RESPONSES TO AVIAN INFLUENZA EMERGENCY RECOMMENDATIONS BASED ON PERCEIVED RISKS AND RELIABILITY OF INFORMATION SOURCES IN ANHUI PROVINCE, PR CHINA

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Abstract. By the end of March 2013, emergence and rapid spread of a previously unknown variant of influenza A (H7N9) virus prompted public health authorities of China to implement appropriate mitigation and containment measures to protect public health. Data were collected from questionnaires distributed to inhabitants of Anhui Province, China. Individual's responses to infection routes, recommended protective actions and information sources were assessed by factor analysis, inter-rater agreement and multivariate analysis of variance. Major findings were: i) regarding knowledge of possible infection routes, recommended protective actions were considered to have a major impact; ii) rank ordering of exposure paths were identified; and iii) level of inter-rater agreement for hazard-related attributes was greater compared to resource-related attributes, but agreement on the two attributes was greater than behavioral expectations. The results call for a better understanding of public perceptions of exposure paths because it will be of great benefit for public health authorities in developing future control measures of epidemic flu. In addition, it is very essential for local officials to use segmentation strategies to disseminate individualized messages to each subgroup that can be divided based on the assessment on public's perceptions of two attributes of protective actions and three attributes of information sources.

Keywords: avian influenza, protective action, risk perception

INTRODUCTION

By the end of March 2013, emergence and rapid spread of a previously unknown variant of influenza A (H7N9) virus prompted public health authorities of China to implement appropriate mitigation and containment measures with the aim of protecting health of the population at large (Lin *et al*, 2017). For example, municipal authorities of Shanghai ordered closure of live bird markets. Public health authorities also issued individual protective action recommendations (PARs), such as avoiding contact with live animals and cooking food thoroughly but the level

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of compliance with these PARs remains unknown.

This is a potential problem because compliance with public health authorities' PARs can be problematic if there are ambiguities or misconceptions of the public regarding pathways of infection exposure and PARs. Although the relationship between response to warnings and cognitive/affective and social-contextual factors has been clarified (Ripberger *et al*, 2015; Boehmert *et al*, 2016; Brody *et al*, 2017), yet decision processes involved in response to a previously encountered pandemic influenza cannot be assumed to be identical in the context of a recent novel influenza epidemic. Thus, research is needed to identify public response to national health preparedness actions and to determine the range and levels of compliance during the recent influenza H7N9 emergency.

There are a number of peer-reviewed publications on public risk perception and emergency response to diverse type of influenza epidemics (Ibuka *et al*, 2010; Kiviniemi *et al*, 2011). Consumers' risk perceptions and reactions to the epizootic avian influenza (H5N1) in Hanoi, Vietnam were examined based on a quantitative survey of 214 households, revealing 97% of the respondents thought they could get sick through contact with sick animals, 45% by consuming contaminated poultry or eggs and 30% by person-to-person contact (Figuie and Fournier, 2008). Liao *et al* (2009) assessed Guangzhou and Hong Kong respondents' perceptions of risk of illness from H5N1 avian influenza associated with one exposure path, purchase of live chickens. Based on asocial cognitive model of risk perception, Prati *et al* (2011) conducted a widespread telephone survey involving 1,010 Italians to investigate the relationship between pandemic influenza H1N1 risk perception and degree to which public compliance with recommended behavior but did not examine beliefs regarding exposure paths by which such infection could occur. However, unlike most research on behavioral health response to influenza H1N1, Durham *et al* (2012) used a survey data to parameterize a Health Belief Model (HBM) (Becker, 1974) to predict individual protective behavior. Rosoff *et al* (2012) in particularly examined how risk perception, emotion and cognitions factors, and preparedness behavior change over the course of H1N1 epidemic. Based on a grid-group cultural theory of risk perception, Song (2014) explored public's health decision factors in terms of perceived benefits and risk perception in the case of childhood vaccination crisis. From a perspective of heuristic and systematic process, Chen (2015) tested determinants of vaccination behavioral intention when considering incorporation of emotion variables and informational cues.

In addition to these research areas, effective risk communication during a pandemic influenza was also examined (Yang, 2012; Schmidt, 2015). However, few studies looked at public compliance with authority recommendations and reasons for noncompliance (Ripberger *et al*, 2015). For example, Lindell *et al* (2016) took a risk perception perspective to examine antecedents of individuals' compliance with advice on water consumption.

Some studies have examined people's perceptions of different protective actions and their willingness to comply with public health authorities' PARs. For example, Prati *et al* (2011) examined the number of PARs that respondents have implemented (cleaning/disinfecting household surfaces such as door knobs,

washing hands more frequently, using tissues when sneezing, avoiding people with influenza symptoms, developing a family plan for avoiding infection, seeing a doctor about avoiding infection, and seeking more information about infection). Ibuka *et al* (2010) using survey data reported 37.9% of the respondents have high expectation of influenza infection in their community, 25.6% believe it comes from personal exposure, 57.6% express willingness to be vaccinated, and 57.1% are willing to take preventive prophylactic and 83.2% curative antiviral medication.

HBM constitutes a key framework for understanding people's perceptions of exposure paths because two of its core components, namely, perceived susceptibility (likelihood of threat consequences) and perceived severity (seriousness of threat consequences) assess expected personal consequences of failing to take protective actions. Moreover, HBM's other two core components, namely, perceived benefits (perceived effectiveness of protective action in reducing risk) and perceived cost (resources required to implement protective action), address the likelihood of taking protective action (Lindell *et al*, 2016). According to HBM, individuals with higher levels of perceived susceptibility, severity and benefits and with lower levels of perceived cost are more likely to comply with health authorities' PARs.

The Protective Action Decision Model (PADM) is another noteworthy framework for understanding people's perceptions of exposure paths and protective actions (Lindell and Perry, 1992; Lindell and Perry, 2012). PADM is a multistage model that identifies three core perceptions, namely, threat, protective action and stakeholder perceptions, that people use to determine whether they are at risk and how to protect themselves against a hazard. Protective action perception refers to protective actions that a person is aware of, as well as hazard-related and resource-related attributes of those protective actions. Hazard-related attributes are efficacies in protecting persons, property and utility for other purposes, while resource-related attributes are costs and requirements for specialized knowledge/skill, specialized tools/equipment, time/effort, and cooperation from others.

Considering previous research findings and based on HBM and PADM models, we posit hypothesis H1 that respondents' mean ratings of likelihood of being infected will be different among exposure paths, as indicated by significant differences in respondents' mean ratings of their perceived risk of becoming sick through the various exposure paths.

In the context of H7N9 emergency, as the sources of infection and transmission routes are unknown to the public, their responses to recommended protective actions may be identical or hugely different. Thus, the study plans to systematically assess respondents' perceptions of protective actions in terms of hazard-related and resource-related attributes and behavioral expectations. In addition, assessment of the levels of agreement will be used to identify whether respondents' ratings are uniformly distributed. It is obvious the ratings' distributions are reflections of perceptions of protective actions, and, hence, specific attention will be paid to examining which types of costs and requirements for implementing protective actions are correlated, and whether their efficacies in protecting persons and property and utility for other purposes are significantly related. Thus, we posit hypothesis H2a that respondents' mean ratings of hazard-

related and resource-related attributes will be different among protective actions, as indicated by significant differences among the protective actions in respondents' mean ratings on each attribute; and hypothesis H2b that respondents will have higher agreement on resource-related attributes than on hazard-related attributes of protective actions which, in turn, will have higher agreement compared to behavioral expectations.

Stakeholder perceptions play a crucial role in an individual's risk perception and behavioral response (Siegrist and Gutscher, 2006; Cova *et al*, 2017). Preference of trust in information source's experts and authorities influences effective risk communication (Slovic, 1987; Hansen *et al*, 2003; Trumbo and McComas, 2003). In addition to the attribute of information source, people reliance on the channels of information dissemination influences their protective action (Lindell and Perry, 2012). In China, local public health department personnel disseminated health messages on H7N9 to the public through local news media, TV, newspaper, website, and leaflet (Fung *et al*, 2013), but not every information channels affect compliance of the recommended behavior, such as the non-effectiveness of leaflet as reported by Rubin *et al* (2009). With the aim of examining stakeholders' perceptions and influences on protective actions, we posit hypothesis H3a that each of the three attributes (expertise, trustworthiness and protection responsibility) will be different among information sources, as indicated by significant differences among the information sources in respondents' mean ratings of each attribute; and hypothesis H3b that respondents will rely on certain information channels more than others and the order will be community leaflet > local news media > national news media > peer > family.

In summary, the purpose of this study was threefold: firstly, to identify the state of public's risk perception during H7N9 emergency, secondly, to compare differences of people's response to governmental-advised preventive measures based on HBM and PADM, and thirdly, to determine other factors affecting an individual compliance with recommended protective actions. The expected findings should identify the study's theoretical and practical implications, and highlight methodological limitations.

MATERIALS AND METHODS

Methodology

Data were collected from a survey conducted in Anhui Province, China during the 2013 Avian Influenza A (H7N9) outbreak. In Anhui Province there were four cases of human infection, two of whom died. During July 2013, questionnaires were handed to residents in Bozhou, Guangde City, Hefei, Huaibei, Huainan, and Suzhou, Anhui Province. Multivariate analysis of variance (MANOVA) was used to analyze differences among exposure paths and ratings of seven protective actions on six attributes.

Ethical assurance was obtained from the School of Public Affairs, University of Science and Technology of China.

RESULTS

Demographic profile of respondents

After excluding invalid replies to the questionnaires, 762 usable responses were collected. As Table 1 indicates, 37.4% were female and 49.9% were single; the average age is 28.4 (ranging from 18 to 58); more than 70% were with a bachelor

or high degree; over 32.9% had more than RMB80,000 yearly household income; 69 respondents or their family members had a fever or cough since the H7N9 outbreak began.

Exposure paths

Consistent with hypothesis H1 (*that mean ratings of respondents' perception of becoming infected will be different depending on exposure paths*), MANOVA revealed

Table 1
Demographic profiles of respondents in Anhui Province, PR China to questionnaires on 2013 avian influenza virus H7N9 outbreak.

Characteristic		Number	Percent ($n = 762$)
Gender	Male	452	59.3
	Female	285	37.4
	NA	25	3.3
Age (years)	≤18	15	2.0
	19-23	163	21.4
	24-30	358	47.0
	31-40	135	17.7
	41-49	67	8.8
	≥50	8	1.0
	NA	16	2.1
Level of education	High school	28	3.7
	High school graduate	37	4.9
	College/vocational school	126	16.5
	College graduate	339	44.5
	Graduate school	199	26.1
	NA	33	4.3
Annual household income (RMB)	<30,000	130	17.1
	30,000-49,999	179	23.5
	50,000-79,999	171	22.4
	80,000-199,999	99	13.0
	>120,000	152	19.9
	NA	31	4.1
History of fever or cough*	Yes	69	9.1
	No	591	77.5
	NA	102	13.4
Marital status	Married	340	44.6
	Single	380	49.9
	Divorced/widowed	11	1.4
	NA	31	4.1

*Respondent or family members' history of having fever or cough since the H7N9 outbreak began.
NA: data not available; RMB: Chinese Yuan Renminbi (RMB1.00 is approximately USD0.15).

there are significant differences among various exposure paths (Wilks $\Lambda = 0.37$, $F_{10, 747} = 125.87$, p-value <0.001). Sharing a restroom with a patient received the highest hazard rating, implying respondents' low confidence in the hygienic conditions of restrooms, and the lowest was infrequent washing of hands (Fig 1). The range between the highest and lowest rated perception of hazard from exposure routes covered 39% of the scale, which is somewhat narrower than one would have expected. One would expect hazard ratings of touching dead birds or hugging a patient to have higher ratings because both activities involve direct contact with potential carriers of pathogens. In fact, the most noticeable pattern of the results is that hazard perceptions from sharing restroom with a patient, touching dead birds and hugging a patient are significantly higher than those from other six exposure paths ($t_{757} = 22.65$, p-value <0.001), which, in turn, are significantly higher from the last two exposure paths ($t_{756} = 25.04$, p-value <0.001) (Fig 1).

Protective actions

Consistent with hypothesis H2a (*that respondents' mean ratings of hazard-related and resource-related attributes will be different among protective actions*), MANOVA revealed significant differences among the seven protective actions (Wilks $\Lambda = 0.40$, $F_{6, 731} = 184.80$, p-value < 0.001) and seven attributes (Wilks $\Lambda = 0.33$, $F_{6, 731} = 252.43$, p-value <0.001). Respondents gave the highest intention rating to protective action "seeing doctor", followed by "practicing hygiene", then "eating fully cooked food", "learning about avian influenza H7N9 flu", "avoiding touching

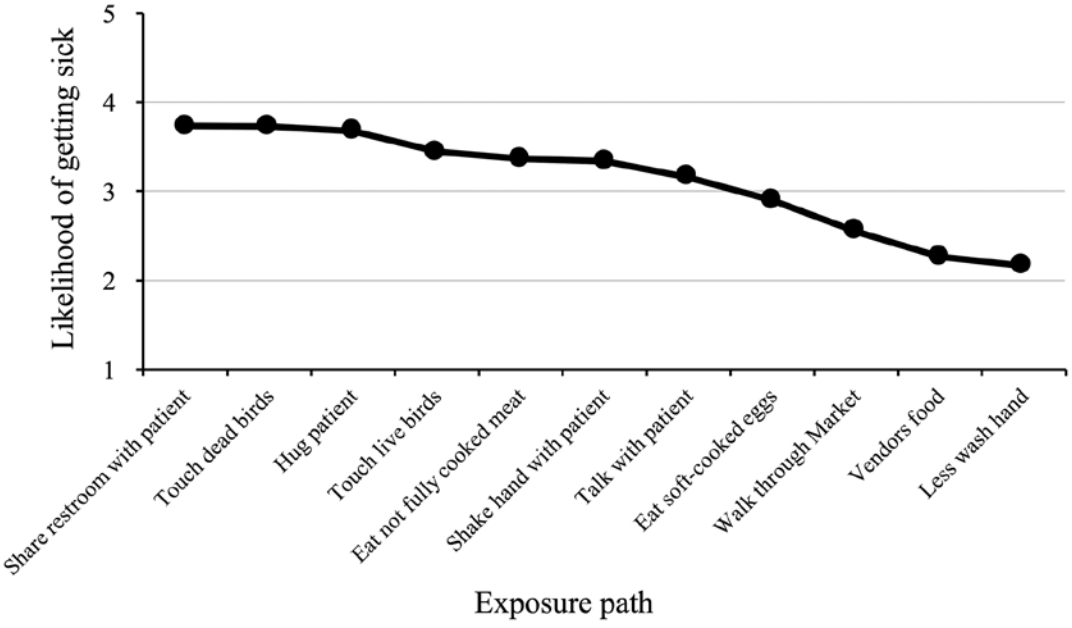

Fig 1-Perceived likelihood of getting sick from different types of exposure to avian influenza virus H7N9 by respondents in Anhui Province, PR China to questionnaires on 2013 avian influenza virus H7N9 outbreak.

1: Least likely; 2: Less likely; 3: Moderate; 4: More likely; 5: Almost certain

animals", "taking medicine", and "reducing outdoor activities" (Fig 2). All protective actions maintained consistent rank order irrespective of mean rating of each of the seven attributes.

Inter-rater agreement (r_{WG}) value, which can range from zero (none of respondents' ratings are uniformly distributed) to 0.58 (each respondents rating is equally likely) of all 49 items (seven protective actions × seven attributes) are significantly different (Table 2). Contrary to hypothesis H2b (*that respondents will have higher agreement on resource-related attributes than on hazard-related attributes of protective actions which, in turn, will have higher agreement compared to behavioral expectations*), the level of inter-rater agreement for the hazard-related attributes was greater that for the resource-related attributes, but, consistent with hypothesis H2b, agreement on resource-related and hazard-related attributes was greater than on behavioral intentions, although the difference was quite small. Agreement on hazard-related attributes was greater than that on all resource-related attributes except that of "reducing outdoor activities". Furthermore, behavioral expectations of "taking medicine" and "reducing outdoor activities" had relatively lower levels of inter-rater agreement. Taken altogether, data supporting hypothesis H2b was weak.

Information sources

Consistent with hypothesis H3a (*that each of the three attributes (expertise,*

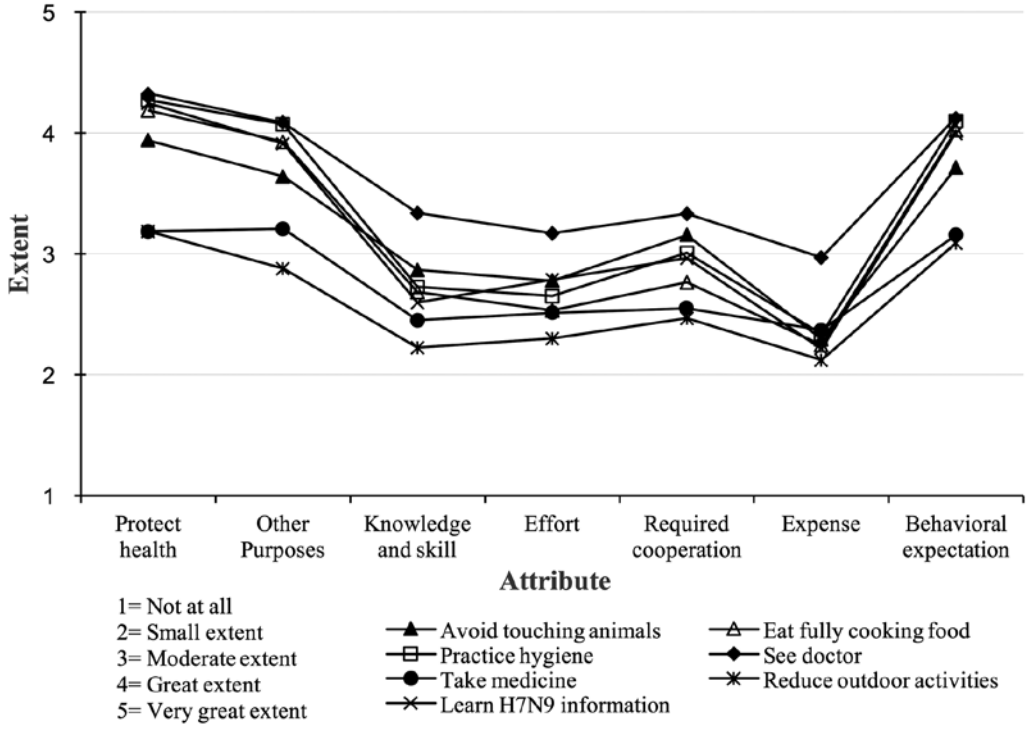

Fig 2-Perception of protective actions against avian influenza virus H7N9 according to attributes by respondents in Anhui Province, PR China to questionnaires on 2013 avian influenza virus H7N9 outbreak.

Table 2
Inter-rater agreement (r_{WG}) towards protective actions and attributes by respondents in Anhui Province, PR China to questionnaires on 2013 avian influenza virus H7N9 outbreak.

Attributes	Protective actions							Mean ratings of each attribute for all protective actions
	Avoid animals	Cook meal well	Practice hygiene	See doctor	Take medicine	Reduce activities	Obtain information	
Protect health	0.45	0.52	0.56	0.58	0.36	0.29	0.55	0.47
Other purposes	0.47	0.50	0.53	0.56	0.39	0.27	0.44	0.45
Knowledge/skill	0.42	0.37	0.37	0.32	0.38	0.47	0.35	0.38
Effort required	0.39	0.41	0.40	0.37	0.37	0.46	0.35	0.39
Cooperation	0.37	0.29	0.27	0.37	0.34	0.37	0.30	0.33
Expense	0.47	0.45	0.40	0.31	0.47	0.51	0.45	0.44
Behavioral expectation	0.36	0.47	0.48	0.49	0.21	0.18	0.49	0.38
Mean ratings of all attributes for each protective action	0.42	0.43	0.43	0.43	0.36	0.37	0.42	0.41

When $r_{WG} > 0.082$ the coefficient is statistically significant at p-value <0.050.

trustworthiness and protection responsibility) will be different among information sources, as indicated by significant differences among information sources in respondents' mean ratings of each attribute), MANOVA revealed significant effects for information sources (Wilks $\Lambda = 0.42$, $F_{8, 736} = 129.12$, p-value <0.001) and attributes (Wilks $\Lambda = 0.86$, $F_{2, 742} = 61.79$, p-value <0.001). Respondents gave high and equal ratings for all three attributes ("expertise", "trustworthiness" and "protection responsibility") to city/state and community doctors, but interestingly accorded higher rating for "protection responsibility" than the other two attributes to national and local health department personnel and local elected official (Fig 3). As regards hypothesis H3b (*that respondents will rely on certain information channels more than others and the order will be community leaflet > local news media > national news media > peer > family*), respondents gave high and equal ratings of the three attributes to local news media, but accorded higher "expertise" rating than the other two attributes to peer, family and social media (Fig 3).

Consistent with hypothesis H3b, post-tests indicated there are statistically significant

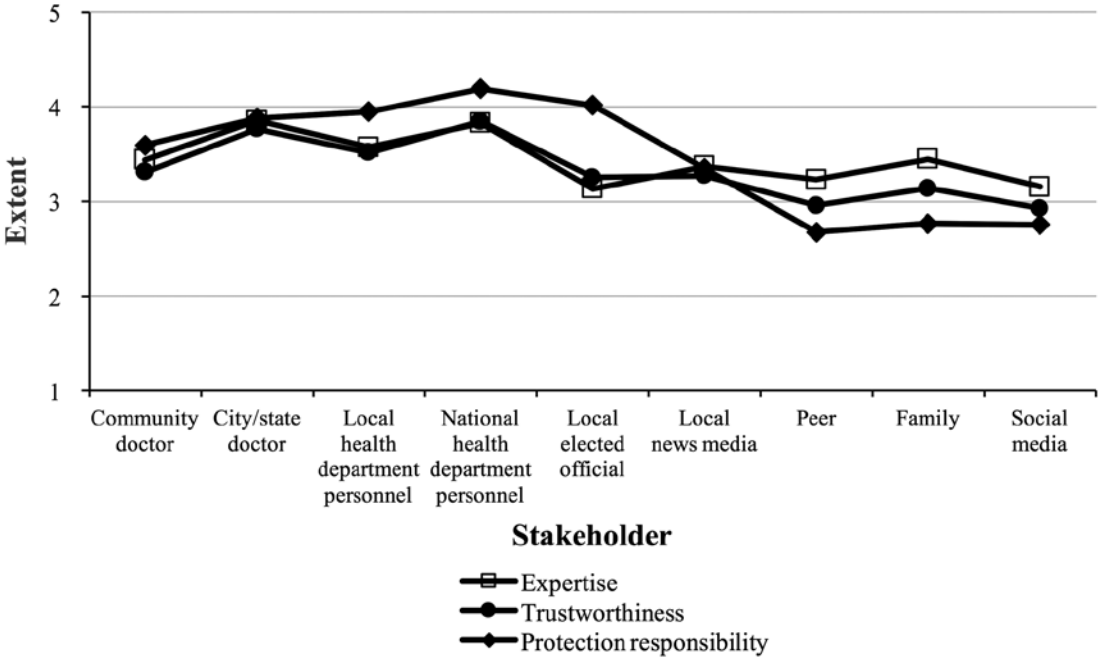

Fig 3-Perception of stakeholders' characteristics by respondents in Anhui Province, PR China to questionnaires on 2013 avian influenza virus H7N9 outbreak.

1: Not at all; 2: Small extent; 3: Moderate extent; 4: Great extent; 5: Very great extent.

differences between the highest and lowest ratings of information sources for each of the three attributes (Table 3). Differences between the lowest and highest rated information sources ranged 18.0-37.8% of the rating scale, indicating these attributes had practical significance in distinguishing among the stakeholders. National health department had the highest rating for two of the attributes and city/state doctor for one; on the other hand local elected official, social media and peer were rated lowest for one of the three attributes.

DISCUSSION

As regards respondentss national health department personnel were the highest rated information st is of interest to note the highest rating was given to sharing a restroom with a possibly infected person, rather than touching potentially infected bird or animal. This might be due to that no reliable information of a person-to-person route of infection. Moreover, accurate and timely awareness of an emerging pandemic influenza was not provided. Thus, insufficient risk information might have contributed to the low level of risk perception from being in contact with an infected individual. These results indicate the need for better understanding of the public perceptions of exposure risks. When people have inadequate decision information, they are prone to rely on their intuitive senses to assess levels of danger (MacGregor *et al*, 1999; Owen *et al*, 1999).

Knowledge of the rating of risk perception of the various infection paths

Table 3
Profile analysis of stakeholders by respondents in Anhui Province, PR China to questionnaires on 2013 avian influenza virus H7N9 outbreak.

Attribute	Low	Mean ratings*	High	Mean ratings*	Difference	% of scale†
Expertise	Local elected official	3.13	City/state doctor	3.85	0.72	18.0
Trustworthiness	Social media	2.93	National health department. personnel	3.84	0.92	23.0
Protection responsibility	Peer	2.68	National health department. personnel	4.19	1.51	37.8

*Mean ratings on the attribute of the information source for all respondents.
†This % of scale equals to the difference value divided by 4 and multiplied by 100 (4 means the maximum difference).

is helpful to public health authorities in formulating future pandemic flu control strategies. Effective public health communication requires authorities to identify the specific exposure paths by which an infection could occur and also correct people's misconceptions about possible exposure paths (Whitney *et al*, 2004). It is recommended that public health authorities should disseminate accurate and convincing warning information to the public in a timely fashion.

Hypothesis H2a was supported by the respondents' replies, in agreement with the study of Arlikatti *et al* (2007) reporting respondents rate authorities as having the highest expertise, followed by news media, then family, and lastly strangers. However, the ratings regarding stakeholders were contrary to the onion theory, which states trust is highest with stakeholders closest to the respondents (*eg* family) and lowest with stakeholders most distant to the respondents (*eg* authorities) (Godschalk *et al*, 1994).

The present study using hazard-related and resource-related attributes to describe protective actions against avian influenza H7N9 flu infection were feasible and meaningful, in keeping with the work of Lindell *et al* (2009) describing resource-related attributes are similar to the required resources used to take protective actions. Ratings of resource-related attributes not only reflect demands for these resources (*eg* time, money and equipment) but also decisions on which precautionary behaviors to take, because people always prefer those having lower costs. May *et al* (2010) observed medical students and residents who do not comply with

vaccination requirement believe they have sufficient time to get a vaccination or that a vaccine would always be available when needed. Hazard-related attributes are the same as perceived benefits that come with protective measures, justifying the types of precautionary measures taken. In addition to these two variables, perceptions of susceptibility and severity (based on HBM) and certainty, severity, immediacy, and duration of adverse outcomes (based on PADM) were critical determinants of protection motivation. Also it is important to point out the magnitudes of differences among the protective actions against avian influenza H7N9 infection were small (25% of the rating scale). This implies health officials will have to make more efforts on refining the precaution guidelines in selecting appropriate protective actions for those with different risks.

Weakness in data supporting hypothesis H2b is of particular interest. It implies an existence of a gap between behavioral intentions and carrying out the intentions, suggesting a need for resources or confidence in taking protective actions. The present study found agreement on hazard-related attributes of reducing outdoor activity was small because most people were not able to take this protective action due to cost to their work. Thus, not all recommended protective actions are suitable for everyone, highlighting the importance in assessing each individual's perceptions of protective action attributes. Local health officials should employ audience segmentation strategies to disseminate messages tailored to each subgroup (Perry and Nelson, 1991). In addition, if there are noncompliance with recommendations, local government officials will need to pay more attentions on identifying the causes of the problem and modify the guidelines in line with users behavior.

Confirmation of hypothesis H3a is important because it shows local health department personnel, provincial or national public health department personnel, and local government elected officials are all considered to be responsible not only for providing public protection measures but also correct and trustworthy information on the avian influenza H7N9 emergency. The three attributes of information source are all determinants of compliance with recommended behavior (Heitz *et al*, 2009; Wachinger, 2013), but there still remains the problem of the lack of credibility of local elected officials, which needs to be resolved.

The findings in the present study on the rating of sources of reliable information are contrary to the research on hurricane warnings by Wu *et al* (2015) who reported respondents rely more on local information than national information sources. However, this might be due to respondents' belief in more accurate and relevant information from national news media. For example, Texas coastal residents depend substantially on official warnings issued by National Hurricane Center when making evacuation decisions (Lindell *et al*, 2013). Surprisingly, in the present study social media received higher ratings than most other information sources, which has not been reported in any previous studies. This result implies respondents in Anhui Province doubted the accuracy of information released by public news media, especial community leaflets, and search supplemental information.

The main limitation of the research was that the reliability of respondents' perceptions of protective actions and

information source were not assessed by longitudinal studies. Future investigation should be conducted confirm the reliability of measuring scale enabling health authorities to be more confident of these results in designing emergency influenza warning programs.

In conclusion, the study demonstrates the central role of hazard-related and resource-related attributes in determining behavioral response to recommendations on avoiding contracting the 2013 avian influenza H7N9 infection, and evaluates its efficiency in protecting public health, providing perceived benefits and utility for other purposes. Time/effort and cooperation from others are also considered as perceived cost, which are rarely tested for their effects on resource requirement. These findings have significant implications in enhancing the effectiveness of risk communication in future pandemic influenza emergencies. Given that people's perception of exposure paths, protective actions and information sources have large impacts, group segmentation strategies aiming at accurately disseminating information are recommended.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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