden	136	45.3
Through to open pit	103	34.3
Through to nearby pond	56	18.7

Table 4: Information about interaction with migratory birds

	No. of family (Total 300)	%
Have you seen the domestic ducks shared the same water land with migratory/wild birds		
Yes	47	15.7
No	253	84.3
You or any of your family members shared the same water land with migratory birds for bathing, washing cloth or fishing		
Yes	277	92.3
No	23	7.7
You or any of your family members catch the migratory birds for eating or entertainment		
Yes	13	4.3
No	287	95.7

are close to those from Mongolia and Russia (Biswas *et al.*, 2008). In fact, birds from Russia and Mongolia migrate to Bangladesh in winter season (Dolberg, 2008). Indeed, Bangladesh does not have any direct poultry trade with these countries; indicating that virus from migratory birds transmitted to poultry population of Bangladesh.

Above assumption was supported by the data from this study. More than 90% of rural poultry owners visited the same scavenging place of migratory/wild birds for their daily necessity (Table 4). About 18% farmers thought that their domestic ducks also have interaction with migratory birds either in watery area or paddy field (Table 2). These people and ducks share the living room or close proximate with no or minimal attachment with chickens indicating that either family members (especially when agricultural and fisheries tools or clothing are contaminated) or domestic ducks introduce viruses from migratory birds to farmers house. Subsequently, the virus may be transmitted to chicken, as they have very close and frequent interaction. Actually, special indication to free scavenging domestic ducks because they were infected with avian influenza virus and showed few clinical signs of the disease (Hulse *et al*., 2005) but capable to shedding appreciable amounts of virus (Gilbert *et al*., 2006; 2008; Henning *et al*., 2011).

The prevailing marketing system of poultry might also be responsible for transmission of viruses. This system is characterized by comprehensive interactions among birds (chicken and ducks) for prolonged duration and unsold or newly bought birds were returned to farmer's house at all instances (97.8%). Moreover, the usual process of slaughtering healthy or sick birds was unhygienic that mostly practiced inside the residence (84.3%).

Findings from this study suggested that the viral circulation into poultry population might be facilitated by the interactions of the integrated agriculture which relies in the integration of farmer-livestock-fisheries-crop production in the presence of domestic ducks scavenging with migratory birds and by the connections with the live-bird marketing and home slaughtering at minimal hygienic condition. Thus, it is predicted that poultry and people might be easily infected by each others due to inadequate knowledge, awareness and information of rural farmers about zoonosis.

However, there are some limitations of this study. We could not show a direct evidence to support that domestic ducks or other animals as well as the members of famer's family transmitted the viruses from migratory birds to poultry population at Bangladesh by analyzing the viral genome. In fact, this observational study was planned to provide insights about importance of public health measures to control future H5N1 virus infection in poultry. If the rural farmers are provided with adequate knowledge about natural reservoir of viruses as well as danger of infection to their poultry, the present biosecurity condition may be improved. Another notable factor is to develop legal measure to block return of unsold poultry from markets. A stock pile of poultry reservoir may be developed at each market or designated market to preserve the unsold poultry. These unsold poultry may be sold in another day by a cooperative society. On the other word, the poultry can be bought by a marketing society on a daily basis to block return of unsold poultry.

In conclusion, this observation study, although far from drawing a conclusive conclusion, represents one of the first approaches to develop insights about rural farmer-based poultry development at Bangladesh. Some of these features may be shared by other developing countries. Analyses of this study may unveil a method to protect poultry from H5N1 virus infection.

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