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# Adaptation and evaluation of the Chinese hospital nursing department disaster preparedness scale: a cross-sectional scale development study

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## ABSTRACT

**Aim** The aim of this study was to adapt the Chinese version of Hospital Nursing Department Disaster Preparedness Scale (HNDDPS) and evaluate the psychometric properties among hospital nurses in China. Two specific objectives were (1) to adapt the HNDDPS from Sadiq's Organisational Disaster Preparedness Scale (SODPS) to fit the context of Chinese hospital nursing system and (2) to establish its validity and reliability.

**Design** Instrument design study.

**Settings and participants** 2657 nurses belonging to 50 nursing organisations of tertiary hospitals spread across seven administrative regions of China.

**Methods** We adapted the Chinese version of HNDDPS through translation of the SODPS, back translation and cultural adaptation. Subsequently, we evaluated the validity of the scale through exploratory factor analysis and confirmatory factor analysis (CFA), each performed on half of the original sample. We also evaluated the internal consistency reliability of the scale.

**Results** The Chinese version of HNDDPS comprised five dimensions, with 72 items. Exploratory factor analysis yielded five factors explaining 61% of the items' variance. CFA confirmed five dimensions of the scale and produced appropriate Goodness of Fit Indexes. Cronbach's α-coefficient was 0.930 for the total scale and ranged from 0.908 to 0.964 for the five dimensions of the scale.

**Conclusion** HNDDPS demonstrates good internal consistency and construct validity. It is a promising, valid and reliable tool for nurses and nursing managers to evaluate hospital nursing department disaster preparedness.

## Strengths and limitations of this study

- There has been no scale measuring disaster preparedness from the perspective of hospital nursing department in China so far.
- The principles and processes for adaptation of the Chinese version of Hospital Nursing Department Disaster Preparedness Scale (HNDDPS) included translation, back translation and cultural modification.
- HNDDPS adapted in this study has demonstrated good reliability and validity.
- HNDDPS can serve as a useful tool to evaluate disaster preparedness of hospital nursing departments in China.
- The findings in this study are restricted to those pertaining to nursing departments of Chinese level III hospitals.

## INTRODUCTION

The last 20 years have witnessed several natural disasters worldwide. Climate-related and geophysical disasters have led to the death of 1.3 million people, injuring 4.4 billion people and rendering them homeless or in need for emergent aid. The economic loss for affected countries has been estimated at 29 080 billion dollars.[1] China is one of the countries most frequently affected by natural disasters.[2] With the rapid urbanisation across the country, China has become even more vulnerable to the impact of natural disasters.[3] Hospitals play an important role in each stage of disaster management.[4–6] The WHO and the International Council of Nurses suggest that nurses, who are the core members of the rescue activity in disasters, play an important and unique role in leading, coordinating with and caring for those affected.[7] As the core functional department under hospital administrative structure in Chinese healthcare facilities, the hospital nursing department is crucial for proper disaster management, and effective disaster management of the nursing department is key to deploy appropriate rescue team to deliver safe nursing care for the emergent rescue and quick relief of the disaster survivors under critical conditions.[8]

Most recent investigations of nursing disaster preparedness have focused on the preparedness of individual nurses rather than preparedness of nursing departments as a whole.[9 10] However, through reviewing

the literature, it is interesting to find that if the hospital nursing department is well prepared for disasters, the disaster response time at the hospital level will be effectively shortened and the disaster relief can be improved.[11] In addition, the disaster-related mortality rate and disability rate can be reduced.[5] Hence, it is necessary to learn the disaster preparedness from departmental or organisational perspectives.

To understand the disaster preparedness of hospital nursing departments, searching a relevant measurement tool becomes the initial step. We did an intensive literature search and found that there had been no scales currently available for the assessment of disaster preparedness of nursing departments within hospitals. However, there were several instruments used to guide organisations to better prepare in disasters in literature such as the Hospital Emergency Response Checklist (HERC),[12] Hospital Safety Index (HSI)[13] and Sadiq's Organisational Disaster Preparedness Scale (SODPS).[14]

The HERC was developed by the WHO Regional Office for Europe to assist hospital administrators and managers in responding effectively to the most likely disaster scenarios. It was a widely used checklist assessing nine key components including command and control, communication, safety and security, triage, surge capacity, continuity of essential services, human resources, logistics and supply management and postdisaster recovery.[12] HSI evaluates the safety performance of the hospital from four aspects: hazards affecting the safety of the hospital and the role of the hospital in emergency and disaster management, structural safety, non-structural safety and emergency and disaster management. It is a tool to assess whether the large general hospitals can function normally in emergency or disaster situations.[13 15] Sadiq developed the Organisational Disaster Preparedness Scale in 2006 to assess the levels of preparation in the face of disasters for organisations in Memphis/Shelby County, Tennessee, the USA. They further revised the scale based on large-scale studies in the USA.[14] This scale had dimensions and items not only to assess the level of organisational disaster preparedness but also to analyse key facilitating and hindering factors affecting the organisational disaster preparedness.[14 16–18]

Since the HERC and HSI tended to evaluate the overall status of organisational disaster preparedness whereas SODPS evaluated the organisational disaster preparedness in a more systematic and comprehensive manner,[14] therefore, we selected SODPS as the reference for further development.

As SODPS was formulated neither from the perspective of hospital nursing department nor in the context of Chinese healthcare system, hence, we adapted the Chinese version of hospital nursing department disaster preparedness from SODPS. In addition, we evaluated the psychometric properties of the adapted scale. Hopefully, the information we obtained from the study can provide an effective measurement scale for the assessment of the disaster preparedness of nursing organisation in hospitals in China.

## AIM AND SPECIFIC OBJECTIVE

The aim of this study was to adapt a scale to measure disaster preparedness for hospital nursing department and to evaluate its reliability and validity, so as to offer an effective tool to the assessment of disaster preparedness of nursing organisations in China. The specific objectives were to (1) adapt the Chinese version of Hospital Nursing Department Disaster Preparedness Scale (HNDDPS) and (2) evaluate the psychometric properties including the reliability, the content validity and the construct validity.

## METHOD

### Adaptation of the HNDDPS

In 2018, we sought permission from the Dr Abdul-Akeem Ademola Sadiq, the original author of SODPS, and we formulated the Chinese version of HNDDPS, which was adapted from Sadiq's original work to Chinese through translation, back translation, cross-cultural adaptation and expert consultation.

#### Translation and back translation of the scale

For translation of the scale from English to Chinese, we recruited two translators, one who had a master's degree in nursing and was familiar with both English and Chinese and one who had a master's degree in English. The first draft of the Chinese version of the scale was analysed, compared and discussed by members of the research group who were familiar with both English and Chinese. The results formulated the first Chinese version of Organisational Disaster Preparedness Scale.

In order to further test the quality of the translation, a postgraduate of medical science and a postgraduate of Chinese language from overseas who were familiar with both English and Chinese were invited to independently back translate the first Chinese version of Organisational Disaster Preparedness Scale into the English versions. The two English versions were then analysed by the members of the research group, disaster nursing experts, statisticians and all translators and compared. We invited an English language specialist to help us to compare the two English versions of the scale and find out any misinterpretations during the translation processes. We adjusted several complex sentences such as the second domain 'loss relative to competitor's loss' in Chinese and English. After appropriate modifications, the second Chinese version of Organisational Disaster Preparedness Scale was formulated.

#### Cross-Cultural Adaptations of the Scale

The cross-cultural adaptations were performed mainly in the following aspects:

First, we used 'hospital nursing department' to replace the term 'organisation' in the original scale, and this change was made throughout the scale.

Second, in the domain of 'concerns about disaster events', the disaster events were adjusted based on the data regarding the frequencies of different types of

disasters in China, obtained from the Emergency Events Databases (EM-DAT) for the past two decades.[19]

Third, in the domain 'concerns about the impacts from disaster events on the organisations', modifications were made for subject terms; for example, the word 'employee' was changed to 'nurse', 'customer' to 'patients' and so on.

Fourth, in the domain 'obstacles to organising disaster preparedness', potential obstacles were adapted to fit the status of Chinese healthcare system, particularly the status of current Chinese healthcare organisations and services. Among them, the term 'upper-level management' in the item 'support from upper-level management within your organisation' was split into two items, 'upper-level hospital management' and 'upper-level nursing management', and the item 'lack of convincing information about the potential impact of disaster events' was revised to 'lack of accurate information about consequences of disasters'.

Fifth, for the 'organisational disaster preparedness' domain, we made modifications based on Han's study in literature.[20 21] In his study, he measured the disaster preparedness by 'disaster preparedness activities' and 'the owners/decision makers' risk perceptions'. Hence, we adapted this domain into two subdomains: 'specific actions were taken by the hospital nursing departments' and 'staff's perceptions of hospital nursing department's disaster management'. These modifications resulted in the Chinese version of the HNDDPS.

### Initial assessment of the Chinese version of HNDDPS

Validity of a research instrument reflects the instrument measures and what it is desired to measure. Validity is generally determined by the content validity, criterion-related validity or structural validity.[22] To ensure the validity of the contents of the scale, six individuals who were experts in disaster medicine, disaster rescue medicine, disaster nursing and risk and contingency management were invited through email to make comments and suggestions about the scale and to score each item according to its relevance to the scale. The scoring method was as follows: 1=not relevant, 2=somewhat relevant, 3=relevant and 4=highly relevant.

The Item-Level Content Validity Index (I-CVI) and the Scale-Level Content Validity Index (S-CVI) were calculated to determine the content validity of the scale. The I-CVI was calculated by dividing the number of experts involved with a score of 3 (general relevant) or 4 (very relevant) by the total number of experts.[22] Three methods have been reported to determine the S-CVI of the total scale.[23] This study used the average of the I-CVI for all entries to determine the S-CVI.

### Formulation of the Chinese version of HNDDPS

The final Chinese version of HNDDPS was formulated based on the suggestions and opinions of the expert panel. The following revisions were made: for the dimension 2 'concerns about the impacts from disaster events on the hospital nursing departments', the expert suggested revising item 2.2 'disasters prevent effective communication among nurses' into 'disasters lead to poor communication in nursing departments'. Similarly, for the dimension 3 'obstacles to organising disaster preparedness', the experts suggested that the item 3.7 'the help of nursing departments for emergency preparedness is not clear' be revised to 'the benefits of nursing departments for emergency preparedness are not clear'.

The final Chinese version of the HNDDPS comprised 72 items. The specific scoring scheme for each dimension was shown in table 1.

## Patient and public involvement

There was no patient or public involvement in this study.

## Participants

Between 25 October 2018 and 6 January 2019, we selected the hospital by stratified convenience sampling. First, 50 level III hospitals were selected from seven administrative regions of China by a convenience sampling. (In China, level III hospitals are normally national-level or provincial-level hospitals, which are larger with better

**Table 1** The scoring scheme for each dimension of the Hospital Nursing Department Disaster Preparedness Scale

| Entries | Amount | Scoring scheme |
|---|---|---|
| Dimension 1: concerns about disaster events | 15 | Evaluate between 0 and 100 |
| Dimension 2: concerns about the impacts from disaster events on the hospital nursing departments | 13 | Score with 5-point Likert Scale: 1–5 are very unimportant, less important, general, more important and very important |
| Dimension 3: obstacles to organising disaster preparedness | 10 | Score with 5-point Likert Scale: 1–5 are very unimportant, less important, general, more important and very important |
| Dimension 4: disaster preparedness of hospital nursing departments (action) | 20 | 0=yes, 1=no |
| Dimension 5: disaster preparedness of hospital nursing departments (perception) | 14 | Score with 5-point Likert Scale: 1–5 are completely disagree, disagree, unclear, agree and agree completely |
| Total entry | 72 | |

Table 2 General information of nurse (N=2657)

| Items | Maximum | Minimum | Median | Mean±SD |
|---|---|---|---|---|
| Age | 62 | 18 | 30 | 31.48±6.647 |
| Age limit of nurse | 40 | 1 | 8 | 9.55±7.200 |
| Age limit of nurse management | 33 | 1 | 6 | 7.89±6.560 |
| | | | Frequency | % |
| Gender | Man | | 252 | 9.50 |
| | Woman | | 2405 | 90.50 |
| Education | Technical secondary school | | 21 | 0.80 |
| Background | Junior college | | 547 | 20.60 |
| | Undergraduate | | 1940 | 73 |
| | Master | | 149 | 5.60 |
| Job title | Primary nurse | | 589 | 22.20 |
| | Nurse practitioner | | 1186 | 44.60 |
| | Nurse in charge | | 726 | 27.30 |
| | Associate professor of nursing | | 156 | 5.90 |
| Section office | Emergency room | | 378 | 14.20 |
| | Intensive care unit | | 446 | 16.80 |
| | Others | | 1833 | 69 |
| Nursing station | Nurse | | 2263 | 85.17 |
| | Nurse management | | 394 | 14.80 |
| Nursing management station | Nurse manager/assistant nurse manager | | 314 | 79.70 |
| | Office nurse manager/assistant nurse manager | | 47 | 11.93 |
| | Director of nursing/assistant director of nursing | | 33 | 8.38 |
| Self disaster experience | No | | 1670 | 62.90 |
| | Yes | | 987 | 37.10 |
| Disaster experience in hospital | No | | 2178 | 82 |
| | Yes | | 417 | 18 |
| Medical rescue experience in disaster | No | | 2400 | 90.30 |
| | Yes | | 257 | 9.70 |
| Disaster-related training | No | | 1275 | 48 |
| | Yes | | 1382 | 52 |
| Total duration of training | Less than a week | | 768 | 55.57 |
| | Between a week and a month | | 300 | 21.71 |
| | Between a month and half a year | | 132 | 9.55 |
| | More than half a year | | 182 | 13.17 |
| Training form | Speech | | 1240 | 46.70 |
| | Seminar | | 219 | 8.20 |
| | Continuing education course | | 513 | 19.30 |
| | Online courses | | 287 | 10.80 |
| | Others | | 19 | 9.74 |
| Flexible nurse | No | | 2168 | 81.60 |
| | Yes | | 489 | 18.40 |

quality than level II, and level II hospitals are larger and better than level I. Each level will be further divided into grade A and grade B. Grade A is better than Grade B. Level III hospitals assume greater responsibilities for disaster management.) Then, the purpose sampling method was used to select the nurses (including nursing managers and general registered nurses (RNs)) from 50 nursing organisations of the level III hospitals.

Table 3 General information of the hospital where the nursing department is located

| Items | Maximum | Minimum | Median | Means±SD |
|---|---|---|---|---|
| Establishment time of the hospital | 152 | 3 | 67.50 | 65.04 |
| Number of bed | 6300 | 283 | 1872.96 | 1872.96 |
| | | Frequency | | % |
| Hospital level | Tertiary grade A | 45 | | 90 |
| | Tertiary grade B | 5 | | 10 |
| Teaching hospital | No | 4 | | 8 |
| | Yes | 46 | | 92 |
| Hospital affiliation | Public hospital | 49 | | 98 |
| | Private hospital | 1 | | 2 |
| Classification of hospital | General hospital | 41 | | 82 |
| | Specialised hospital | 9 | | 18 |
| Disaster budget in hospital level | No | 26 | | 52 |
| | Yes | 24 | | 48 |
| Disaster budget of nursing department | No | 42 | | 84 |
| | Yes | 8 | | 16 |
| Emergency manager | No | 4 | | 8 |
| | Yes | 46 | | 92 |
| Emergency manager working model | Full time | 6 | | 13.04 |
| | Part time | 40 | | 86.96 |
| Emergency management office | No | 16 | | 32 |
| | Yes | 34 | | 68 |
| Emergency management office operation mode | Independent | 11 | | 32.35 |
| | Dependent | 23 | | 67.65 |
| Flexible nurse team | No | 7 | | 86 |
| | Yes | 43 | | 14 |

The participants in this study included nursing managers and front-line RNs. Nursing managers included directors of nursing departments and head nurses. Nurses from the emergency department and the intensive care unit of the above 50 hospitals were all invited to participate. Participants' eligibility criteria in this study were as follows: nursing managers in nursing departments of level III hospitals, RNs with at least 1-year working experience in the selected hospital and voluntary participation. The exclusion criteria included the following: (1) level III hospitals without emergency department and (2) nurses who were on maternity leave or sick leave, were studying abroad and were in the internship period or probation period and postrotation period during the investigation.

We distributed 2862 questionnaires for nurses and nursing managers in above 50 hospitals, 2657 questionnaires were valid, resulting in 98.45% valid response rate.

Table 4 Internal consistency of the Hospital Nursing Department Disaster Preparedness Scale

| Entries | Amount | Internal consistency (Cronbach's α-coefficient) |
|---|---|---|
| Dimension 1: concerns about disaster events | 15 | 0.945 |
| Dimension 2: concerns about the impacts from disaster events on the hospital nursing departments | 13 | 0.940 |
| Dimension 3:obstacles to organising disaster preparedness | 10 | 0.964 |
| Dimension 4: disaster preparedness of hospital nursing departments (action) | 20 | 0.923 |
| Dimension 5: disaster preparedness of hospital nursing departments (perception) | 14 | 0.978 |
| Total entry | 72 | 0.930 |

Table 5 Principal component analysis result

| | Initial eigenvalue | | | Square sum load of each factor after rotation | | |
|---|---|---|---|---|---|---|
| Factors | Eigenvalues | Variance contribution rate (%) | Cumulative variance contribution rate (%) | Eigenvalues | Variance contribution rate (%) | Cumulative variance contribution rate (%) |
| 1 | 15.067 | 20.927 | 20.927 | 10.918 | 15.164 | 15.164 |
| 2 | 8.795 | 12.215 | 33.142 | 8.794 | 12.214 | 27.378 |
| 3 | 8.287 | 11.509 | 44.651 | 8.649 | 12.012 | 39.390 |
| 4 | 6.005 | 8.340 | 52.991 | 8.050 | 11.181 | 50.571 |
| 5 | 5.861 | 8.141 | 61.132 | 7.604 | 10.561 | 61.132 |

### Instruments and data collection

We applied the above-mentioned HNDDPS plus a self-made General Information Questionnaire (GIQ) to collect data in this study. The GIQ contained two levels of information: information related to hospital nursing department as well as the information related to individual nurse. It included the type, size, manpower, disaster experience and emergency management mode about the hospital, as well as the nurses' gender, age, education, disaster training experience, disaster rescue experience and nursing management experience.

We used the Chinese Survey Monkey (Wen Juan Xing) to collect data. Team members were trained in regard to the explanations of every single item of the instruments before the actual data collection.

We recruited a volunteer as our liaison to the nursing department at each of the participating hospitals. All the liaison nurses were trained to collect data regarding hospital and nursing department such as hospital types (general vs specialised hospital; public vs private hospital), hospital size (no. of hospital beds), hospital manpower information and disaster experience. The members of the research group issued online questionnaires. The questionnaire was distributed to all the volunteers, and the research team members regularly monitored the process and maintained close contact with the liaison nurses to optimise the return rate and ensure the quality of the returned questionnaires.

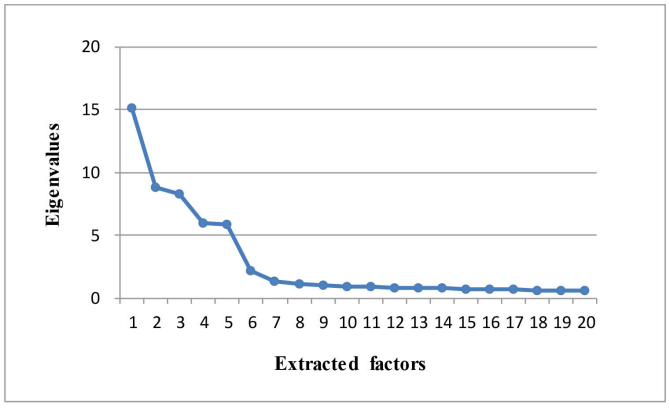


Figure 1 Scree plot for exploratory factor analysis of the Hospital Nursing Department Disaster Preparedness Scale.

### Data analysis

All statistical analyses in this study were performed using SPSS V.20 and AMOS V.24 statistical software. Descriptive statistics for all variables including demographic information were provided. Means and SDs were used to describe continuous variables, medians, IQRs or percentage and categorical variables. The internal consistency test, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed to test the reliability and validity of the instrument.

### Ethical considerations

Before the start of the investigation, all nurses and hospitals participating in the study were informed about the purpose and nature of the study. Each nurse filled in an informed consent form before completing the questionnaire.

The participants were instructed to refrain from disclosing their identity and discussing the data with anyone other than the research team members. They were also reminded that the collected data were not to be used for any purposes other than this research.

## RESULTS

### Descriptive statistics of general information

General information of the nurse and the hospital where the nursing department is located are shown in tables 2 and 3.

### Reliability

Since the majority of items in this scale were rated with a 5-point Likert Scale, ranging from strongly disagree to strongly agree, a few items were binary (yes vs no); therefore, the standardised α-coefficient was used as the reliability index value.[24] Cronbach's α-coefficient for the overall scale was 0.930, while Cronbach's α-coefficient for five dimensions was calculated as 0.908–0.964 (see table 4 for details).

### Content validity

The I-CVI of each entry was determined to be 0.83–1, and the I-CVI for each dimension was 0.95–1; the S-CVI of the HNDDPS reached 0.96.

**Table 6** The component matrix after rotation

| Numbers of entries | Factors 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| A1 | 0.041 | 0.102 | 0.711 | 0.026 | 0.005 |
| A2 | 0.047 | 0.167 | 0.758 | 0.061 | −0.045 |
| A3 | 0.068 | 0.124 | 0.658 | 0.069 | −0.099 |
| A4 | 0.013 | 0.106 | 0.732 | 0.034 | −0.015 |
| A5 | 0.040 | 0.083 | 0.788 | −0.010 | −0.005 |
| A6 | 0.047 | 0.093 | 0.762 | 0.027 | −0.030 |
| A7 | 0.062 | 0.135 | 0.761 | 0.013 | −0.021 |
| A8 | 0.076 | 0.159 | 0.527 | 0.123 | −0.129 |
| A9 | 0.066 | 0.143 | 0.728 | 0.061 | −0.041 |
| A10 | 0.054 | 0.073 | 0.790 | 0.006 | −0.012 |
| A11 | 0.051 | 0.068 | 0.803 | −0.021 | 0.034 |
| A12 | 0.041 | 0.067 | 0.803 | 0.015 | 0.007 |
| A13 | 0.078 | 0.137 | 0.704 | 0.041 | −0.043 |
| A14 | 0.083 | 0.138 | 0.760 | 0.061 | −0.053 |
| A15 | 0.079 | 0.192 | 0.702 | 0.094 | −0.079 |
| B1 | 0.088 | 0.109 | 0.149 | 0.410 | 0.136 |
| B2 | 0.061 | 0.081 | 0.132 | 0.557 | 0.078 |
| B3 | 0.118 | 0.012 | 0.032 | 0.721 | 0.004 |
| B4 | 0.056 | 0.005 | 0.050 | 0.628 | 0.154 |
| B5 | 0.018 | 0.034 | 0.038 | 0.771 | 0.136 |
| B6 | 0.043 | 0.044 | 0.062 | 0.748 | 0.085 |
| B7 | 0.069 | 0.039 | 0.024 | 0.837 | 0.038 |
| B8 | 0.092 | 0.030 | 0.011 | 0.854 | 0.028 |
| B9 | 0.084 | 0.044 | 0.024 | 0.879 | 0.018 |
| B10 | 0.073 | 0.067 | 0.041 | 0.831 | 0.003 |
| B11 | 0.088 | 0.061 | −0.009 | 0.863 | 0.003 |
| B12 | 0.075 | 0.049 | −0.017 | 0.864 | 0.008 |
| B13 | 0.081 | 0.067 | −0.014 | 0.847 | 0.029 |
| C1 | −0.014 | 0.036 | 0.040 | 0.227 | 0.426 |
| C2 | −0.066 | −0.049 | −0.049 | 0.058 | 0.908 |
| C3 | −0.064 | −0.036 | −0.072 | 0.046 | 0.925 |
| C4 | −0.077 | −0.052 | −0.058 | 0.027 | 0.935 |
| C5 | −0.092 | −0.070 | −0.047 | 0.031 | 0.938 |
| C6 | −0.083 | −0.074 | −0.049 | 0.025 | 0.933 |
| C7 | −0.078 | −0.062 | −0.054 | 0.035 | 0.929 |
| C8 | −0.054 | −0.076 | −0.088 | 0.106 | 0.842 |
| C9 | −0.050 | −0.049 | −0.075 | 0.140 | 0.795 |
| C10 | −0.077 | −0.031 | −0.066 | 0.075 | 0.822 |
| D1 | 0.104 | 0.631 | 0.066 | 0.053 | −0.115 |
| D2 | 0.060 | 0.618 | 0.159 | −0.048 | −0.046 |
| D3 | 0.138 | 0.654 | 0.033 | 0.085 | −0.099 |
| D4 | 0.069 | 0.675 | −0.017 | 0.122 | −0.059 |
| D5 | 0.100 | 0.682 | 0.133 | 0.039 | −0.039 |
| D6 | 0.090 | 0.670 | 0.153 | 0.037 | −0.044 |
| D7 | 0.076 | 0.679 | −0.006 | 0.148 | −0.060 |
| D8 | 0.080 | 0.629 | 0.159 | 0.036 | 0.020 |
| D9 | 0.022 | 0.433 | 0.200 | −0.114 | 0.128 |
| D10 | 0.074 | 0.575 | 0.174 | 0.027 | −0.040 |
| D11 | 0.060 | 0.647 | −0.017 | 0.163 | −0.053 |
| D12 | 0.056 | 0.686 | −0.021 | 0.125 | −0.066 |
| D13 | 0.071 | 0.660 | 0.006 | 0.106 | −0.033 |
| D14 | 0.056 | 0.689 | 0.030 | 0.124 | −0.053 |
| D15 | 0.024 | 0.700 | 0.021 | 0.093 | −0.032 |
| D16 | 0.075 | 0.604 | 0.176 | −0.012 | 0.026 |
| D17 | 0.062 | 0.618 | 0.186 | −0.082 | 0.055 |
| D18 | 0.059 | 0.645 | 0.217 | −0.081 | 0.027 |
| D19 | 0.059 | 0.678 | 0.212 | −0.038 | 0.021 |
| D20 | 0.082 | 0.664 | 0.199 | −0.076 | 0.010 |
| E1 | 0.862 | 0.071 | 0.061 | 0.090 | −0.073 |
| E2 | 0.884 | 0.032 | 0.022 | 0.108 | −0.067 |
| E3 | 0.888 | 0.051 | 0.030 | 0.109 | −0.066 |
| E4 | 0.893 | 0.060 | 0.047 | 0.076 | −0.074 |
| E5 | 0.892 | 0.104 | 0.070 | 0.059 | −0.052 |
| E6 | 0.786 | 0.117 | 0.096 | 0.041 | −0.022 |
| E7 | 0.866 | 0.154 | 0.116 | 0.029 | −0.055 |
| E8 | 0.842 | 0.121 | 0.058 | 0.065 | −0.046 |
| E9 | 0.859 | 0.163 | 0.118 | 0.046 | −0.031 |
| E10 | 0.906 | 0.145 | 0.076 | 0.088 | −0.068 |
| E11 | 0.893 | 0.151 | 0.078 | 0.102 | −0.063 |
| E12 | 0.893 | 0.137 | 0.091 | 0.096 | −0.069 |
| E13 | 0.834 | 0.068 | 0.033 | 0.105 | −0.006 |
| E14 | 0.893 | 0.123 | 0.058 | 0.087 | −0.053 |

## Construct validity

### Exploratory factor analysis (EFA)

The suitability of the factor analysis for the data was tested, and the Kaiser-Meyer-Olkin (KMO) test value was determined to be 0.949. Additionally, Bartlett's spherical approximation $\chi^2$ value was 90 922.34 (df=2556), with p<0. This suggested that the data were suitable for EFA. Half of the 2657 participants, that is, 1320 participants, were randomly selected, and their data were used for EFA.

Principal component analysis with varimax rotation was performed, and five principal factors were limited to extract; the eigenvalues of the five common factors were 10.9, 8.8, 8.6, 8.05 and 7.6. The rate of cumulative variance contribution was calculated to be 61.1% (see table 5). The gravel map test is shown in figure 1. And the factor loading of each entry was ≥0.4 (see table 6). Thus, the results of factor analysis and the scale and the five factors extracted were found to be consistent with the five dimensions of the preset scale (see table 7).

Table 7 Comparison table of extraction factors and scales

| Factor | Factor load | Contribution rate (%) | Corresponding scale dimension | Entry |
|---|---|---|---|---|
| Factor 1 | 0.433–0.700 | 15.164 | Disaster preparedness (perception) | 14 |
| Factor 2 | 0.506–0.816 | 12.214 | Disaster preparedness (action) | 20 |
| Factor 3 | 0.527–0.803 | 12.012 | Concerns about disaster events | 15 |
| Factor 4 | 0.410–0.864 | 11.181 | Concerns about the impacts from disaster events on the hospital nursing departments | 13 |
| Factor 5 | 0.426–0.938 | 10.561 | Obstacles to organising disaster preparedness | 10 |

### Confirmatory factor analysis

Taking into consideration the results of EFA, the remaining half of the data (1337 cases) was used for CFA. The purpose of CFA was to adapt a model based on the existing theory and verify the model based on the measurement results in order to obtain more realistic results. The maximum likelihood method was used to calculate each parameter. The results were as follows: $\chi^2$/df ratio (<2) was 1.782; approximate error root mean square was <0.05; Goodness of Fit Index (GFI) and absolute GFI were >0.90; Normalised Fitting Index, Value-Added Fitting Index, Tucker-Lewis Index and relative GFI were >0.95; and reduced GFI, streamlined normalised GFI and streamlined relative GFI were >0.50; thus, all parameters met the basic criteria of the model. The fit indexes are shown in table 8. Thus, CFA further validated the results of EFA, indicating that the HNDDPS factor model fits well.

## DISCUSSION

### Adaptation of the Chinese version of HNDDPS

In this study, the scientific approaches were employed to formulate the Chinese version of HNDDPS. First, translation and back translation were performed with bilingual language experts to ensure the meanings of each item of the original scale are maintained. Second, cross-cultural adaptations were also performed to make the scale items fit into Chinese culture, Chinese healthcare system and Chinese nursing departments. The major differences between the original and the Chinese version of HNDDPS were on the original dimension of 'organisations engaged in an disaster related activities'. It was split into two subdimensions: 'specific disaster management actions were taken by the nursing departments' and 'staff's perception of nursing department's disaster management.' For the remaining domains, the wordings were adapted to ensure that the scale was in line with Chinese reading habits as well as Chinese healthcare system conditions. Unlike the other scales that have been put forth for the measurement of an organisation's disaster preparedness,[12 25] HNDDPS investigates not only the level of disaster preparedness but also the factors affecting the disaster preparedness of the nursing departments. HNDDPS is a multidimensional scale that covers several dimensions, such as concerns about disaster events, concerns about the impacts from disaster events on the hospital nursing departments, obstacles to organising disaster preparedness and disaster preparedness of hospital nursing departments (action and perception).

### The validity of HNDDPS

In this study, we evaluated content validity in addition to structural validity of the scale. Determining the content validity allows the most fundamental assessment of validity of the scale. A scale is considered to have good content validity if the values of I-CVI and S-CVI/Ave reach ≥0.78 and≥0.90, respectively.[22 26 27] In this study, content validity was evaluated by experts in disaster medicine, disaster nursing, disaster medical rescue, risk emergency

Table 8 Fit indexes for confirmatory factor analysis

| Fitting indexes | Numbers | Compliance with good fit reference standards[28] |
|---|---|---|
| $\chi^2$/df | 1.782 | $1<\chi^2<2$ |
| Approximate error root mean square | 0.024 | <0.08 indicates good fit; <0.05 indicates excellent fit |
| Absolute Goodness of Fit Index (GFI) | 0.919 | >0.90 |
| Adjusted GFI | 0.905 | >0.90 |
| Reduced GFI | 0.783 | >0.50 |
| Normalised Fitting Index | 0.959 | >0.90 indicates good fit; >0.95 indicates excellent fit |
| Value-Added Fitting Index | 0.982 | >0.90 indicates good fit; >0.95 indicates excellent fit |
| Tucker-Lewis Index | 0.979 | >0.90 indicates good fit; >0.95 indicates excellent fit |
| Relative GFI | 0.982 | >0.90 indicates good fit; >0.95 indicates excellent fit |
| Streamlined normalised GFI | 0.840 | >0.50 |
| Streamlined relative GFI | 0.860 | >0.50 |

management and statistics. The content validity score reached 0.96, which indicates that the content validity of HNDDPS is good.

In terms of construct validity, we identified five common factors by EFA and found that the cumulative variance contribution rate was 61.132%; this percentage is higher than the required ≥40% for good instrument validity.[22] Studies have shown that a scale has good structural validity if the following conditions are met: (1) the factor is consistent with the scale structure, as hypothesised, and (2) each entry has a factor loading higher than that of the corresponding common factor (>0.4) while that of other factors is lower. CFA revealed that the observation index fits well with the five-factor theoretical model considered in this study. Thus, it can be inferred that the five factors represent the overall structure of the scale, which is consistent with the dimensional structure of the original scale; this confirms the good structural validity of the scale.

### The reliability of HNDDPS

Reliability of a research instrument is defined as the degree of consistency and accuracy of its results. The main aspects of reliability are stability, internal consistency and equivalence.[22] The choice of the appropriate features that will reflect the reliability of the research tool depends on the nature of the scale as well as the reliability characteristics of the research tool as identified by the researchers themselves.[22 27] Generally, the higher the value of Cronbach's α-coefficient for a given scale, the closer the reliability is to 1. Further, studies have also shown that if Cronbach's α-coefficient of the scale is greater than 0.75, the internal consistency of the scale would be high. Thus, the better the reliability, the more reliable the scale.[22 25 27] Cronbach's α-coefficient of the original scale ranges from 0.81 to 0.88, while for the overall, the revised scale was 0.930 and for five dimensions ranged from 0.908 to 0.964. Thus, the newly adapted version of HNDDPS demonstrates good reliability.

## CONCLUSIONS

HNDDPS adapted in this study has demonstrated preferable reliability and validity. It can serve as a useful evaluation for the assessment of the disaster preparedness of an organisation by nursing professionals and thereby provide an insight into the disaster preparedness of nursing departments of hospitals in China. Further research is necessary to validate the adapted scale and dynamically observe the changes and improvement in disaster preparedness of hospital nursing departments.

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