A Confirmatory Factor Analysis of the knowledge, attitude and practice questionnaire towards prevention of Respiratory tract infections during Hajj and Umrah

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Mohammd Dauda Goni
Ministry of Agriculture and Environment, IBB Secretariat Complex, Yobe State Nigeria

ORCiD: https://orcid.org/0000-0003-1301-5351

Nyi Nyi Naing

syedhatim@unisza.edu.my

Corresponding Author

Habsah Hasan
Universiti Sains Malaysia

Nadiah Wan-Arfah
Universiti Sultan Zainal Abidin

Zakuan Zainy Deris
Universiti Sains Malaysia

Wan Nor Arifin
Universiti Sains Malaysia

Aisha Abubakar Baaba
Universiti Malaysia Kelantan

Stanley Njaka
Universiti Sains Malaysia

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Abstract
Background Respiratory tract infections are one of the common infection associated with Hajj pilgrimage that is of great public health and global concern. This study is aimed at determining the factor structure of the knowledge, attitude and practice questionnaire for the prevention of respiratory tract infections during Hajj by confirmatory factor analysis (CFA).

Methods A multistage cluster sampling method was conducted on Malaysian Umrah pilgrims during the weekly Umrah orientation course. A total of 200 Umrah pilgrims participated in the study. The KAP questionnaire was distributed to pilgrims at the beginning of the orientation and retrieved immediately at the end of the orientation. The robust maximum likelihood was used for the estimation due to the multivariate normality assumption violation. A two-factor model was tested for measurement model validity and construct validity for each of the attitude and practice domains.

Results CFA of a 25-item in total, two-factor model yielded adequate goodness-of-fit values. The measurement model also showed a good convergent and discriminant validity after model re-specification. A two-factor model was tested for measurement model validity and construct validity for each of the attitude and practice domains.

Conclusion The KAP questionnaire was proven to have a valid measurement model and reliable constructs. It was deemed suitable for use to measure the KAP of Hajj and Umrah pilgrims towards the prevention of respiratory tract infections.

Background
The Holy pilgrimage to Mecca, Saudi Arabia is one of the five cardinal pillars of worship upon every financially and physically able Muslim individual. Hajj is among the largest mass gathering in the world with approximately 2 million pilgrims participating from different countries every year. This poses a great risk to public health considering the overcrowding, presence of comorbidities among the pilgrims and adverse climatic condition are huge challenges to both participating and the host countries especially regarding infectious diseases such as respiratory tract infections [1]. Respiratory tract infections are the most prevalent illnesses spread throughout the Hajj period, and influenza virus and rhinovirus are the most commonly reported respiratory viruses among pilgrims.
[2]. However, a high prevalence of respiratory tract illnesses is still reported among Malaysian Hajj pilgrims at over 90% despite the implementation of different preventive measures over the recent years [3].

CFA is advance construct validity and superior to exploratory factor analysis (EFA) and simple reliability analysis (test-retest and internal consistency reliabilities in several ways. CFA is also a kind of structural equation modelling (SEM) that is related to measurement models [4]. The application of CFA is worthwhile to support the links connecting items and their respective domains. This permits the fixing of these relations in the measurement model and presents measures to evaluate the fit of the proposed theoretical model to the collected data [5]. Therefore, CFA is regarded as a vital means for validation in social and behavioural sciences [4]. Measurement scale development involves numerous processes and protocols to establish its validity and reliability. The content and characteristics of the basic constructs and the choice of items to be included can also be established in a pilot study or adopted from a previous similar study and validated by confirmatory factory analysis (CFA) [6]. The application of improper measurement tools that are not validated can lead to inaccurate and misleading findings, resulting in a poor plan for interventions and therefore to unreliable efficacy [7]. The Item Response Theory models (Rasch model) utilizes the principle of true Score models which comprises a collection of dogmatic formulae for systematic analysis to achieve the desired objective [8].

So far, there are few studies that specifically reported the knowledge, attitude and practice of various respiratory tract infections preventive behaviours by Hajj pilgrims [9–16], however, none of these studies were documented to have employed a questionnaire that is properly developed and validated. Therefore, this study was aimed at determining the construct validity and reliability of the KAP questionnaire towards the prevention of respiratory tract infections during Hajj and Umrah among Malaysian Hajj pilgrims.

**Methodology**

**Research Design and Study Population**

A cross-sectional study was carried out among Malaysian Umrah pilgrims attending a weekly Umrah
orientation course organized by private Umrah tour companies from March to June 2018. This study was the second stage of a large study. In the first stage, we conducted exploratory factor analysis of the measurement tool.

**Sample Size and Sampling Method**

A total of 200 Umrah pilgrims were recruited through a multistage sampling method for the 72 items in the KAP questionnaire for prevention of RTI during Hajj. The sample size for this study was based on a simulation study as recommended by Hair (2010) for CFA. Therefore the sample size for this study was fixed at \( n = 200 \) when the anticipated domains were seven or less and items commonality was less than 0.5 and no under identified domains.

**Measurement Tool**

A self-administered questionnaire for the measurement of the knowledge, attitude and practice of Malaysian Hajj and Umrah pilgrims towards the prevention of RTIs. All the domains, as well as the sub-domains, have been developed and exploratory factor analysis (EFA) was done in the previous part of this same project [17]. The knowledge domain was based on a literature review and a qualitative study to include aetiology, transmission, signs and symptoms, risk factor and prevention measures. The attitude domain was factored on barriers to prevention and self-motivation while the practice domain was developed based healthy lifestyle and protective practices. The final questionnaire consisted of 72 questions and items.

**Data Collection Procedures**

All data were collected from June 2018 to August 2018. A self-administered questionnaires were distributed to the Umrah pilgrims before their weekly course that met the inclusion criteria. Pilgrims are that aged 18 and above, able to write and speak in Bahasa Malay and are willing to participate are considered to have fulfilled the inclusion criteria. Participants were briefed on the purpose of the study, the procedures, and the confidentiality of their responses. Informed consent was obtained from
the participants that are willing to be part of the study prior to the administration of the questionnaire. The pilgrims were also instructed to give their honest responses when answering the questionnaire. The completed questionnaire was immediately retrieved from the participants at the end of the day’s orientation. The time to complete the questionnaire was approximately 10 to 15 minutes.

**Data Management and Preliminary Analysis**

All data were entered and checked for missing data using SPSS software version 24 and then transferred to R version 3.5.0 for Item Response Theory (IRT) and Confirmatory factor analysis (CFA) analysis. Data analysis was done using R version 3.5.0 in the R Studio environment.

**Item Response Theory (IRT)**

Considering the unidimensionality of the items consisting of dichotomous responses of the knowledge, the section was analyzed by two-parameter logistic item response theory (2-PL IRT) analysis, using the ltm package version 1.0.0.

**Confirmatory factor analysis (CFA)**

Confirmatory factor analysis (CFA) was conducted to confirm the factorial structure of the KAP questionnaire identified in the EFA published in the other part of this study. The attitude and practice domains were analysed as recommended by lavaan package version 0.5–22.[18] Several indices indicated a good model fit for the construct, they include: the ratio of chi-square to degree of freedom ($\chi^2/df < 5.0$), root mean square error of approximation (RMSEA) \( \leq 0.08 \), comparative fit index (CFI) > 0.9, Tucker Lewis Index (TLI) > 0.9, and $p > 0.05$ for the chi-square test [19]. For composite reliability, semTools package version 0.4-14 5-6 was used to determine the Raykov’s rho [19, 20]. Hair et al (2009) suggested that model fitness can be decided by at least a minimum of three different indices. A good relationship between items and respective factors are shown by a standardized factor loading greater than 0.5 as well as a p-value of less than 0.05 and it therefore
further proves the validity of the construct. A composite reliability of the domains was calculated with a value of 0.7 and above was considered acceptable [21, 22].

Results

A total of 200 Umrah pilgrims responded to this study. On data screening, no missing data was found. The socio-demographic characteristics of the participants are shown in Table 1. The age of the participants from this study ranged from 18 to 80 years old with a mean age of 39.13 (SD 16.03). The females (65.5%) dominated the number of pilgrims.

Table 1
Socio-demographic characteristics of participants (n = 200)

| Variables                  | Mean (SD)     | Frequency (%) |
|----------------------------|---------------|---------------|
| Age (years)                | 39.13 (16.029)|               |
| Gender                     |               |               |
| Male                       | 65 (35.5)     |               |
| Female                     | 131 (65.5)    |               |
| Ethnicity                  |               |               |
| Malay                      | 197 (98.5)    |               |
| Indian                     | 1 (0.5)       |               |
| Others                     | 2 (1.0)       |               |
| Marital status             |               |               |
| Single                     | 89 (44.5)     |               |
| Married                    | 109 (54.5)    |               |
| Divorced/widowed           | 2 (1.0)       |               |
| Occupation                 |               |               |
| Student                    | 19 (9.5)      |               |
| Civil servant              | 37 (18.5)     |               |
| Private sector             | 95 (47.5)     |               |
| Pensioner                  | 22 (11)       |               |
| Housewife                  | 15 (7.5)      |               |
| Self-employed              | 12 (6)        |               |
| Highest level of education |               |               |
| PhD                        | 4 (2.0)       |               |
| Master’s degree            | 13 (6.5)      |               |
| Bachelor’s degree          | 42 (21.0)     |               |
| Diploma                    | 73 (36.5)     |               |
| Secondary school           | 54 (27.0)     |               |
| Primary school             | 14 (7.0)      |               |
| History of vaccination     |               |               |
| Meningococcal vaccine      | 60 (30)       |               |
| Influenza (flu) vaccine    | 29 (14.5)     |               |
| Pneumococcal vaccine       | 24 (12.0)     |               |
| Presence of Co-morbidities |               |               |
| Chronic lung disease       | 1 (0.5)       |               |
| Neuromuscular disease      | 9 (4.5)       |               |
| Allergic rhinitis          | 2 (1.0)       |               |
| Diabetes                   | 6 (3.0)       |               |
| Hypertension               | 29 (14.5)     |               |
| Heart disease              | 2 (1.0)       |               |
| Chronic kidney disease     | 2 (2)         |               |
| Immune deficiency disorders| 1 (0.5)       |               |

Table 2
Result of the IRT analysis in the knowledge section (n = 200)

| Items | b     | a     | λ    | \( \chi^2 \) (df = 8) | P values |
|-------|-------|-------|------|-------------------------|----------|
| 1     |       |       |      |                         |          |
| i     | Flu-like illnesses are caused by: |       |      |                         |          |
| i     | Virus | -1.04 | 3.12 | 0.87                    | 120.2    | < 0.001 |
| ii    | Bacteria | -0.54 | 2.16 | 0.78                    | 62.98    | < 0.001 |
| iii   | Allergies | -0.41 | 3.50 | 0.90                    | 100.55   | < 0.001 |
| 2     | Flu-like illnesses are spread by: |       |      |                         |          |
| i     | Water | 0.24  | 2.32 | 0.82                    | 88.76    | < 0.001 |
| ii    |       |       |      |                         |          |
### 3. Sharing towels with an infected person

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| ii | Sharing towels with an infected person | -0.32 | 3.95 | 0.94 | 52.78 | < 0.001 |
| iii | Dust | -0.86 | 2.24 | 0.79 | 26.19 | 0.001 |
| iv | Air | -1.10 | 3.39 | 0.88 | 24.34 | 0.002 |
| v | Shaking the hands of an infected person with a cough and/or cold | -0.16 | 1.90 | 0.75 | 52.42 | < 0.001 |

#### 3. Flu-like illnesses are spread quickly

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| iii | Dust | -0.86 | 2.24 | 0.79 | 26.19 | 0.001 |
| iv | Air | -1.10 | 3.39 | 0.88 | 24.34 | 0.002 |
| v | Shaking the hands of an infected person with a cough and/or cold | -0.16 | 1.90 | 0.75 | 52.42 | < 0.001 |

#### 4. The following persons are at an increased risk of flu-like illnesses:

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| i | Senior citizens aged 65 and older | -0.57 | 1.94 | 0.75 | 29.26 | < 0.001 |
| ii | Smokers | -0.14 | 3.08 | 0.87 | 75.46 | < 0.001 |
| iii | Asthmatics | -0.87 | 2.83 | 0.86 | 43.63 | < 0.001 |
| iv | Diabetics | 0.40 | 4.32 | 0.93 | 21.16 | 0.007 |
| v | People with arthritis | 0.43 | 2.34 | 0.80 | 50.84 | < 0.001 |
| vi | Those in crowded places/among a lot of people | -1.13 | 1.83 | 0.73 | 49.71 | < 0.001 |

#### 5. What are the complications of flu-like illnesses?

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| i | Pneumonia | -0.27 | 2.76 | 0.90 | 91.12 | < 0.001 |
| ii | Bronchitis | -0.14 | 2.93 | 0.91 | 126.49 | < 0.001 |
| iii | Difficulty in breathing | 0.64 | 6.26 | 0.88 | 22.80 | 0.004 |
| iv | Multi-organ failure | 0.55 | 2.85 | 0.89 | 170.57 | < 0.001 |

#### 6. The following practices can help protect you from flu-like illnesses:

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| i | Ensuring a healthy diet | -1.05 | 2.29 | 0.50 | 38.14 | < 0.001 |
| ii | Receiving vaccinations | -0.80 | 2.26 | 0.85 | 66.51 | < 0.001 |
| iii | Washing your hands with hand sanitizers | -0.86 | 6.29 | 0.78 | 15.08 | < 0.001 |
| iv | Covering your nose with your hands | -0.67 | 1.75 | 0.92 | 71.99 | < 0.001 |
| v | Wearing a face mask | -1.22 | 5.07 | 0.71 | 10.75 | < 0.001 |

#### 7. The following are reasons for wearing a mask:
|   | Being in crowded places | Factor loading | Reliability (Raykov’s rho) |
|---|--------------------------|----------------|---------------------------|
| i | -1.03 | 6.11 | 0.97 | 11.82 | < 0.001 |

|   | Being near people who are coughing | Factor loading | Reliability (Raykov’s rho) |
|---|-----------------------------------|----------------|---------------------------|
| ii | -1.26 | 4.83 | 0.96 | 20.75 | 0.008 |

|   | When I am sick | Factor loading | Reliability (Raykov’s rho) |
|---|----------------|----------------|---------------------------|
| iii | -0.91 | 4.33 | 0.94 | 49.03 | < 0.001 |

|   | A cloth facial mask is as effective as a 2-ply surgical facial mask | Factor loading | Reliability (Raykov’s rho) |
|---|-----------------------------------------------------------------|----------------|---------------------------|
| 8 | 1.02 | 1.29 | 0.60 | 60.85 | < 0.001 |

|   | If I am not sick, the used face mask can be stored in a bag for later use | Factor loading | Reliability (Raykov’s rho) |
|---|-----------------------------------------------------------------|----------------|---------------------------|
| 9 | 0.72 | 1.56 | 0.67 | 182.10 | < 0.001 |

Table 3
Results of CFA of the attitude section

| Factors            | Items                                                                                      | Factor loading | Reliability (Raykov’s rho) |
|--------------------|-------------------------------------------------------------------------------------------|----------------|---------------------------|
| Barriers to compliance | A3: Since the bird flu, SARS, MERS-COV and H1N1 crises are over, I no longer need to worry about contracting flu-like illnesses | 0.696 | 0.76 |
|                    | A8: I am generally opposed to wearing a face mask                                          | 0.555 |   |
|                    | A9: Flu vaccinations have unpleasant side effects                                          | 0.376 |   |
|                    | A10: I am influence by negative news about flu vaccines                                     | 0.751 |   |
|                    | A11: It is too much trouble to get a flu vaccine                                           | 0.751 |   |
| Self-motivation    | A4 If I have a flu-like illness, I may spread it to others                                  | 0.516 | 0.72 |
|                    | A5: I feel that someone that have influenza-like illness should:                           |               |   |
|                    | A5A: cover his mouth and nose with his bare hand when coughing or sneezing                | 0.603 |   |
|                    | A5B: cover his mouth and nose with a handkerchief when coughing or sneezing                | 0.402 |   |
|                    | A6: Influenza vaccines protects hajj pilgrims from influenza                                | 0.75 |   |
|                    | A7: Using a hand wash can prevent you from getting flu like illness                         | 0.652 |   |
|                    | A12A: I think coughs and the flu can be prevented by wearing a mask outside my house       | 0.424 |   |
|                    | A13: Wearing a well-fitting face mask is effective in preventing flu-like illnesses         | 0.431 |   |
Table 4
Results of CFA of the practice domain

| Factors                      | Items                                                                 | Factor loading | Reliability (Raykov’s rho) |
|------------------------------|-----------------------------------------------------------------------|----------------|----------------------------|
| Health lifestyle             | P1: I eat vegetables                                                  | 0.918          | 0.863                      |
|                              | P2: I eat fruits                                                     | 0.888          |                            |
|                              | P5: I use soap to wash my hands                                     | 0.664          |                            |
| Prevention practices         | P4: When wearing a mask, I test it to ensure it fits properly       | 0.535          | 0.827                      |
|                              | P6: I use disinfectant or disposable wipes or hand gel to wash my hands | 0.483          |                            |
|                              | P7: I use a washable cloth handkerchief to clean my hands           | 0.284          |                            |
|                              | P8: I wash my hands after:                                          |                |                            |
|                              | P8A: touching the personal items of someone who has a cough and/or cold | 0.744          |                            |
|                              | P8B: shaking hands with people who have a cough and/or cold         | 0.787          |                            |
|                              | P8C: touching doorknobs                                              | 0.692          |                            |
|                              | P9: I refrain from:                                                 |                |                            |
|                              | P9A: being close to those who cough or sneeze                       | 0.562          |                            |
|                              | P9B: shaking the hands of those who have a cough and/or cold        | 0.577          |                            |
|                              | P9C: often touching my nose                                         | 0.365          |                            |
|                              | P10: I received the flu vaccine                                      | 0.511          |                            |

In the knowledge section, IRT analysis results showed an acceptable range for both difficulty (− 3 to + 3) and the discrimination parameter on each of the items. However, all the items were retained because they had acceptable difficulty and discrimination values. The amount of information tapped by the items between − 3 and + 3 difficulty range was 93.1%. The unidimensionality assumption was not supported by the modified parallel test at α = 0.05 (p = 0.010). In terms of internal consistency reliability, Cronbach’s alpha was 0.9.

For the attitude domain, the two-factor model was then tested by CFA using an MLR estimation method. MLR was used because the data did not follow a multivariate normal distribution required by the MLR. Satisfactory model fitness was not demonstrated by the initial 12-item factor. To achieve the model fitness, the MI values were examined and re-analysed to achieve a better model fit. To be
included in the model, items with high correlated errors within the same factor will be considered. The two-factor model showed a good fit ($\chi^2$ [df = 6] = 43, $p < 0.001$; CFI$_{robust} = 0.928$; TLI$_{robust} = 0.890$; RMSEA$_{robust} = 0.063$; SRMR = 0.079) as shown in Table after correlated errors (A12A↔A13, $r = 0.341$; A3↔A9, $r = -0.267$; A5A↔A5B, $r = 0.265$; A8↔A7, $r = 0.268$; A8↔A9, $r = 0.240$; A10↔A4, $r = -0.237$; A10↔A7, $r = -0.191$; A3↔A5B, $r = 0.267$; A9↔A5B, $r = -0.168$; A10↔A5B, $r = 0.205$) were added. However, the two sub-domains under attitude (barriers to compliance and self-motivation) have correlation between them of $r = 0.444$. The composite reliability of the barriers to compliance and self-motivation factor all have satisfactory cut-off value of > 0.7.

For practice domain which comprises of 13 items, the two-factor model was analyzed by CFA. The model showed an acceptable fitness, as shown in Tables ($\chi^2$ [df = 64] = 31.49, $p < 0.001$; CFI$_{robust} = 0.903$; TLI$_{robust} = 0.882$; RMSEA$_{robust} = 0.073$; SRMR = 0.067). The correlations between the factors were: Healthy-lifestyle↔Prevention-practices ($r = 0.471$). The composite reliability of the healthy lifestyle and prevention practices factors were above the cutoff value of 0.7 (Raykov’s rho = 0.863 and 0.827), despite the low standardized loading for item P7.

**Discussion**

This study validated a Malay questionnaire for the KAP evaluation of Hajj pilgrims towards the prevention of respiratory tract infections. Overall, the results of the CFA for all the domains indicated that the measurement model for each construct are fit except the attitude domain that undergone through model modification to improve the model fit. Finding from this study could not be compared with the psychometric properties from other studies conducted on the knowledge, attitudes and practices on respiratory tract infection due to the paucity of documented and described validation process. Our findings support the originally developed two-factor sub-domain for each of the attitude and practice.

Based on the assumptions checking for multivariate, the data were not normally distributed for CFA. Therefore, MLR was the preferred method for fitting the CFA model to turn over the violation of the normality of the multivariate analysis. Due to the aforementioned reason, estimation of MLR was done using robust (Huber-White) with standard errors and a scaled test statistic that is hypothetically
matched the Yuan-Bentler test statistic [22, 24].

Our findings showed a reasonably good fit for the questionnaire, giving confirmatory details for the factor structure for both domains. All the fit indices (RMSEA, CFI, TLI, SRMR) are within acceptable values and therefore supported the construct validity [25]. There are numerous studies done in Malaysia which support the accepted values of the fit indices which is similar to the present study results [26–28].

The reliability of the various domains was based on the Raykov’s rho which accounts for what of each individual item stands for and its latent error, however, they provide much less biased estimate of Cronbach’s alpha. The attitude and practice factors of the KAP questionnaire had good reliability as shown by the reliability coefficients exceeding 0.70.

In this study, like much other research, has some limitations. Firstly, data were collected from Umrah pilgrims using a sampling that is non-random in nature and thus should not necessarily be considered representative of the population and may not be a similar experience to Hajj pilgrimage. Secondly, majority of the participants are of Malay race, future research should incorporate other race to make it heterogenous population. Finally, as stated earlier, this is the first study on confirmatory factor analysis of KAP on respiratory tract infection prevention in Malaysia and therefore comparison to other studies is not possible.

Conclusions
The KAP questionnaire has shown to have good validity, reliability and psychometric properties towards measuring knowledge, attitude and practice of Malaysian Hajj pilgrims towards prevention of respiratory tract infection.

Abbreviations
RTI: Respiratory tract infection; IRT: Item response theory; CFA: Confirmatory factor analysis; KAP: Knowledge, attitude, and practice

Declarations

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**Availability of data and materials**

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

**Authors’ contributions**

MDG, NNN and HH designed the research, developed the questionnaire, collected the data, and performed the statistical analysis; NNN, HH, WNA and AAB participated in the design, the development of the questionnaire, and the data collection and data analysis and critically reviewed the work and this report; and NWA, ZZD, and SN participated in the design and critically reviewed the statistical analysis and the work of this report. All authors read and approved the final manuscript.

**Competing interests**

The authors declare that they have no competing interest.

**Ethics approval and consent to participate**

Ethical approvals were obtained from the Human Research Ethics Committee of Universiti Sains Malaysia [ref no: USM/JEPeM/17020146]. The questionnaire was designed to be anonymous, and
informed written consent was obtained from every respondent. The data were kept confidential and the results would not identify the respondents personally.

Consent for publication

Not applicable

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