Abstract

Background: With the emergence of Middle East respiratory syndrome (MERS), health care preparedness has received increasing attention, which requires valid tools to assess the knowledge and attitude of health workers, such as nurses, with regard to this disease.

Aims: This study aimed to develop and evaluate a knowledge and attitudes questionnaire on MERS coronavirus for Iranian nurses.

Methods: A questionnaire was developed based on international and national guidelines and a literature review. Ten nurses were recruited to assess face validity and 11 experts reviewed the instrument to determine the content validity ratio and index. Exploratory factor analysis was then done with a random sample of 155 nurses in Tabriz city, Islamic Republic of Iran.

Results: Following determination of face and content validity, 78 items (61 knowledge and 17 attitude) were retained in the final version of the questionnaire. The knowledge scale had an average content validity index of 0.80 and the attitude scale a value of 0.91. In the exploratory factor analysis, five dimensions with eigenvalues > 1 and loading level ≥ 0.4 were extracted for the knowledge scale (46 items) and two for the attitude scale (16 items). The Kuder–Richardson 21 coefficient and intraclass correlation coefficient for the knowledge scale were 0.94 and 0.91 respectively. In the attitude scale, the Cronbach alpha coefficient and intraclass correlation coefficients were 0.82 and 0.89 respectively.

Conclusions: The scale developed in this study is reliable and stable and a suitable instrument for evaluating the knowledge and attitude of nurses about MERS-CoV.

Keywords: Middle East respiratory syndrome, surveys and questionnaires, knowledge, attitude, health care providers, Islamic Republic of Iran

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Introduction

Middle East respiratory syndrome (MERS) is a respiratory disease caused by a coronavirus (MERS-CoV). The disease was first reported in Saudi Arabia in 2012. Coronaviruses are a large family of viruses that can cause various diseases from colds to severe acute respiratory syndrome (SARS) (1). Since it was first reported in 2012 to 27 April 2017, 1952 laboratory-confirmed cases of infection with MERS-CoV have been reported to the World Health Organization (WHO), including at least 693 related deaths (2). Cases of MERS have been reported in 27 countries in and around the Arabian peninsula, including the Islamic Republic of Iran, and more distant countries – Germany, United Kingdom, United States of America, Korea, Turkey, Egypt and Malaysia – as a result of travel to affected countries (3). In the Islamic Republic of Iran, a cluster of the disease was reported in five people in 2014 (4) and another case was reported in 2015 (5).

The disease is transmitted through direct or indirect contact with infected camel secretions and/or droplets of people with the virus. Symptoms of MERS resemble those of influenza-like illness with fever, cough and severe dyspnoea (6). No vaccines and treatments are available for the disease. The highest prevalence of MERS is reported from health centres (1,7). In Korea (8) and Jeddah, Saudi Arabia (9), for example, the disease spread through contact with affected people in hospital. Disease transmission through common interpersonal contact between people is unknown in the community.

Since most reported cases of MERS are from the Middle East, and Iranians frequently travel to neighbouring Arab countries, including Saudi Arabia (10), health care personnel in the Islamic Republic of Iran need to have an understanding of the disease and the infection control measures that should be used (11). At the same time, health care providers may have concerns about occupational safety and disease transmission to friends and family while providing health services to patients with MERS. To manage coronavirus diseases, it is therefore essential to evaluate the knowledge and attitudes of health care providers about the disease in order to determine the extent to which they are prepared for the necessary measures for this disease and to provide in-service training where required (12).

Given that the disease has emerged quite recently, few studies have been conducted and a limited number of instruments developed to assess the knowledge and attitudes of health care providers about MERS-CoV. Despite the importance of a valid and reliable instrument to evaluate health care workers knowledge and attitudes about the virus and the disease, a review of the literature suggests inadequacies in the design and psychometry of existing tools (10,13–17).

Researchers in Saudi Arabia used a questionnaire to examine the knowledge and attitudes of health care providers about MERS-CoV in 2015 (13), but the results for content validity ratio and content validity index of the items was not reported, nor was the reliability of the questionnaire, even though these measures were done. In another similar study in Saudi Arabia (10), the questionnaire used was evaluated for face and content validity but no results were presented for the content validity ratio and index. The Cronbach alpha for reliability of the questionnaire was given as 0.74, but it was not clear whether this value applied to the attitude or knowledge scale. In a study in the Republic of Korea on knowledge, preventive behaviour and risk perception of nursing students at the outbreak of MERS-CoV in the country, the authors reported the content validity index and Kuder–Richardson values, but they provided no data on the content validity ratio, face validity and construct validity (14). A study in Turkey on the knowledge, attitude, and practices of Hajj and Umra pilgrims about MERS did not report the validity and reliability of the questionnaire used (15). Similarly, these measures were not reported in a study on the knowledge of physicians about MERS-CoV in Pakistan (16) and another study on the knowledge, attitude and practices of health care providers in Saudi Arabia (17).

Reliable and valid instruments to measure the knowledge and attitude of health care providers about coronaviruses are also lacking in the Islamic Republic of Iran. This study, therefore, aimed to develop and evaluate a knowledge and attitude scale for MERS-CoV.

Methods

Study design

A methodological study with cross-sectional data collection was conducted to develop a knowledge and attitude scale for nurses about MERS-CoV and make a psychometric evaluation.

Development of the scale
Guidelines on MERS were obtained from the websites of WHO, Centers for Disease Control and Prevention (CDC), USA and the Iranian Centre for Communicable Disease Management. The guidelines were analysed for quantitative content and the aspects of MERS that a nurse should be aware of. Scopus, PubMed, ProQuest and Google Scholar, and Iranmedex, Scientific Information Database (SID) and Magiran in the Islamic Republic of Iran were searched for articles and related tools. A combined search method was used in order to incorporate dimensions and attributes not identified previously. Keywords used were: knowledge, attitude, design, psychometry and Middle East respiratory syndrome. In the literature review, the questionnaire designed by Nour and colleagues in 2015 was used to extract knowledge and attitude items after obtaining permission from the developers of the questionnaire (13).

The scale was divided in two sections. The first part contained the knowledge items with six dimensions and 46 items in a triple-choice response scale (true, false and don’t know). The dimensions were: nature of the disease (eight items), transmission of the disease (five items), characteristics of people infected by the coronavirus (three items), prevention (three items), actions in dealing with suspected, probable and confirmed cases (24 items), and precautionary measures by health care providers (three items). The second part of the scale contained items on attitude including 11 items with a 5-point Likert scale (strongly agree, agree, uncertain, disagree and strongly disagree).

**Face and content validity**

The validity of the scale was assessed though face and content validity. Ten nurses working at Tabriz University of Medical Sciences were selected by convenience sampling and were interviewed to get their views on the appearance, simplicity, and understandability of the items. The nurses were also asked to judge the importance of the items for assessing knowledge and attitudes about MERS-CoV using a 5-point Likert scale: 1, unimportant; 2, slightly important; 3, important; 4, very important; and 5, extremely important. For each item, an impact score was calculated by the number nurses who scored the item 4 or 5 in the importance scale multiplied by the mean score of the item’s importance. Items with impact scores of less than 1.5 were excluded from the questionnaire (18).

A panel of 11 experts was then selected: four experts in infection control working in selected hospitals in Tabriz, four infectious disease specialists—one each from Imam Reza Hospital in Tabriz, the Centre for Infectious Diseases Control, the Treatment Department of East Azerbaijan Province and the Iranian Centre for Communicable Disease Control—and three researchers and lecturer in emerging diseases at the Faculty of Nursing and Midwifery of Tabriz University of Medical Sciences. After obtaining necessary permission from the Ethics Committee of Tabriz University of Medical Sciences, the experts were sent the revised scale after face validity and invited to undertake content validity assessment. All the 11 experts responded.

To examine the content validity ratio, the panellists were asked to rate the items on the scale as: necessary, useful but not necessary, or not necessary. Then, the content validity ratio for each item was calculated with the formula: content validity ratio = (Ne–N/2)/N/2, where N is the number of panellists in the content validity evaluation and Ne is the number of panellists who rated the item as essential (19). Items with a content validity ratio value less than 0.62 (the critical value in the Lawshe table for 11 panellists) were excluded (19).

After excluding items in the content validity assessment, the content validity index of the scale was determined according to the Waltz and Bausell criteria (20). The comments of the 11 experts on the relevance of each item to whatever had to be measured were assessed based on the following responses: not relevant, item needs some revision, relevant but needs minor revision, and very relevant (20). Experts were also asked to comment on the face validity of items in order to correct them accordingly. The content validity index was calculated for each item and as an average for the whole scale (S-CVI/Ave). To calculate the content validity index of each item, the number of panellists who judged the item as very relevant and relevant but needs minor revision was divided by the total number of panellists.

Items with content validity indexes greater than 0.79 were retained in the scale, those with content validity indexes between 0.70 and 0.79 were revised, and those with content validity indexes less than 0.70 were excluded (21). The content validity index values of all the items were averaged to obtain the S-CVI/Ave for the knowledge and attitude scales.

**Construct validity**

To determine the construct validity of the scale, 155 nurses were randomly selected from hospitals affiliated with Tabriz University of Medical Sciences (Table 1). The nurses self-completed the knowledge and attitude scales that had been revised after face and content validity between October 2016 and April 2017. Exploratory factor analysis was used, applying the Kaiser–Meyer–Olkin test for sampling adequacy, the Bartlett test of sphericity, principal component analysis, scree plot and varimax rotation with a cut-off point of 0.4 for factor loading to extract the dimensions of the scale or for the simplification of interrelated measures to discover patterns in a set of variables (22).

**Reliability assessment**
Internal consistency and stability reliability were used to determine the reliability of the revised scale. In a pilot study with 25 randomly selected nurses working in a research environment, the internal consistency of the knowledge scale was determined using the Kuder–Richardson-21 formula and that of the attitude scale was ascertained by the Cronbach alpha method. In order to determine the stability of both scales, the same 25 nurses completed the scales two weeks later and the intraclass correlation coefficients were calculated for the scores.

**Data analysis**

Data were analysed using SPSS, version 21. The Pearson correlation coefficient was calculated and exploratory factor analysis done. P < 0.05 was considered statistically significant.

**Ethical considerations**

This study was approved by the ethics committee of Tabriz University of Medical Sciences (IR.TBZMED.REC.1395.1065). All stages of data collection were carried out with the agreement of the managers of the study hospitals and head nurses. Prior to data collection, the research objectives were explained to participating nurses and their written informed consent was obtained. They were assured of the confidentiality of their answers and that they had the right to withdraw from the study at any time.

**Results**

**Face and content validity**

Based on the qualitative judgment of the 10 nurses of the completeness of the dimensions of the knowledge scale, an additional dimension was added called “treatment of the disease”. For this new dimension, five items were generated based on the Iranian, WHO and CDC guidelines. The content validity of these new items were then evaluated.

In addition, items were added to the following dimensions.

**Nature of the disease:**

(i) the coronavirus is contagious up to 24 hours after fever and other symptoms have gone.

**Transmission of the disease:**

(i) disease transmission from asymptomatic patients and/or those in the disease incubation period, (ii) communicability of MERS by injection of a needle infected with patient’s secretions and (iii) communicability of MERS from deceased patients.

**Actions in dealing with suspected, probable and confirmed cases:**

(i) cleaning all contaminated surfaces with a diluted (10%) bleach solution (ii) elimination of MERS-COV by 70% alcohol.

**Precautionary measures by health care providers:**

(i) use of personal protective equipment by those responsible for the transfer of deceased patients.

After face and content validity, the knowledge scale had seven dimensions with 61 items. S-CVI/Ave was 0.80.

In the attitude scale, based on the comments of the 11 panellists, an item was excluded (coronavirus infection can be treated at home), 10 items were corrected, and seven items were added to the content validity: dimension 1, statements 1–5 and 10, dimensions 2, statement 5 (Table 2). This resulted in a 17-item attitude scale in one dimension. S-CVI/Ave was 0.91.

**Construct validity**

In the exploratory factor analysis for the items of the attitude questionnaire, the sampling adequacy was examined with the Kaiser–Meyer–Olkin test which gave a result of 0.758. The Bartlett test was used to determine whether the correlation matrix obtained was significantly different from zero and could be justified based on factor analysis (P < 0.001). In exploratory factor analysis using varimax rotation, two components with eigenvalues greater than 1.0 were extracted which explained 45.72% of the variance. The first component with 11 items accounted for 27.72%
of the variance and was called "fear and threats of MERS-CoV". The second component accounted for 18.0% of the variance with five items and was called "beliefs about the prevention of MERS-CoV" (Table 2).

To assess the validity of the knowledge scale, the sampling adequacy was examined by the Kaiser–Meyer–Olkin test which gave a result of 0.864 and the Bartlett test was significant (P < 0.001). In the exploratory factor analysis using varimax rotation, five components with eigenvalues more than 1.0 were extracted which explained 41.23% of the variance. The first component with nine items accounted for 5.30% of the variance and was called "nature of the disease". The second component with seven items accounted for 4.63% of the variance and was called "transmission of the disease". The third component with 20 items accounted for 18.54% of the variance and was called "actions in dealing with suspected, probable and confirmed cases". The fourth component with five items accounted for 15.5% of the variance and was called "precautionary measures by health care providers". Finally, the fifth component with five items accounted for 5.15% of the variance and was called "treatment of the disease" (Table 3).

The correlation matrix in Table 4 shows significant correlations between total knowledge scores and total attitude scores (P < 0.001), beliefs about the prevention of MERS-CoV (P < 0.001) and the fears and threats of MERS-CoV (P = 0.019).

Reliability

The total internal consistency of the knowledge scale, assessed using Kuder–Richardson-21, was 0.94; its five dimensions Kuder–Richardson-21 ranged from 0.72 to 0.93. The internal consistency of the attitude scale was evaluated using the Cronbach alpha which gave values of 0.81, 0.73 and 0.82 for the dimensions of fears and threats of MERS-CoV, beliefs about the prevention of MERS-CoV, and for the entire scale respectively. When the questionnaire was assessed again after a two-week interval in the same sample of nurses, the value of the intraclass correlation coefficient for the entire knowledge scale was 0.91 and ranged from 0.76–0.88 for its dimensions. Intraclass correlation coefficient values for the two dimensions of attitude were 0.85 for beliefs about the prevention of MERS-CoV and 0.89 for fears and threats of MERS-CoV, and 0.89 for the entire scale (Table 5).

Scoring of the instrument

Our final MERS-CoV instrument is composed of both knowledge and attitude scales. The knowledge scale includes five domains and 46 items in a triple-choice response scale (true, false and don’t know) including: actions to deal with suspected, probable and confirmed cases (20 items), nature of the disease (9 items), precautionary measures by health care providers (5 items), treatment of the disease (5 items) and transmission of the disease (5 items). True answers scored 1 point and others scored 0. A high score on the knowledge scale represents a high level of knowledge about MERS disease. The principle for scoring these scales is the same in all cases: (i) Estimate the sum of the items that contribute to the subscale – this is the raw score and (ii) Use a linear transformation to standardize the raw score so that scores range from 0 to 100 – a higher score represents a higher level of knowledge. The linear transformation score is derived as follows: linear transformation score = (raw score – minimum total score)/(maximum total score – minimum total score) × 100. For example, in the subscale of actions to deal with suspected, probable and confirmed cases, the range of scores is 0 to 20 and the linear transformation score is equal to (raw score – 0)/(20 – 0) × 100.

The attitude scale includes two domains, one with 11 items (fears and threats of MERS-CoV) and one with five (beliefs about the prevention of MERS-CoV) which are rated on a 5-point Likert response scale. Therefore, scores in the two subscales range from 11 to 55, and 5 to 25 respectively. For example, in the first subscale of attitude, the linear transformation score is (raw score – 11)/(55 – 11) × 100.

Discussion

We aimed to design and psychometrically evaluate an instrument and to assess nurses’ knowledge of and attitude to MERS-CoV. Acceptable S-CVI/Ave values of 0.80 and 0.91 were obtained for the knowledge and attitude scales respectively (21,23).

In the exploratory factor analysis of the knowledge and attitude scales, the Kaiser–Meyer–Olkin sampling adequacy indexes (0.864 and 0.758 respectively) and Bartlett’s test (P < 0.001) indicated that implementation of factor analysis was justifiable based on the correlation matrix obtained in the sample. A Kaiser–Meyer–Olkin level greater than 0.5 allows factor analysis (24).

The internal consistency of the knowledge scale assessed by the Kuder–Richardson-21 formula equalled to 0.94 for the total knowledge scale and 0.72–0.93 for its dimensions. Cronbach alpha values of 0.73 and 0.81 were obtained for the dimensions of the attitude scale; values equal to or higher than 0.7 are acceptable and indicative of internal consistency of a scale (25). The intraclass correlation coefficient for the entire knowledge scale was 0.91 and that for the attitudes scale was 0.89; values equal to or more than 0.4 are acceptable (26), indicating that the questionnaires developed in our study was stable and reliable.
Following exploratory factor analysis, the knowledge scale items were categorized in five dimensions. The dimension that explained the greatest score variance in the knowledge scale (18.45%) was actions in dealing with suspected, probable and confirmed cases. This dimension addresses measures on infection control, isolation, disinfection of surfaces, and actions in dealing with suspected, probable and confirmed cases (27). Nature of the disease explained 5.30% of the variance; this dimension focuses on the causative agent, disease reservoirs, diagnosis path, incubation period and the disease symptoms (28,29). Precautionary actions by health care providers explained 5.15% of the score variance; this dimension emphasizes standard precautions, airborne and contact precautions, and high-risk groups (30). Treatment of the disease explained 5.15% of the score variance; this dimension concentrates on disease treatment approaches (30). Finally, disease transmission explained 4.63% of the variance; this dimension refers to the ways the disease is transmitted from animals to humans and/or from infected individuals to others (8,31,32).

Attitude items were categorized into two dimensions (fears and threats of MERS-CoV) which explained 27.72% of the variance, and beliefs about prevention of MERS-CoV which explained 18.0% of the variance. The items of our scale on fears and threats of the disease are not consistent with those of the Korean study (14). This can be explained by the fact that the researchers developed the questionnaire based on one that assessed the public fear of severe acute respiratory syndrome.

The findings of our study are in line with a study in Saudi Arabia in 2014 with regard to knowledge questions (nature, etiology, symptoms, consequences, transmission, prevention and treatment). However, no measures were included in the Saudi Arabian questionnaire dealing with suspected, probable and confirmed cases, and precautions (10). All items in our questionnaire are also consistent with those used in a 2015 study in Saudi Arabia on the knowledge, attitude and practice of health care providers, although some of their questions had more than one answer (13). Moreover, three dimensions of our knowledge scale (nature, and treatment and prevention of the disease) agree with that of a Chinese study in 2015 that investigated MERS and knowledge, attitudes and practices of medical students related to MERS (33).

To the best of our knowledge, our study is one of the most rigorous studies to develop a reliable and valid instrument for assessing the knowledge and attitude of nurses in the front line of health care provision for people with MERS-CoV infection (34). We used face and content validity (quantitative and qualitative) methods, construct validity using exploratory factor analysis, and scale reliability using two methods of internal consistency and stability. Another significant feature of our study is using CDC and WHO guidelines on MERS as well as those of the Iranian Centre for Communicable Diseases. In addition, relevant scientific literature was reviewed to determine the content domains of MERS and generate items for the knowledge and attitude scales.

Considering the use of extensive literature review and expert opinion for designing this scale and the evidence of the validity and reliability of our MERS-CoV knowledge and attitude scale, we recommend its use to assess the knowledge and attitudes of nurses and hospital managers before and after training courses on the disease and in other research.

A limitation of this study was that it was only conducted among nurses and in two hospitals affiliated to Tabriz University of Medical Sciences. Nonetheless, the reliability of the scale can be examined for other health care service providers (e.g. physicians, paramedics, and medical, paramedical and nursing students), and in different locations in the Islamic Republic of Iran or even other parts of the world.

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References

5. Middle East Respiratory Syndrome coronavirus (MERS-CoV) – Iran. World Health Organization, Emergencies preparedness response,


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