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Original Article

Poultry rearing and slaughtering practices in rural Egypt: an exploration of risk factors for H5N1 virus human transmission

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Background Highly pathogenic avian influenza (H5N1) virus continues to cause infections in Egypt. This study describes the practices associated with raising and slaughtering household poultry to identify risk factors for H5N1 infection and reasons for non-compliance with preventive measures.

Methods An investigation was conducted of 56 households with household flocks (19 households with human H5N1 cases, 19 with poultry H5N1 cases, and 18 with no reported poultry or human H5N1 cases). Data were collected via structured observations and in-depth interviews.

Results Half of the households kept at least some free-range poultry and mixed at least some different species of poultry as it was considered beneficial for the poultry. Feeding and cleaning practices exposed children to contact with poultry; slaughtering contaminated homes; use of personal protective barriers was not a norm; waste management exposed the communities to slaughtering waste and dead chickens; and reporting of sick and dead poultry was not a practice. Only minor changes in poultry-handling took place following H5N1 virus outbreaks.

Discussion H5N1 virus prevention in Egypt represents both an epidemiological and socio-cultural challenge. Traditional poultry-rearing practices that likely increase exposures to H5N1-infected poultry are common throughout Egypt. Despite education campaigns following sporadic H5N1 outbreaks, no differences in these practices could be detected between households with previous H5N1 human or poultry cases and those households with any previous experience with H5N1. Development of H5N1 infection–related education campaign strategies should focus on perceptions underlying traditional practices in order to tailor public awareness messages that are meaningful for communities.

Keywords Backyard poultry, human H5N1 risk factors, socio-cultural.

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Introduction

Highly pathogenic avian influenza (H5N1) virus continues to cause outbreaks in poultry and sporadic human infections in several countries.[1,2] In Egypt, the virus was first reported in 2006, when outbreaks were described at commercial farms and in household flocks in three governorates in the Nile Delta. Since then, the virus has spread to multiple locations nationwide and remains endemic in poultry. A total of 149 H5N1 human cases and 51 deaths have been documented in Egypt between March 2006 and June 2011. In the past 2 years, Egypt reported the highest number of cases worldwide: 39 of 73 (53%) globally in 2009 and 29 of 48 (60%) globally in 2010. However, previous studies have shown that H5N1 viruses can cause a rate of mild or subclinical infections in humans that can be often missed as people in resource-poor settings do not look for medical care except in severe cases. In addition, criteria for confirmation of human case of H5N1 by WHO used in Egypt captures cases more likely to be severe leaving opportunities for misdiagnosis and making H5N1 detection rates lower than in reality.[3]

Over half (54%) the cases in Egypt were children younger than 15 years of age, and almost 65% were females. The changing age-based patterns in H5N1 infection in Egypt have raised concerns. From December 2008 through July, from 32 human H5N1 cases in Egypt 28 were children <8 years old.[4] Although the 29% fatality rate in Egypt was

significantly lower than in other countries, women over age 15 accounted for 83% of deaths.[5] Based on experience in other countries, it is expected that sporadic human infections and associated deaths will continue to occur as long as the virus circulates in poultry.[6]

Risk factors for the zoonotic transmission of H5N1 virus are not well understood. Previous studies have shown that human infections usually result from direct contact with sick or dead poultry.[7,8] Data also increasingly suggest that human infections can result from indirect contact (i.e., any contact not involving direct touching of poultry, such as swimming in H5N1 virus–contaminated water or exposure to live poultry markets) with infected poultry, contact with apparently healthy poultry, or contact with contaminated environments.[9,10] Epidemiological data from Egypt provide evidence that handling infected poultry, including slaughtering and de-feathering, represents the primary source of exposure.[5,11,12] Although it is likely that many thousands of H5N1-infected birds have been unwittingly slaughtered by poultry keepers in recent years, reported human infections remain relatively low.

Poultry rearing is an important part of Egyptian rural culture. It is estimated that approximately 5 million Egyptian families raise poultry. Poultry and eggs are important sources of animal protein for a large proportion of the Egyptian population, and the sale of poultry and eggs provides an addition to household income. Household poultry represent a form of flexible capital and can be sold whenever a need for cash arises, such as the need to pay for school supplies or obtain cash for unexpected expenses. Women are the main caretakers and decision makers as regards poultry.

Control efforts of H5N1 in Egypt initially focused on mass culling of infected farms and dangerous contact flocks, with compensation provided for short period of time to commercial producers but not to household producers. Mass vaccination of household poultry began in 2006, but the impact of the current vaccination strategy has been limited.[13] Public awareness campaigns aimed at preventing transmission of H5N1 virus from poultry to humans began in Egypt in 2006, as a part of pandemic preparedness planning. Initial campaigns called for the application of several basic protective measures, such as keeping poultry caged, keeping different poultry species separated, washing hands after handling poultry, and using protective barriers such as gloves, masks, and dedicated clothes and shoes when dealing with poultry. Although these campaigns have succeeded in raising awareness about H5N1 virus and associated preventative measures, behavioral gaps nevertheless remain.[14]

This study examined household poultry-rearing practices in Egypt that may place humans at higher risk for H5N1 infection and identified behavioral gaps that challenge the adoption of protective measures.

Methods

Between January 23, 2009, and June 15, 2009, a total of 30 cases of H5N1 were reported by the Ministry of Health in Egypt to the World Health Organization (WHO). Households in which nineteen of these cases occurred, located in 10 of Egypt's 29 governorates, were included in the study (type A household). Eleven of the cases were located in Lower Egyptian governorates (Nile Delta) and eight cases were from Upper Egypt (southern regions of Egypt). The median age of H5N1 cases was 4·4 years with a range from 1·5 years to 38 years. Households with fatal cases ($n = 4$) and those that no longer contained household poultry ($n = 7$) were excluded. For each type A household, the closest household reporting a poultry H5N1 outbreak but no human H5N1 case (type B household, $n = 19$) and a household reporting no human H5N1 cases or poultry H5N1 outbreaks (type C household, $n = 18$) were included in the sample.

Data were collected between October and November 2011. A semi-structured observation lasting 4–8 hours was conducted in each household to monitor human–poultry contact by looking at different poultry-rearing practices, exposure of children to poultry, and compliance with recommended preventive measures. In addition, an in-depth interview was conducted in each household with a person identified as a primary poultry caretaker to complement observations by exploring community perceptions related to poultry-rearing practices, including disposition of sick and dead poultry, which could not be observed during household visits.

The preparation phase included 2 days of training in data collection for six field workers, all Egyptian women with previous interviewing experience. Preparation for data collection required attention as the topic of study was expected to raise mistrust among local communities due to earlier unpopular measures taken by the government, including the compulsory culling of vast amounts of poultry. Therefore, fieldwork started by briefing the local female health educator (*ra'ida*) in each governorate, who was asked to introduce field workers to sample households and to make household members at ease with field worker visit. Only one type C household in the Qena governorate refused to participate. Observation began from the moment the field team entered the household and lasted until departure. Observation lasted a minimum of 4 hours to allow observation and recording as many daily poultry-rearing activities as possible and to give household members an opportunity to get accustomed to the field team. At each household, field workers also observed the slaughter of a chicken by a household member. At the end of the visit, one of the field workers conducted the in-depth interview.

Data analysis

Quantitative data from the structured observations were entered into a Microsoft Office Access database using double data-entry techniques to ensure accuracy. Data were then cleaned and analyzed using Statistical Analysis Software (SAS), version 9·0 (Copyright© 2002–2003 by SAS Institute Inc., Carey, NC, USA).

Data analysis of qualitative data started in the field in a debriefing session between the investigator and the field workers directly after each household visit. In debriefing session, field workers shared their experiences and observations with the investigator and identified issues to be investigated further. Each team of field workers wrote short field notes during the interviews and extended them immediately after the debriefing session. Field notes and debriefing notes were translated from Arabic to English. Recorded interviews were transcribed and translated from Arabic to English. Accuracy of the transcription was checked by the investigator by listening to the recordings and comparing them to the transcripts. Extended field notes were compared with the transcripts to strengthen the reliability of the data. Data analysis of the transcribed text was by content analysis to search for emerging themes or divergent data that appeared significant. The analysts read the transcribed texts multiple times to extract the main themes and meanings of the participants' words as they related to feeding, cleaning and slaughtering practices, dealing with sick and dead poultry, changes in practices after H5N1 cases, and reasons for non-compliance with protective barriers. The themes were compared across different household types. In the final stage, the investigator interpreted the data collected from all the sources and developed a conceptual schema in response to the research questions.

Ethical considerations

Verbal consent was obtained from each household member before observation and before each interview. All the interviewers were trained in research ethics. The study was approved as an outbreak investigation by the US Naval Medical Research Unit No.3.

Results

Household characteristics did not differ significantly between households with previous human H5N1 cases, previous poultry H5N1 cases and no previous H5N1 cases reported (Table 1). An average of eight persons lived in an average of four rooms in each household. Most houses were constructed with concrete, tile, or ceramic flooring (71%). The majority (80%) of households had running water but only 22% had a sewage system. All households were headed by a male household member; 48% of these had received no education; 16% had completed primary or preparatory school; and 36% had completed higher institute or university studies. All poultry caretakers in study households were females; 66% of these had no education; 12% had completed only primary or preparatory school; and 21% had completed higher education.

Households kept an average of 39 birds each, or 5·6 birds per household member. Most households (78%) kept two or more bird species, and over half of the households mixed different species of birds. Most of households (79%) had at least one chicken. No statistically significant differences in poultry-keeping practices were noted between the three types of households (Table 2).

In 28 (50%) households, all poultry were contained in a designated room inside the house, in a coop in the yard; or on the rooftop. All poultry were free to roam inside or outside in 21 (37%) households. Several poultry caretakers explained that it was easier to care for and feed poultry if birds were free and in close proximity. Many poultry caretakers interacted regularly with poultry (mainly chickens) to ''develop a friendship'' so that the birds would produce more eggs. Some poultry caretakers did not understand why healthy poultry should be separated from humans, and in many households with unconfined poultry, children were also in frequent contact with poultry by playing with them. The remaining 7 (13%) households had a mixture of contained and unconfined poultry. In most of these households, poultry were caged during the night but could move freely inside and outside of the house during the day. Poultry were caged to avoid conflicts between different types of poultry or to separate poultry of different ages rather than to prevent H5N1 infection. Poultry were often separated during the night but mixed during the day.

Poultry caretakers in households with caged poultry explained that feeding usually occurred twice a day, but in households with unconfined poultry, feeding occurred whenever household members had leftover food. Observation confirmed these differing practices. Poultry caretakers of all household types also described using forced feeding when they wanted to fatten poultry. In households with dedicated poultry areas, small children were often observed joining adult females during feeding. In households with unconfined poultry, children frequently fed poultry.

Observations of contacts between household members and poultry included carrying or transporting poultry (41%), feeding poultry (18%), playing with poultry (17%), cleaning poultry-living areas (13%), and collecting eggs (5%). An average of 2·8 contacts were observed in each household, with no significant difference between household types with adjustments for household size ($P = 0{\cdot}10$) or flock size ($P = 0{\cdot}32$). Most of the observed contacts involved live birds (67%), but observed contacts also exposed household members to feathers (18%), skin

Table 1. Sample household characteristics

Variables of interest	Household with human H5N1 case	Household with poultry H5N1 case	Household no reported H5N1 cases	Total	*P*-value
Average number of persons	7·3 (4, 12)	7·8 (5, 20)	9·9 (3, 35)	8·2 (3, 35)	0·37
Average number of rooms	3·3 (1, 10)	3·6 (1, 10)	4·6 (2, 11)	3·8 (1, 11)	0·25
	n (%)	*n* (%)	*n* (%)	*n* (%)	
Construction					
Formal floor (not dirt)	11/19 (58)	13/18 (72)	15/18 (83)	39/55 (71)	0·26
Running water	13/19 (68)	17/19 (90)	15/18 (83)	45/56 (80)	0·28
Sewage system	2/14 (14)	5/19 (26)	4/18 (22)	11/51 (22)	0·83
Additional wealth indicators					
Television	17/19 (90)	19/19 (100)	17/18 (94)	53/56 (95)	0·53
Fan	15/19 (79)	17/19 (90)	17/19 (90)	49/56 (88)	0·48
Refrigerator	14/19 (74)	18/19 (95)	16/19 (84)	48/56 (86)	0·18
Satellite	13/19 (68)	13/19 (68)	14/18 (78)	40/56 (71)	0·81
Washing machine	8/18 (44)	11/19 (58)	7/18 (39)	26/55 (47)	0·50
Air conditioning	0/19 (0)	0/19 (0)	0/18 (0)	0/56 (0)	–
Perceived social class by participants					
Lower class	13/14 (93)	11/18 (58)	7/12 (58)	31/45 (69)	0·17
Middle class	1/14 (7)	6/18 (32)	4/12 (33)	11/45 (24)	
Upper class	0/14 (0)	2/18 (11)	1/12 (8)	3/45 (7)	
Head of household education					
None	10/19 (53)	7/19 (37)	10/18 (56)	27/56 (48)	0·54
Primary/preparatory school	2/19 (11)	3/19 (16)	4/18 (22)	9/56 (16)	
Advanced studies	7/19 (37)	9/19 (47)	4/18 (22)	29/56 (36)	

Table 2. Poultry-keeping practices

Variables of interest	Household with human H5N1 case	Household with poultry H5N1 case	Household with no reported H5N1 cases	Total	*P*-value
Average total number of birds	34 (6, 89)	34 (4, 140)	48 (4, 275)	39 (4, 275)	0·66
	n (%)	*n* (%)	*n* (%)	*n* (%)	
Types of birds					
Chickens	12 (63)	16 (84)	16 (89)	44 (79)	0·18
Ducks	13 (68)	13 (68)	12 (67)	38 (68)	1·00
Pigeons	11 (58)	9 (47)	9 (50)	28 (50)	0·79
Geese	6 (32)	6 (32)	7 (39)	19 (34)	0·88
Turkeys	0 (0)	1 (5)	1 (6)	2 (4)	0·77
Number of species					
1	6 (32)	2 (11)	4 (22)	12 (22)	0·51
2	6 (32)	10 (53)	6 (33)	22 (39)	
3+	7 (37)	7 (37)	8 (45)	22 (39)	
Keeping of birds					
All birds caged	7 (37)	10 (53)	11 (61)	28 (50)	0·35
At least some birds free	12 (63)	9 (47)	7 (39)	28 (50)	
Mixing of birds					
All species separated	9 (47)	8 (42)	8 (44)	25 (45)	1·00
At least some birds mixed	10 (53)	11 (58)	10 (56)	31 (55)	
Total	19 (100)	19 (100)	18 (100)	56 (100)	

(12%), excreta (12%), and blood (8%) of poultry. Eleven (28%) households had at least one contact that involved a child <2 years of age.

Field workers developed an impression during the field work that general cleanliness of households was better in Lower Egypt than in Upper Egypt. Cleansing of

Table 3. Slaughtering practices

Variables of interest	Household with human H5N1 case	Household with poultry H5N1 case	Household with no reported H5N1 cases	Total	*P*-value
Average number of persons involved in slaughter	1·9 (1, 3)	1·6 (1, 3)	1·5 (1, 2)	1·7 (1, 3)	0·24
	n (%)	*n* (%)	*n* (%)	*n* (%)	
Slaughtering location					
Inside the house	4/18 (22)	7/17 (41)	6/16 (38)	17 (33)	0·33
Outside the house	14/18 (78)	10/17 (59)	10/16 (63)	34 (67)	
Protective measures used					
Washing hands with water but no soap	10/19 (53)	11/19 (58)	10/18 (56)	31 (56)	0·96
Wearing gloves or covering hands with plastic bags	8/19 (42)	6/19 (32)	4/18 (22)	18 (32)	0·52
Wearing mask	9/19 (47)	3/19 (16)	3/18 (17)	15 (27)	0·06
Washing hands with soap	4/19 (21)	3/19 (16)	7/18 (39)	14 (25)	0·29
Dedicated clothing and/or shoes	2/18 (11)	2/19 (11)	2/18 (11)	6 (11)	1·00
No protective measures	4/19 (21)	4/19 (21)	2/18 (11)	10 (18)	0·74

poultry-keeping areas was commonly accomplished by sweeping and/or collecting excreta daily or every two to 3 days. Many households also reported changing hay or rice straw bedding around the breeding area. The use of disinfectants for cleaning was reported only once, in a type B household. Several respondents considered the heat of the sun as an effective natural cleanser that made daily cleaning unnecessary. On several occasions, respondents reported cleaning the poultry-keeping areas outside more frequently than indoor poultry-keeping areas. One household reported cleaning the poultry-keeping area and changing the rice straw every 2 weeks. Although poultry caretakers frequently explained that cleaning was not the job of small children, children were often present in households with unconfined poultry when the floors were being swept.

Slaughtering was most often carried out by one or two household members (Table 3). Although the poultry caretaker was usually responsible for slaughter, occasionally the eldest female member of the household was assisted by the designated poultry caretaker. Men and small children were not directly involved in slaughter, although small children were often observed watching the process in close proximity. Slaughter usually took place either in the front room of the house or in an inside yard, using a similar method in all the households. If only one person was involved in slaughter, he/she held the bird under her feet to cut its throat; if two people were involved, one held the wings while the other held its legs and cut the throat. Usually, chickens were slaughtered on a bare floor, but plastic buckets were sometimes used to reduce blood splatter. In most cases, however, chickens were placed in a bucket or on a plate only after their throats were cut. Chickens were then smothered with the lid of a bucket or a piece of cardboard. In two Upper Egyptian homes, slaughtered chickens were left to wander about until they died. Once dead, chickens were usually taken to the kitchen or another room, where the carcass was immersed in boiling water and then de-feathered. In some households, a pot of boiling water was brought to the slaughtering area for these steps.

Feathers were either discarded in the bucket in which the chicken was transported or thrown into a garbage bin in the same room. Once the carcass was fully de-feathered, it was washed under running water (in households having access to running water) or in a bucket full of water. Generally, the cleaning process was conducted in close proximity to the water source or tap. After cleaning, the chicken was eviscerated and its organs either discarded or kept for future consumption. The bird was then thoroughly washed again, inside and out, with water. In the final stage of cleaning, some households applied vinegar, lemon, or flour to the carcass.

Washing hands with soap at some point during slaughter was conducted in 25% of the households. Gloves or plastic bags to cover the hands were used in 32% of households during the process. In most cases, the slaughterer placed plastic bags over his/her hands while he/she cut the chicken's throat but removed the plastic bags during cleaning and de-feathering. While 47% of those in households that had had a human case of H5N1 (type A households) covered their mouths and noses with a scarf at some point during slaughtering, only 16% of those in type B households and 16% of those in type C households took the same precautions ($P = 0{\cdot}06$). The person who slaughtered usually kept his/her scarf on only while cutting the neck and when pushing the chicken against a lid or the ground to die. In 18% of observed slaughtering, no protective measures were used.

Slaughter waste was usually disposed of in the same way as regular waste: by tying it up in a plastic bag and throwing it into a drainage canal. This means of disposal was widely used among all household types in Upper and Lower Egypt. In most households, slaughter waste was not disposed of immediately, and in many cases, the slaughter area was not cleaned immediately. Only one type B household was observed using disinfectants during the waste-disposal process. Small children were often tasked with disposing of slaughter waste. In two households, children were seen disposing waste in a drainage canal. In one Upper Egyptian household, local custom required that the main poultry caretaker, a woman, stay inside the house when her husband was absent, so children were entirely responsible for waste disposal.

Three type C households, five type B households, and eleven type A households reported burying dead poultry. Dead poultry were usually disposed of in the same manner as slaughter waste. Only one household had access to a modern sanitation system involving regular trash pick-up.

Some respondents explained that people in the village seldom, if ever, reported sick birds to the authorities, citing fear of the actions of government officers. Respondents of type A and type B households also frequently complained that health officials culled not only their poultry following the H5N1 outbreaks, but also that of their neighbors, who blamed them for the financial loss. Some neighbors had severed their relations with type A and type B households following the outbreaks and visits of the authorities. Only one poultry caretaker from Upper Egypt said she did not slaughter sick poultry, although she explained that chickens could be eaten if they showed only minor signs of lethargy and were both boiled and fried before consumption. Poultry caretakers discussed isolating sick poultry and actively keeping children away from sick poultry. Use of protective barriers, however, was seldom mentioned. Respondents also discussed providing sick poultry with antibiotics, although they rarely resorted to the use of veterinary services.

All type A households (100%), most type B households (79%), and some type C households (22%) temporarily stopped breeding poultry or kept their poultry in neighboring households, following H5N1 poultry outbreaks in their villages. Most type A households (42%) began caging poultry at the initiation of an outbreak, while few type B households (15%) and no type C households (0%) made any attempt to change their approach to unconfined poultry raising following an outbreak. Almost half of the respondents said that after the first outbreak, they began raising only geese, ducks, or pigeons. Members of type A and type B households also said they began separating different poultry types. Three respondents from type B households said they had made changes in terms of where they kept poultry. Many respondents said that following the outbreak, they had actively kept children away from poultry.

Poultry caretakers were also reluctant to apply barriers that were seen as strange or alien. ''I use a special outfit, but the others make fun of me,'' said one poultry caretaker in a type A household in Lower Egypt. Interviews also revealed the role played by traditional and often fatalistic world views in respondents' reluctance to apply protective barriers. ''I don't wear a mask or gloves,'' said one poultry caretaker in a type C household in Lower Egypt. ''I leave it to God.''

Less than half of the poultry caretakers believed that the use of barriers only applied when dealing with sick poultry. None of the respondents mentioned asymptomatic nature of H5N1 virus but voiced confidence in knowing when their poultry was sick and would require precautions. ''There's no need for precautions since we only slaughter healthy birds,'' said one member of an Upper Egyptian type A household. One poultry caretaker in type B household in Lower Egypt, meanwhile, asserted ''all my birds are healthy, so protective barriers aren't necessary.''

In many type A and type B households, concerns about H5N1 infection were dominated by fear of potential financial losses from obligatory culling rather than by health risks. Almost half of the respondents believed that people diagnosed with H5N1 were actually infected with seasonal influenza. Many rumors and conspiracy theories were mentioned, suggesting that the government or foreign powers were responsible for the creation and spread of H5N1 to sell more meat or to serve other aspects of globalization and trade. Migratory birds were also occasionally blamed for H5N1 infection. ''If strange birds drink from the same water as our poultry, they may get sick,'' as one respondent put it.

Type A household respondents also frequently expressed disbelief that human infections in their homes had been caused by their poultry. Rather, they believed that household members had been infected by neighbors' birds or those in the marketplace.

Discussion

H5N1 virus poses both epidemiological and socio-cultural challenges in Egypt, as household poultry rearing includes many traditional practices and beliefs that could potentially expose poultry caretakers and family to infection. Many of these risky practices create public health risks and may also contribute to the spread of the virus among poultry. This study documented various traditional practices such as keeping unconfined birds, mixing of different species of poultry, involvement of women and children in poultry rearing, minimal cleaning of poultry-keeping areas,

slaughter and poultry rearing with minimal hand hygiene, environmental pollution arising from poultry waste management including disposal of dead poultry, and reluctance to report sick and dead poultry. Although the role of social, cultural, and economic factors in influenza control in other countries has been noted in several studies,[15–17] studies on the cultural aspects of H5N1 infection in Egypt have focused mainly on changes in the community's knowledge and attitudes toward the virus.[14,18]

This study was initiated to test the hypothesis that cultural practices within the household increased the risk of human H5N1 infections. Previous studies investigating the purported increased risk of H5N1 infection in Egyptian children have pointed to associations with dead and sick poultry and mentioned cultural patterns and customs as a possible reason for an infection; no studies to date have actually systematically explored the practices of children in the households with household poultry in Egypt.[4] Our observations and interviews revealed that children were often in frequent contact with poultry, especially in households with unconfined poultry. Although many poultry-related tasks were not necessary a dedicated task of children, except waste disposal, children were often either observing or assisting the poultry caretaker. We did not observe clear differences in poultry-rearing practices between households with previous human or poultry H5N1 cases and households with no reported H5N1 cases. Our findings do not indicate that households that experienced human and poultry outbreaks had different risk practices before H5N1 outbreaks that put them at higher risk for infection, as all households reported only minor changes after H5N1 infection occurrence.

Household members considered close co-existence and social relations with their poultry more important than recommendations to cage poultry and separate different species of birds. In fact, household members often reported an intimacy with their poultry that resulted in a preference for unconfined poultry when possible. Frequent daily interaction and contact with poultry has also been detected to place people at risk of H5N1 virus transmission in other countries.[19,20] This close relationship of household members with their poultry needs to be considered when developing H5N1 infection prevention messages.

Women were responsible for raising household flocks and were often aided by small children. In households with unconfined poultry, children often fed birds and played in close contact. Although children were not directly involved in slaughter, they often played a role in the removal of slaughter waste, especially in areas where women are customarily confined to the home. Such socio-cultural factors may partly explain the higher exposure rate of women and children to H5N1 infection in Egypt. As highlighted in a USAID avian gender assessment, different gender relations in Upper Egypt and the Nile Delta, particularly in terms of women's mobility, should be taken into account when discussing prevention and control of H5N1 infection.[6]

Slaughter occurred at home or within close proximity to home with little commitment to cleaning the site or rapid disposal of slaughtering waste. Lack of a communal waste management system may partly explain inadequate clean-up and disposal of chicken waste after slaughtering. Inadequate hand washing after slaughter may be related to a need to minimize water consumption. Almost 80% of the households reported not having sewage system but relying on traditional on-site sanitation system locally called *transch*. The more water households consume, the more frequently these pits have to be emptied, at significant cost to the households. Previous studies have identified lack of a sewage system as one of the major barriers for hand hygiene in rural communities in Egypt.[21] Overall, there is a need to improve hygiene-related public awareness messages, which were poorly applied in most households. A recent assessment of household poultry farms in Nigeria similarly highlighted the need to improve hygiene promotion.[11]

Slaughtering and cooking sick poultry was rarely reported, with only one poultry caretaker admitting to doing so. This contrasts with the situation in Indonesia, where it is commonly believed that H5N1 in poultry can be neutralized by cooking the carcass.[16] Sick poultry are seldom entrusted to outsiders, including veterinary authorities. This reluctance to report sick or dead poultry to health officials, despite clear instructions to do so by Egyptian authorities, has also been reported in other countries.[22] The isolation of poultry showing symptoms of illness is in line with government instructions and was one of the most commonly adopted protective measures. However, many poultry caretakers appeared unaware of the asymptomatic nature of certain infections, not realizing that birds might be sick without showing any obvious symptoms. Messages to explain asymptomatic infection are important to consider for subsequent risk communication campaigns.

An important challenge in communicating H5N1 virus prevention messages is the government authorities' ability to gain the trust of the communities. For most households with an H5N1 human or poultry outbreak, the incident disrupted life and negatively impacted food security and social relations with family, neighbors, and the community at large. The relationship between community members and authorities was greatly affected by the way H5N1 outbreaks were handled by the authorities. The relationship between community members and authorities has been diminished by inefficient vaccination campaigns.[13] Community members did not perceive benefits of protecting themselves from H5N1 and did not always believe that H5N1 virus was anything more than seasonal flu. H5N1 infection was seen as a threat that harmed their financial

status and social relations with neighbors and with their community at large. One of the major challenges in the current situation is for the authorities to gain the trust of the communities in order to be able to deliver H5N1 infection–related health messages successfully.

The use of personal protective barriers was not understood or acceptable on the cultural level. It was generally considered unnecessary, with many respondents saying they were embarrassed to use protective barriers in front of neighbors when handling healthy birds. Many Egyptian poultry caretakers questioned the lethal nature, if not the very existence of H5N1 infection, similarly to Indonesian poultry caretakers.[17] The covering of hands during the slaughtering and de-feathering phases, meanwhile, was not considered practical or even possible in many cases. It is also possible that previous mass vaccination campaigns have created false sense of security, decreasing the use of protective barriers and other protective measures as reported by previous studies.[13]

The findings of the present study further suggest that, in order to foster a preventative approach to H5N1 infection and reduce the risk of transmission, messages on desired poultry-rearing practices need to be developed into social norms that are comprehensive within a socio-cultural context. Each message needs to be evaluated in terms of applicability and acceptability within the local context. The process should be carried out through grassroots-level consultations with the poultry keepers.

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