Factors affecting emergency preparedness competency of public health inspectors: a cross-sectional study in northeastern China

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ABSTRACT

Objectives: To determine the emergency preparedness competency specific to public health inspectors (PHIs), preparedness limitations and needs of the workforce, as well as to identify important factors that affect the preparedness competency of PHIs.

Setting: Cross-sectional survey was conducted in Heilongjiang, a province in northeastern China.

Participants: A questionnaire was administered to a sample of 368 PHIs from 17 public health inspection agencies, chosen by stratified cluster sampling strategy. 9 PHIs and 6 agency’s leaders were invited to participate in an in-depth interview.

Outcome measures: Self-rated preparedness competency in quantitative study was measured. Multivariate logistic regression model was used to test the associations between individual determinants and self-rated preparedness competency. Key themes relating to preparedness competency of PHIs in qualitative study were analysed.

Results: Although 82% of PHIs highly rated their general preparedness competency, there were significant differences among the assessment on specific domains of their competency. Comparing with attitude, the domains of skills and knowledge tend to be lower (p<0.000). Awareness on one’s own responsibilities regarding emergency response work was identified as the most important factor associated with preparedness competency (adjusted OR=6.33, 95% CI 3.30 to 12.16). Lack of explicit national job requirements, overlapping responsibilities and poor collaboration among agencies, together with poor knowledge and skills level of personnel, led to an ambiguity of responsibility, and hindered the preparedness competency enhancement of PHIs furthermore.

Conclusions: Ambiguity responsibility in emergency response is still a prominent issue that hinders the further improvement on the preparedness competency for PHIs in China. Intensified capacity-building activities targeting at individuals’ weakness in specific knowledge and skills are urgently needed; in addition, capacity building at policy and system level as well as agency levels is of equal importance.

INTRODUCTION

Public health inspectors (PHIs), also known as environmental health officers, are technicians committed to administering and enforcing the legislation related to public health security and protection, serving as a backbone of locally driven public health emergency response in China. Public health emergency remains threat and challenge to national and global public health security.

Recently, the frequent outbreaks of environmental health emergencies originated from food safety, such as horsemeat scandals in Europe and food safety scandals in China, have made PHIs become the targets of the public fury and criticism. How to assure PHIs with sufficient competencies that enable them to respond to public health threats timely and properly, which is not only the key concern of China but also key concern of the world.

The development history of PHIs in China experiences distinctive phases. After 1949, China, following the Soviet model, established the agency called epidemic prevention organisation to undertake the function of monitoring and supervising on public health in addition to disease prevention and control. The workforce, mainly majored in preventive
played fully. Especially, the recent outcry of public reasons, their role and functions have not been dis-
acknowledged. The lack of systematic training on legal affairs and other fields means that PHIs are mainly from public health background; due to lack of systematic training on legal affairs and other reasons, their role and functions have not been displayed fully. Especially, the recent outcry of public discontent on the performance of PHIs has pushed the Chinese government and the society to explore various factors that cause the incompetence of PHIs and disabled them from efficient response to public health threats as expected.

Being fully aware of the importance of identifying the underlying predictors for preparedness competency of PHIs, several studies have been conducted to explore its measurement in China, but Chen’s et al research showed that there was still a need to make a further improvement on the specific evaluation tool for PHIs. Based on the core emergency preparedness competencies for public health workers developed by Gebbie and Merrill and the knowledge, skills and attitudes (KSAs) model developed by the Association of Schools of Public Health and CDC of America, this study was to explore emergency preparedness competencies specific to PHIs, determine the level of perceived competency of PHIs in China, to find out preparedness limitations and needs of the workforce as well as to identify important factors that affect the preparedness competency, providing much needed evidence for China to better preparing its PHIs to meet the challenges brought by frequent public health emergencies.

METHODS
This study was a combination of a quantitative face-to-face survey with a qualitative in-depth interview.

Face-to-face survey
The survey was carried out by researchers from Harbin Medical University in Heilongjiang province which is located in northeast China. There exist 13 jurisdictional regions and 153 agencies responsible for HIS. Considering the geographical and jurisdictional diversity, stratified cluster sampling method was adopted. First, we classified 13 jurisdictional regions into three subgroups according to their regional economic development status (per capita gross domestic product, higher than ¥20 000, between ¥10 000 and ¥20 000 and lower than ¥10 000) according to the data from statistics yearbook of Heilongjiang province in 2011. In each subgroup, the other two indicators were also taken into account, which was the number of PHIs per 10 000 population (≥0.75, national average level) and the coverage rate of health surveillance (≥80%, national average level). Finally, three jurisdictional regions including Harbin, Mudanjiang and Yichun were sampled. The entire 48 agencies responsible for HIS within these three regions were queried regarding interest in participating in the survey. After hearing detailed explanation on the objective of this investigation, 17 facilities expressed interest to participate in this survey. The researchers travelled to 17 agencies to conduct the face-to-face survey, and all the PHIs were invited to participate except those on business travel. Each participant was interviewed by interviewer following a structured questionnaire within 20 min. All participants signed written informed consent. In total, 368 individuals completed the questionnaire.

The survey questionnaire was developed by the researchers, involving demographic variables, behavioural variables and cognitive variables. Demographic variables included gender, age, educational level, educational background and working experience: whether or not the PHIs were from epidemic prevention station. Behavioural variables derived from Gebbie and Merrill’s model were administered to participants if (1) they can describe the agency’s emergency response plan, (2) they had ever experienced the public health emergencies, (2) they had ever been trained and (3) they had ever participated in drills in public health emergency-related areas. All the response option was ‘Yes’ or ‘No’. Cognitive variables were self-assessment on general preparedness competency and specific preparedness competency derived from KSAs model. Responses were rated on an ordinal scale (1 = ‘very low’, 2 = ‘low’, 3 = ‘average’, 4 = ‘high’, 5 = ‘very high’). The specific competency measured three dimensions: knowledge (K), skill (S) and attitude (A). K1 for ‘how knowledgeable they were with the condition of the administrative object (‘not at all knowledgeable’ to ‘very knowledgeable’); K2 for ‘how knowledgeable they were with the legal powers associated with public health emergency (‘not at all knowledgeable’ to ‘very knowledgeable’); K3 for ‘how knowledgeable they were about essential medical knowledge and theory (‘not at all knowledgeable’ to ‘very knowledgeable’); S1 for ‘how proficiency they were to document appropriate information relative to the application of the law (‘not at all proficiency’ to ‘very proficiency’); S2 for ‘how proficiency they were to implement investigation and evidence collection (‘not at all proficiency’ to ‘very proficiency’); S3 for ‘how proficiency they were to apply technique of rapid detection on-site (‘not at all proficiency’ to ‘very proficiency’); S4 for ‘how proficiency they were to communicate with emergency response partners (‘not at all proficiency’ to ‘very proficiency’).
proficiency’ to ‘very proficiency’)’ and A for ‘how well they thought to maintain awareness of one’s own active-
ness for job (‘not at all ’ to ‘very well’)

Pilot study with 20 PHIs working in nearby HIS agen-
cies was conducted in October 2012, which focused on
survey length, question clarity and whether respondents
felt the survey to be neutral. Some minor amendments
to wording were made in light of the responses. The
main survey was then conducted from October to
December, 2012.

Survey data were organised and analysed using SPSS
statistical software V.19.0. Initial univariate descriptive sta-
tistics were obtained for the entire study. Pearson χ²
was used to examine demographic factors associated with
self-rated preparedness competency. Those associations
that were found to be significant (p<0.05) were then an-
alysed with multivariate logistic regressions following a
step-wise modelling strategy. The self-rated general com-
petency as dependant variable was dichotomised at the
median. OR and their 95% CIs were estimated to assess
the relationship between the predictors and overall com-
petency. The data of score on specific competency was
analysed by one-way analysis of variance.

In-depth interview
Following the face-to-face survey, an in-depth interview
was conducted onsite. The interviewees were purposively
selected based on their roles and experience in public HIS in 17 agencies. Three senior researchers with exten-
sive experience in qualitative research conducted all
interviews in-person and one-on-one to ensure the feed-
back to be independent and confidential. Meanwhile, the
researchers developed a semistructured interview
protocol to ensure that all relevant topics were covered.
Topics covered were: (1) to list all the important policy,
institutional or other factors that have signifi-
cant influence on the preparedness competency of PHIs, and how to divide them into different categories; (2) how the agencies either facilitated or impeded the preparedness
activities, including interagency cooperation and (3) how
the individual strengthen preparedness competency.

The interview data were categorised and analysed ther-
etically by three researchers independently using tri-
angulation method. The coding framework was
developed inductively from the data. The initial coding
used open coding (codes derived directly from the data)
and theoretical coding. The initial codes were then refined to produce a smaller set of themes and a con-
sensus was reached among researchers.

RESULTS

Face-to-face survey

The distribution of self-assessment on general preparedness
competency

Of the 368 PHIs who participated in the face-to-face
survey (see table 1), 44% and 38% of the respondents
rated ‘very high’ and ‘high’ on their own competency
contrasted with 12.8% on ‘average’, 3.8% on ‘low’ and
1.4% on ‘very low’. Except for gender, there exist signifi-
cant differences in sociodemographic characteristics on
self-rated general competency. Those senior, better edu-
cated, without working experience in epidemic preven-
tion station tended to have a relative higher self-assessment. Also, those respondents who have been
trained, drilled or participated in emergency response activities tended to have clearer description on his/her
own role as well as their agency’s role in public health
response.

The reliability and validity of the structured question-
naires were tested by internal consistency (Cronbach’s
α=0.87) and construct validity (related coefficient fluctuated
between 0.36 and 0.77, p<0.01), which indicated that the
evaluation instrument was of high quality and accredited.

Factors associated with the general preparedness
competency by multivariate model

In multivariate analysis, the dependent variable of
general preparedness competency was dichotomised
according to the respondents’ self-assessment level (those
who rated themselves as good and very good enter in
Table 1; those who rated themselves as average, low
and very low enter in group 2; see table 2). Better knowl-
edge and perception on their job description relating to
public health emergencies response had the strongest
association with increased general preparedness compe-
tency; those who clearly understood their job and role
were 6.33 times (95% CI 3.30 to 12.16) more likely to be
competent than those who were ambiguous on their job
responsibilities. The general competency score of those
in 50–59 age group was 8.42 (95% CI 1.67 to 42.56) times
higher than those in 20–29 age group. Those having
experience of public health emergency-related training
was also associated with their increased competency by
2.22 times (95% CI 1.31 to 3.74).

The multivariate model also showed that the history of
previous working experience had a statistical significance
relating to general preparedness competence of PHIs.
Nearly half of the staff (49.7%) who had undergone the
agency reconstruction from epidemic prevention station
were 0.41 times (95% CI 0.25 to 0.66) less likely to gain
higher competency than their colleagues who were
transferred from other sectors or were newly enrolled.

Specific preparedness competency assessment based on
KSAs model

Significant difference among three dimensions in spe-
cific competency was found to be that ‘attitude, A’ had
the highest average score (3.92±0.66), compared with
‘knowledge, K’ (3.61±0.66) and ‘skills, S’ (3.53±0.80;
p<0.001; see figure 1). The S3 ‘Application of technique
of rapid on-site detection’ (3.11±0.86) and K3 ‘Being
knowledgeable about essential medical knowledge and
theory’ (3.51±0.67) were identified by PHIs as their
weakness in skill and knowledge domain, respectively.
In-depth interview

Of the 15 individuals who participated in the in-depth interview, 9 were PHIs who had taken part in previous face-to-face survey and 6 were agency’s leaders. Half of the PHIs had working experience of epidemic prevention station and all the leaders had engaged in administrative work for more than 10 years. Three themes about preparedness competency of PHIs was categorised according to capacity assessment model developed by the UNDP\(^{18}\) (see figure 2) and a consensus had been reached. The inter-reliability\(^{19}\) was above 90%.

Theme 1: The broader system, which includes the political, economic and physical environment factors, might have an original impact on the abilities of PHIs. In recent years, the Chinese government underwent frequent institution reshuffle on the administrative power over the supervision function on food hygiene, occupational hygiene and radiological protection, resulting in the inconsistent responsibilities among different agencies. Although there are relevant legislation and regulations for PHIs to act on, specific guidelines related to emergency response are still lacking.

Theme 2: In the institutional level, poor collaboration among agencies was found to be the hindrance for preparedness competency enhancement. Owing to the diversity characteristic of public health emergency and lack of special fund for preparedness, there exists overlapping function between health supervision agency and relevant agencies, resulting in the state that multiagencies executed law enforcement out of their own interests.

### Table 1 The distribution of self-assessment on general preparedness competency in this survey

| Variable | N (% of 368) | Very low n (% of 5) | Low n (% of 14) | Average n (% of 47) | High n (% of 140) | Very high n (% of 162) | p Value |
|----------|--------------|---------------------|-----------------|--------------------|-------------------|------------------------|---------|
| Gender   |              |                     |                 |                    |                   |                        |         |
| Female   | 161 (43.8)  | 3 (60.0)            | 8 (57.1)        | 24 (51.1)          | 60 (42.9)         | 66 (40.7)              | 0.522   |
| Male     | 207 (56.2)  | 2 (40.0)            | 6 (42.9)        | 23 (48.9)          | 80 (57.1)         | 96 (59.3)              |         |
| Age      |              |                     |                 |                    |                   |                        |         |
| 20–29    | 23 (6.3)    | 0                   | 1 (7.1)         | 8 (17.0)           | 12 (8.6)          | 2 (1.2)                | 0.014   |
| 30–39    | 125 (34.0)  | 2 (40.0)            | 3 (21.4)        | 20 (42.6)          | 50 (35.7)         | 50 (30.9)              |         |
| 40–49    | 154 (41.8)  | 2 (40.0)            | 6 (42.9)        | 13 (27.7)          | 55 (39.3)         | 78 (48.1)              |         |
| 50–59    | 66 (17.9)   | 1 (20.0)            | 4 (28.6)        | 6 (12.8)           | 23 (16.4)         | 32 (19.8)              |         |
| Education|              |                     |                 |                    |                   |                        |         |
| Senior high school | 57 (15.5) | 0                   | 4 (28.6)        | 11 (23.9)          | 22 (15.7)         | 20 (12.3)              |         |
| Junior college | 142 (38.6) | 2 (40.0)            | 7 (50.0)        | 13 (28.3)          | 68 (48.6)         | 52 (32.1)              | 0.007   |
| University | 168 (45.7) | 3 (60.0)            | 3 (21.4)        | 22 (47.8)          | 50 (35.7)         | 90 (55.6)              |         |
| Public health major | Yes | 188 (51.1) | 2 (40.0) | 6 (42.9) | 19 (40.4) | 65 (46.4) | 96 (59.3) | 0.081 |
| No | 180 (48.9) | 3 (60.0) | 8 (57.1) | 28 (59.6) | 75 (53.6) | 66 (40.7) | | |
| Working experience (from epidemic prevention station) | Yes | 183 (49.7) | 2 (40.0) | 8 (57.1) | 29 (61.7) | 85 (60.7) | 59 (36.4) | 0.000 |
| No | 185 (50.3) | 3 (60.0) | 6 (42.9) | 18 (38.3) | 55 (39.3) | 103 (63.6) | | |
| Emergency-related practices | With the experience in emergency response | Yes | 242 (65.8) | 2 (40.0) | 8 (57.1) | 29 (61.7) | 91 (65.0) | 112 (69.1) | 0.536 |
| No | 126 (34.2) | 3 (60.0) | 6 (42.9) | 18 (38.3) | 49 (35.0) | 50 (30.9) | | |
| Trained in emergency response | Yes | 222 (60.3) | 1 (20.0) | 3 (21.4) | 14 (29.8) | 78 (55.7) | 126 (77.8) | 0.000 |
| No | 146 (39.7) | 4 (80.0) | 11 (78.6) | 33 (70.2) | 62 (44.3) | 36 (22.2) | | |
| Participate in drill in emergency response | Yes | 171 (46.5) | 0 | 0 | 12 (25.5) | 62 (44.3) | 97 (59.9) | 0.000 |
| No | 197 (53.5) | 5 (100.0) | 14 (100.0) | 35 (74.5) | 78 (55.7) | 65 (40.1) | | |
| Perception on emergency response | Identify and locate the agency emergency response plan | Yes | 348 (94.6) | 4 (80.0) | 12 (85.7) | 43 (91.5) | 132 (94.3) | 157 (96.9) | 0.146 |
| No | 20 (5.4) | 1 (20.0) | 2 (14.3) | 4 (8.5) | 8 (5.7) | 5 (3.1) | | |
| Describe the agency’s role in emergency response | Yes | 203 (55.2) | 1 (20.0) | 9 (64.3) | 17 (36.2) | 81 (57.9) | 95 (58.6) | 0.026 |
| No | 165 (44.8) | 4 (80.0) | 5 (35.7) | 30 (63.8) | 59 (42.1) | 67 (41.4) | | |
| Describe one’s own functional role in emergency response | Yes | 259 (70.4) | 1 (20.0) | 4 (28.6) | 13 (27.7) | 93 (66.4) | 148 (91.4) | 0.000 |
| No | 109 (29.6) | 4 (80.0) | 10 (71.4) | 34 (72.3) | 47 (33.6) | 14 (8.6) | | |
were about essential medical knowledge and theory with public health emergency; K3
knowledgeable they were with the legal powers associated with the condition of administrative object; K2
was very competent. K1 for scale was adopted in which 1 was not at all competent and competency of public health inspectors. A five-point Likert

Table 2  Factors associated with general preparedness competency of public health inspectors

| Variables                                                                 | Full model* Coefficient | p Value | Parsimonious model† Coefficient | OR (95% CI) |
|---------------------------------------------------------------------------|--------------------------|---------|---------------------------------|-------------|
| Age group (30–39) vs (20–29)                                             | 1.963                    | 0.016   | 1.940                           | 6.96(1.44 to 33.62) |
| Age group (40–49) vs (20–29)                                             | 2.174                    | 0.007   | 2.070                           | 7.93(1.67 to 37.73) |
| Age group (50–59) vs (20–29)                                             | 2.434                    | 0.004   | 2.131                           | 8.42(1.67 to 42.56) |
| Education (junior college) vs (senior high school)                       | 0.040                    | 0.914   | –                               | –           |
| Education (University) vs (senior high school)                           | 0.702                    | 0.077   | –                               | –           |
| Have working experience of epidemic prevention station vs no experience   | –0.657                   | 0.015   | –0.890                          | 0.41(0.25 to 0.66) |
| Have been trained in emergency response vs none                           | 0.714                    | 0.032   | 0.795                           | 2.22(1.31 to 3.74) |
| Have participated in drill in emergency response vs none                  | 0.058                    | 0.854   | –                               | –           |
| Describe the agency’s role in emergency response vs not sure             | 0.154                    | 0.546   | –                               | –           |
| Describe one’s own functional role in emergency response vs not sure      | 1.881                    | 0.000   | 1.846                           | 6.33(3.30 to 12.16) |

*The model was fit using multivariate logistic regression by stepwise method. Dependant variable was dichotomised self-rated general competency and independent variables included significant variables listed in table 1, such as age, education, working experience, emergency-related practice and perception on emergency response.
†The model included predictor variables that were associated with dependant variable.

In addition, most of the agencies neglected the human resource management, which can detect their staff’s competence deficiency.

Theme 3: At the individual level, half of the PHIs who were transferred from epidemic prevention stations could not adapt well to their changing new jobs. Owing to lack of specific guideline and regular training and drill, many PHIs are confused with the emergency-related operational procedure and how to put relevant skills into practice.

DISCUSSION
This study focused on the preparedness competency of PHIs in China. The results showed that 44% and 38% of the respondents rated ‘very high’ and ‘high’ on their own competency while only 18% rated ordinary or below; due to the subjective nature of self-assessment, there may exist overestimation of their actual overall competency. Therefore, it is necessary to decompose the general competency into specific domains to avoid systematic bias. The results showed that there existing an unsatisfactory performance in knowledge, skills among PHIs compared with their attitude score, the difference has statistical significance, especially in skills domain. As health law enforcement staff, PHIs need comprehensive competency to apply large-scale public health knowledge and skill to facilitate their law enforcement activities.10 Thus, improving being relevant knowledge and skill for PHIs should become a priority in the public health emergencies preparedness.

Further exploration on the factors influencing general preparedness competency of PHIs found that those junior, without better education, tended to be in the ‘poor’ level of self-assessment competency. Also, these respondents have seldom been trained or exercised in related emergency response and they were difficult to describe the agency’s and his/her own role in emergency response. Meanwhile, PHIs who experienced institution reshuffle showed a low-level competency. One possible reason is that they could not be adapted to the changing responsibilities. More than 30% of PHIs who

Figure 1  Self-rated score on specific preparedness competency of public health inspectors. A five-point Likert scale was adopted in which 1 was not at all competent and 5 was very competent. K1 for ‘how knowledgeable they were with the condition of administrative object; K2 ‘how knowledgeable they were with the legal powers associated with public health emergency; K3 ‘how knowledgeable they were about essential medical knowledge and theory; S1 ‘how proficiency they were to document appropriate information relative to the application of the law; S2 ‘how proficiency they were to implement investigation and evidence collection’; S3 ‘how proficiency they were to apply technique of rapid detection on-site’; S4 ‘how proficiency they were to communicate with emergency response partners’; A1 ‘how well they thought to maintain awareness of one’s own activeness for job’.
were transferred from the epidemic prevention station had confusion on their function and role. Most of those staff having public health education background found it difficult to switch to the present job of law enforcement, which not only led to the lower general preparedness competency, but also weak abilities in specific knowledge and skills domains.

Besides the major characteristic factors, awareness on one’s specific function and role in emergency response was identified as the most important factor that have the strongest association with preparedness competency, which is consistent with previous studies. Kristine et al studied proposed that the first step towards emergency preparedness is the identification of who needs to know how to do what. Li et al’s study also found that 91.8% of administrators of health supervision agency in China identified ambiguity of their function and role of PHIs in emergency response was the primary and key issue. However, reasons for the responsibilities ambiguity on PHIs are complex, which were also supported by the qualitative analysis.

The dominant reason might be due to the lack of specific guidelines related to emergency response at national level. Although the Chinese government has legislation and regulations on orientation and development for health supervision agencies, frequent institution reshuffle resulted in the overlapping work scope and ambiguity in job responsibilities among PHIs. At present, the responsibilities of PHIs only derived from National Public Health Emergency Response Plan and Specification of Health Emergency Management for National Health Department, which has not provided the detail job requirements for PHIs to respond to public health emergencies.

Another reason highlighted the poor collaboration between HIS and CDC. Separation from epidemic prevention station failed to achieve the reform goal as expected to improve the administrative law enforcement capacity of health system. According to the new legislation, the responsibilities of health surveillance and supervision were divided between CDC and HIS, respectively. Evidence has proven that only coordinated operation on surveillance and supervision can respond to public health threats more effectively. However, for seeking organisation’s own interests, poor cooperation among different institutions was identified by all leaders interviewed as one of the most important factors that hindered the smooth implementation of their functional role and improvement of preparedness competency. The lowest score in skill of applying technique of rapid on-site detection in this study also partly explained this fact.

In addition, lack of effective human resource management at agency level disabled each organisation from identifying timely the weakness of their staff and to develop tailored training or drill programmes to enhance their overall competency in handling public health emergencies, which also influenced the awareness on responsibilities and competency enhancement of PHIs. Besides, the realities of basic personnel qualifications that were enrolled as PHIs are also not optimistic. The existence of staff who were little educated and lack of specialised training in grassroots also made it hard to adapt to the responsibilities changing. Only through effective and continuous training and drilling programmes the preparedness competency of existing staff can be improved.

There are a number of limitations existed in this study. Since we surveyed only 368 PHIs from 17 agencies in one province, which may not represent the overall situation of this target population, these findings could not be generalised to other geographic areas. Another issue that needs to be noted is that there may exist an overestimation of the PHIs general emergency preparedness competency level due to the adoption of self-assessment evaluation tool by this study. In order to get...
China to better prepare its PHIs to meet the challenges of emergency preparedness competency of PHIs. In conclusion, ambiguity in emergency responsibilities is the most important factor undermining the preparedness competency of PHIs. The findings of this study and cause analysis provided much needed evidence for China to better prepare its PHIs to meet the challenges brought by frequent public health emergencies.

**Contributors** QW, YH and NN designed and planned this study; LG and HS undertook the fieldwork and data collection; NN, ZK and MJ performed statistical analysis and wrote the first draft; QW and NN had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. QW and YH revised the article. NN, ZK and MJ contributed equally to this article.

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