

# Reliability and Validity Testing of the Occupational Exposure Risk Awareness Scale (OERAS) for Medical Personnel in Disinfection Supply Centers

Yubing Mu<sup>1</sup>, Xiangyun Qian<sup>2</sup>

<sup>1</sup>Disinfection Supply Center, Hai'an People's Hospital of Nantong/Hai'an Hospital Affiliated to Nantong University, Hai'an, Jiangsu, 226600, People's Republic of China; <sup>2</sup>Nursing Department, Nantong Third Hospital Affiliated to Nantong University/Nantong Third People's Hospital, Nantong, Jiangsu, 226000, People's Republic of China

Correspondence: Xiangyun Qian, Email [qianxiangyun@protonmail.com](mailto:qianxiangyun@protonmail.com)

**Background:** Medical personnel working in hospital disinfection and supply centers face high levels of occupational exposure to biological, chemical, and physical hazards. Assessing their awareness of these risks is essential for preventing workplace injuries and improving safety behavior. This study aimed to develop and validate the Occupational Exposure Risk Awareness Scale (OERAS) for healthcare workers in such settings.

**Methods:** A cross-sectional psychometric validation study was conducted among 959 medical staff from disinfection and supply centers in Jiangsu Province, China. The 20-item OERAS was developed through literature review, expert consultation, and pilot testing, and it comprised four dimensions: Occupational Exposure Knowledge, Protection Measures, Incident Response, Training and Education. Internal consistency, test–retest reliability, split-half reliability, content validity, construct validity, and criterion-related validity were analyzed using SPSS 26.0 and AMOS 24.0.

**Results:** The OERAS demonstrated high reliability, with Cronbach's  $\alpha = 0.85$  for the total scale, Spearman's  $\rho = 0.83$  for test–retest reliability, and a split-half coefficient of 0.81. Content validity was excellent (mean CVI = 0.88). Exploratory factor analysis extracted four factors explaining 62.8% of total variance, while confirmatory factor analysis confirmed good model fit (CFI = 0.93, TLI = 0.91, RMSEA = 0.05). Criterion validity showed a significant but low/moderate correlation ( $\rho = 0.42$ ,  $p < 0.001$ ) with an external safety knowledge test.

**Conclusion:** The corrected OERAS exhibits strong internal reliability and construct validity, making it a robust and practical tool for measuring occupational exposure risk awareness among medical personnel. Although criterion validity was low/moderate, this reflects that awareness and knowledge are related yet distinct constructs. The OERAS can support targeted training and policy interventions to enhance occupational safety in healthcare environments.

**Keywords:** occupational exposure, risk awareness, psychometric validation, healthcare workers, disinfection and supply centers, reliability, validity, safety behavior, scale development, China

## Introduction

With the development of modern medicine and the increasing demand for healthcare services, medical staff in hospitals and other healthcare institutions are exposed to a variety of occupational risks.<sup>1</sup> These risks not only threaten the health and safety of medical staff, but may also indirectly affect the outcome and safety of patients.<sup>2</sup> Occupational exposure is one of the main risks faced by healthcare workers in the work environment, especially in high-risk work environments such as sterile supply centers.<sup>3</sup> Occupational Exposure (OE) refers to the exposure of staff to potentially harmful substances or environmental conditions in the course of their work.<sup>4</sup> These hazardous substances or conditions can be of various types including biological, chemical, physical and psychosocial.<sup>5</sup> For medical staff, occupational exposure mainly involves the following types: Biological exposure: eg needle-stick injuries, exposure to blood and body fluids, etc., which may result in medical staff contracting infectious diseases such as hepatitis B, hepatitis C and HIV.<sup>6</sup> Chemical exposures: such as exposure to



disinfectants, chemicals and chemotherapeutic drugs, which may cause acute poisoning, chronic diseases or other health problems.<sup>7</sup> Physical exposures: such as radiation, noise, and heat, which may cause physical injury or long-term health problems for medical staff.<sup>8</sup> Psychosocial exposures: such as high work pressure, shift work and tense interpersonal relationships may lead to mental health problems such as anxiety, depression and burnout among healthcare workers.<sup>9</sup>

Occupational exposures pose a serious threat to the health and safety of medical personnel. Firstly, occupational exposure may lead to acute health problems such as infections, allergic reactions and acute poisoning.<sup>10</sup> Secondly, long-term occupational exposures may cause chronic diseases, such as cancer, chronic respiratory diseases and skin diseases.<sup>11</sup> In addition, occupational exposures may have a negative impact on the mental health of healthcare workers, increasing the risk of psychological stress and burnout.<sup>12</sup> Occupational exposures not only have a significant impact on individual healthcare workers, but may also have a knock-on effect on the operation of healthcare organizations and patient safety.<sup>13</sup> For example, illness or mental health problems among healthcare workers due to occupational exposures may lead to decreased productivity, increased medical errors, and reduced patient satisfaction.<sup>14</sup> Therefore, systematically identifying, assessing and managing occupational exposure risks is important for protecting the health and safety of medical staff and improving the quality of healthcare services. Occupational exposure risk awareness refers to the extent to which medical personnel understand and recognise the potential occupational exposure risks that exist in their working environment.<sup>15</sup> Occupational exposure risk awareness is of great significance to medical personnel, which is reflected in the following aspects: firstly, medical personnel's awareness of occupational exposure risks can significantly improve their protection consciousness.<sup>16</sup> For example, familiarity with the risks of needlestick injuries and their protective measures can greatly reduce the chances of needlestick injuries and the risk of infectious disease transmission.<sup>17</sup> The second is that knowledge of occupational exposure risks not only prevents the occurrence of exposure events, but also prompts medical staff to respond and handle occupational exposure events promptly and correctly when they occur.<sup>17</sup> Timely response and management measures, such as immediately cleaning the exposed area, reporting the incident, and receiving necessary medical evaluation and treatment, can effectively reduce the negative impact of occupational exposure on the health of medical staff and reduce long-term health risks.<sup>18</sup> Then the increased awareness of occupational exposure risks helps medical staff to actively participate in the improvement of the work environment and the construction of a safety culture.<sup>19</sup> Through feedback on safety hazards at work and suggestions for improvement, medical staff can push medical organizations to improve safety management systems and protective facilities to create a safer working environment.<sup>20</sup> In addition, a good awareness of occupational exposure risks can promote mutual supervision and support among medical staff, forming a favorable atmosphere for jointly maintaining occupational safety.<sup>21</sup> As well as the need for a high level of occupational exposure risk awareness, medical staff can be more confident in facing various risks at work, enhancing their professional self-confidence and satisfaction.<sup>22</sup> Knowing how to protect and cope with occupational exposure not only makes medical staff feel safer at work, but also improves their sense of identity and loyalty to their profession, helping to reduce burnout and turnover.<sup>23</sup> Finally, it is the level of medical staff's occupational exposure risk awareness that directly affects their health and safety, and it is healthy and safe medical staff who can provide high quality healthcare services.<sup>24</sup> Ensuring the health and safety of medical staff through effective occupational exposure risk management can improve the stability and continuity of medical services, enhance patient trust and satisfaction, and thus improve the overall quality of medical services.<sup>25</sup>

In order to effectively manage and reduce the risk of occupational exposure, a set of scientific and valid assessment tools is needed to evaluate the level of medical staff's awareness of occupational exposure risk. The aim of this study was to develop and validate the Occupational Exposure Risk Awareness Scale (OERAS) to assess medical staff's awareness of occupational exposure risks. The reliability and validity of the scale will be tested to ensure the reliability and validity of the scale, which will provide a scientific basis for the development of occupational exposure risk management and intervention measures.

## Materials and Methods

### Study Design and Participants

This cross-sectional psychometric validation study was conducted to develop and evaluate the Occupational Exposure Risk Awareness Scale (OERAS) among medical personnel working in hospital disinfection and supply centers in Jiangsu

Province, China. A total of 959 participants were recruited, including nurses, technicians, and physicians directly engaged in instrument cleaning, sterilization, and supply activities. Demographic data such as age, gender, and years of work experience were collected and are summarized in [Table 1](#). Participation was voluntary and anonymous, and written informed consent was obtained from all respondents in accordance with institutional ethical standards.

## Instrument Development

The 20-item Occupational Exposure Risk Awareness Scale (OERAS), developed for this study, assesses four domains of occupational exposure awareness: knowledge, protection measures, incident response, and training. Each item is rated on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The complete questionnaire is presented and detailed in [Supplementary File 1](#).

## Data Collection Procedure

Data were collected using self-administered printed questionnaires. All participants completed the scale once. The same cohort completed it again after an interval of two to four weeks to evaluate test–retest reliability. Responses with missing data were excluded from analysis. The final dataset therefore contained 959 valid paired responses, allowing for complete reliability and validity testing.

## Statistical Analysis

All analyses were performed using IBM SPSS Statistics 26.0 and AMOS 24.0. Descriptive statistics were calculated for demographic variables and OERAS scores ([Table 1](#)). Internal consistency reliability was assessed with Cronbach's  $\alpha$  for each subscale and for the total scale ([Table 2](#)). Test–retest reliability was measured by correlating Time 1 and Time 2 total scores using Spearman's  $\rho$  ([Table 3](#)). Split-half reliability was evaluated through the Spearman–Brown coefficient ([Table 4](#)). Content validity was assessed through expert panel review, with item-level and mean Content Validity Index (CVI) values computed ([Table 5](#)). Construct validity was examined using Exploratory Factor Analysis (EFA) to determine factor structure ([Table 6](#)) followed by Confirmatory Factor Analysis (CFA) to test model fit ([Table 7](#)).

**Table 1** Demographic Characteristics and Occupational Exposure Risk Awareness Scores of Participants

Variable	Total (N = 959) Mean $\pm$ SD	Male (N = 479) Mean $\pm$ SD	Female (N = 480) Mean $\pm$ SD
Age (years)	40.25 $\pm$ 10.5	41.3 $\pm$ 10.7	39.2 $\pm$ 10.3
Working experience (years)	15.8 $\pm$ 8.6	16.5 $\pm$ 8.9	15.1 $\pm$ 8.3
Dimension 1 – Occupational Exposure Knowledge (5–25)	18.6 $\pm$ 3.4	18.8 $\pm$ 3.3	18.4 $\pm$ 3.5
Dimension 2 – Protection Measures (5–25)	19.4 $\pm$ 3.6	19.6 $\pm$ 3.5	19.2 $\pm$ 3.7
Dimension 3 – Incident Response (5–25)	18.8 $\pm$ 3.8	19.0 $\pm$ 3.7	18.6 $\pm$ 3.9
Dimension 4 – Training & Education (5–25)	19.1 $\pm$ 3.5	19.3 $\pm$ 3.4	18.9 $\pm$ 3.6
Total OERAS Score (20–100)	75.9 $\pm$ 8.7	76.7 $\pm$ 8.6	75.1 $\pm$ 8.8

**Notes:** Data are presented as mean ( $\pm$  standard deviation). Each dimension contains 5 items scored 1–5, producing sub-scale ranges of 5–25 and an overall scale range of 20–100. Higher scores indicate greater occupational exposure risk awareness.

**Table 2** Internal Consistency (Cronbach's  $\alpha$  Coefficients)

Dimension	Number of Items	Cronbach's $\alpha$
Knowledge	5	0.78
Protection Measures	5	0.8
Incident Response	5	0.82
Training & Education	5	0.75
Overall Scale	20	0.85

**Note:** "20" indicates total items, not score range.

**Table 3** Test–Retest Reliability (N = 959)

Variable	Time 1 Mean ± SD	Time 2 Mean ± SD	Correlation ( $\rho$ )
Total OERAS Score (20–100)	75.9 ± 8.7	76.3 ± 8.6	0.83

Notes: Spearman's  $\rho = 0.83$ ,  $p < 0.001$ , demonstrating excellent temporal stability.

**Table 4** Split-Half Reliability (Spearman–Brown Coefficient)

Variable	Coefficient
Split-Half Reliability	0.81

**Table 5** Content Validity Index (CVI)

Dimension	Item-Level CVI (min–max)	Mean CVI
Knowledge	0.84–0.92	0.88
Protection Measures	0.83–0.90	0.87
Incident Response	0.85–0.93	0.89
Training & Education	0.82–0.89	0.86
Overall	0.82–0.93	0.88

**Table 6** Exploratory Factor Analysis (EFA)

Factor	Eigenvalue	% Variance Explained	Cumulative %
Factor 1 – Knowledge	4.35	21.80%	21.80%
Factor 2 – Protection Measures	3.1	15.50%	37.30%
Factor 3 – Incident Response	2.65	13.30%	50.60%
Factor 4 – Training & Education	2.45	12.20%	62.80%

Notes: KMO = 0.91; Bartlett's  $\chi^2 = 4326.5$ ,  $p < 0.001$ .

**Table 7** Confirmatory Factor Analysis (CFA) Model Fit Indices

Model Fit Index	Value	Acceptable Threshold	Interpretation
CFI	0.93	$\geq 0.90$	Good fit
TLI	0.91	$\geq 0.90$	Good fit
RMSEA	0.05	$\leq 0.08$	Excellent fit
$\chi^2/df$	2.43	$\leq 3.00$	Acceptable

Criterion-related validity was evaluated by correlating total OERAS scores with scores on an independent Occupational Safety Knowledge Test, using Spearman's  $\rho$  (Table 8). A coefficient of 0.70 or higher was predefined as evidence of strong criterion validity. Statistical significance was established at  $p < 0.05$ .

**Table 8** Criterion-Related Validity Between OERAS Scores and Occupational Safety Knowledge Test

Variable Pair	Correlation Coefficient ( $\rho$ )	p value	Interpretation
Total OERAS vs Knowledge Test	0.42	$< 0.001$	Low/Moderate positive correlation - below pre-specified $\geq 0.70$ criterion

Notes: Although statistically significant, the observed correlation ( $\rho = 0.42$ ) does not reach the predefined threshold ( $\geq 0.70$ ) for strong criterion validity; therefore, convergence is low/moderate rather than strong.

## Results

### Participant Characteristics

A total of 959 medical staff completed the survey. As shown in Table 1, the mean age was  $40.25 \pm 10.5$  years, and the mean duration of work experience was  $15.8 \pm 8.6$  years. The gender distribution was balanced, with 479 males and 480 females. The mean total OERAS score was  $75.9 \pm 8.7$  (out of 100), reflecting a moderate-to-high level of occupational exposure risk awareness. Among the four dimensions, average scores ranged from 18.6 for Occupational Exposure Knowledge to 19.4 for Protection Measures, showing that awareness levels were consistently high across all dimensions.

### Reliability Analysis

Reliability results are summarized in Tables 2–4. Test–retest reliability was strong, with a Spearman's  $\rho$  of 0.83 ( $p < 0.001$ ) between the first and second administrations (Table 2). Split-half reliability was similarly high, with a Spearman–Brown coefficient of 0.81, confirming the internal stability of the instrument (Table 3). Internal consistency analysis produced Cronbach's  $\alpha$  values ranging from 0.75 to 0.82 across the four subscales and 0.85 for the total scale, demonstrating excellent internal consistency (Table 4). These results indicate that the OERAS yields stable and reliable measurements over time and across items.

### Validity Analysis

#### Content Validity

Content validity indices are presented in Table 5. Expert evaluation of the 20 items yielded item-level CVI values ranging from 0.82 to 0.93 and a mean scale-level CVI of 0.88, indicating excellent agreement among reviewers on item relevance and clarity.

#### Construct Validity

Construct validity results are shown in Tables 6 and 7. The EFA identified a clear four-factor structure that aligned with the theoretical design of the instrument, explaining 62.8% of the total variance. Sampling adequacy was confirmed (KMO = 0.91), and Bartlett's test was significant ( $\chi^2 = 4326.5$ ,  $p < 0.001$ ), supporting factorability of the data (Table 6). The subsequent CFA confirmed that this four-factor model provided an excellent fit to the observed data, with CFI = 0.93, TLI = 0.91, RMSEA = 0.05, and  $\chi^2/df = 2.43$ , all within accepted thresholds for good model fit (Table 7). These findings affirm the robustness of the OERAS's four-dimensional structure.

#### Criterion-Related Validity

Criterion validity results are detailed in Table 8. The correlation between total OERAS scores and Occupational Safety Knowledge Test scores was  $\rho = 0.42$  ( $p < 0.001$ ). Although statistically significant, this coefficient did not reach the predefined criterion of  $\geq 0.70$  for strong criterion validity. Therefore, the relationship between awareness and safety knowledge is considered low/moderate, reflecting that the OERAS primarily measures cognitive and behavioral awareness rather than factual knowledge alone.

#### Overall Psychometric Performance

Across all analyses, the OERAS exhibited robust psychometric characteristics. The instrument achieved high internal consistency (Cronbach's  $\alpha = 0.85$ ), strong test–retest reliability ( $\rho = 0.83$ ), and satisfactory split-half reliability (0.81). Content validity was excellent (CVI = 0.88), while the four-factor structure accounted for 62.8% of total variance with good model-fit indices (CFI = 0.93, TLI = 0.91, RMSEA = 0.05). Although criterion-related validity was low/moderate ( $\rho = 0.42$ ), it remained statistically significant and consistent with the conceptual distinction between awareness and knowledge constructs. Collectively, these results confirm that the corrected OERAS is a reliable and valid instrument for assessing occupational exposure risk awareness among medical staff working in disinfection and supply center environments.

## Discussion

This study developed and validated the Occupational Exposure Risk Awareness Scale (OERAS) to assess the awareness of occupational exposure risks among medical personnel working in disinfection and supply centers. The results confirm that the OERAS is a reliable and valid instrument with strong psychometric properties. The corrected scoring system and comprehensive analysis have established a stable four-dimensional structure that captures key aspects of occupational exposure awareness, including knowledge, protection, incident response, and training.

The demographic data show that participants in this study had a balanced gender distribution, a wide range of ages, and varying lengths of professional experience. The overall mean OERAS score of 75.9 out of 100 indicates that the study population had a moderate to high level of awareness regarding occupational exposure risks. This suggests that ongoing safety education and regulatory training in disinfection and supply centers may already be producing a positive impact on occupational safety consciousness. The relatively even distribution of sub-dimension scores further supports that medical staff are comparably aware across the domains of knowledge, protection, and response, reflecting a broad and well-integrated understanding of workplace safety.

The reliability analyses demonstrated strong internal consistency, stability, and coherence. The overall Cronbach's alpha of 0.85, as shown in [Table 4](#), indicates that the scale items are highly correlated and measure a consistent construct. The test-retest correlation of 0.83 ([Table 2](#)) confirms that the OERAS produces reproducible results over time, and the split-half coefficient of 0.81 ([Table 3](#)) reinforces its internal stability. Together, these findings indicate that the OERAS can be confidently used in both cross-sectional studies and longitudinal monitoring of occupational exposure awareness.

Validity testing also provided robust support for the OERAS. The expert-based content validity index ([Table 5](#)) reached a mean of 0.88, confirming that the items were clearly worded, relevant, and representative of the intended construct. The exploratory factor analysis revealed a clear four-factor solution that explained 62.8% of the total variance ([Table 6](#)), while confirmatory factor analysis ([Table 7](#)) further verified the adequacy of this model with excellent fit indices (CFI = 0.93, TLI = 0.91, RMSEA = 0.05). These results demonstrate that the structure of the scale is theoretically sound and statistically well supported, aligning with the conceptual framework of occupational exposure risk awareness. The consistency between the EFA and CFA outcomes adds confidence to the multidimensional design of the instrument.

The criterion-related validity analysis, however, revealed a low/moderate correlation ( $\rho = 0.42$ ) between OERAS scores and occupational safety knowledge test scores ([Table 8](#)). Although this relationship was statistically significant, it did not meet the pre-specified benchmark of 0.70 that was originally intended to represent strong criterion validity. This low/moderate relationship likely reflects a conceptual distinction between "awareness" and knowledge. Awareness involves cognitive and behavioral understanding of potential occupational hazards and the readiness to apply protective behaviors, whereas knowledge tests typically measure factual recall or procedural understanding. In this context, the low/moderate correlation is logical and supports the notion that awareness is an independent but related construct that complements rather than duplicates safety knowledge.

The results of this study are consistent with findings from previous occupational health research, which have reported similar multidimensional structures and low/moderate correlations between awareness and knowledge-based measures.<sup>26–28</sup> The high internal reliability and strong construct validity of the OERAS parallel those of comparable safety-awareness instruments developed for nurses and industrial workers.<sup>29–32</sup> The scale's focus on awareness rather than technical knowledge makes it particularly useful for identifying perceptual and behavioral gaps that may not be captured by traditional knowledge assessments.

Several factors likely explain the observed low-to-moderate criterion validity coefficient ( $\rho = 0.42$ ). The OERAS is designed to assess awareness, a construct that incorporates perceptions, behavioral intentions, and situational appraisal whereas the external criterion measure evaluates factual safety knowledge. These two domains are theoretically related but not equivalent. Also, awareness is influenced by experiential, contextual, and organizational factors (eg, personal exposure history, training culture, perceived workload), none of which are captured by a knowledge-only test. Lastly, the response tendencies such as social desirability or differences in safety culture across departments may elevate awareness scores without proportionally affecting knowledge performance. So, the knowledge test itself may not fully reflect the breadth of cognitive and behavioral components in the OERAS, contributing to partial rather than strong convergence.

Overall, the corrected and validated OERAS provides a comprehensive, reliable, and practical tool for assessing awareness of occupational exposure risks among medical staff. Its strong psychometric properties make it suitable for

both research and applied settings, including workforce training evaluations and safety program audits. The low/moderate criterion validity highlights the importance of integrating both awareness and knowledge interventions in occupational safety education, as each contributes uniquely to effective risk prevention. Future studies should expand sample diversity across hospitals and professional roles, and longitudinal designs could be used to examine how awareness evolves over time in response to targeted training or policy changes.

## Conclusion

The Occupational Exposure Risk Awareness Scale (OERAS) developed and validated in this study is a reliable and valid instrument for assessing awareness of occupational exposure risks among medical personnel working in disinfection and supply centers. The corrected scoring method and robust analyses confirmed strong internal consistency, excellent construct validity, and good temporal stability. Although the correlation with the external knowledge test was low/moderate, this finding reflects that awareness and knowledge are related yet distinct dimensions of occupational safety. The OERAS can therefore serve as a practical tool for identifying strengths and gaps in awareness, guiding targeted education and training programs, and evaluating the effectiveness of safety interventions. Future research should apply this instrument across diverse healthcare settings and professional groups to further confirm its generalizability and to monitor changes in awareness following continuous safety education initiatives.

## Abbreviations

OERAS, Occupational Exposure Risk Awareness Scale; SD, Standard Deviation;  $\rho$ , Spearman Correlation Coefficient;  $\alpha$ , Cronbach's Alpha; CVI, Content Validity Index; EFA, Exploratory Factor Analysis; CFA, Confirmatory Factor Analysis; CFI, Comparative Fit Index; TLI, Tucker–Lewis Index; RMSEA, Root Mean Square Error of Approximation; KMO, Kaiser–Meyer–Olkin Measure of Sampling Adequacy; SPSS, Statistical Package for the Social Sciences.

## Data Sharing Statement

The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request.

## Ethical Statement and Consent to Participate

This study was conducted in accordance with the ethical guidelines of the Declaration of Helsinki and approved by Ethics Committee of Nantong University, 19 Qixiu Road, Chongchuan District, Nantong, China, 226006 in Nantong University. Informed consent was obtained from all participants prior to their involvement.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors declare no conflicts of interest related to this study.

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