Original article

Psychometric properties of the household food insecurity assess scale among households with tuberculosis patients in South India

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Abstract. *Background/Aim: w*e conducted this study to assess the psychometric properties (construct validity and internal consistency) of the Household Food Insecurity Access Scale (HFIAS) in measuring household food insecurity among households with tuberculosis (TB) patients in South India. *Methods:* Cross-sectional analysis of data from large-scale cohort study under RePORT-India consortium, conducted between 2014 and 2019 amongst three districts of South India (Pondicherry district in Puducherry, Villupuram and Cuddalore in Tamil Nadu. Households with newly diagnosed smear positive TB patients aged ≥6 years were selected as study participants. Construct validity of HFIAS was assessed through exploratory and confirmatory factor analysis. Reliability assessment was done through Cronbach's alpha. *Results:* We found that 33.4% of the households with TB patients had food insecurity. The principal component analysis in this study found two-factor model for HFIAS, representing insufficient food quality and quantity. Both these factors explained 88% of the total variance. Confirmatory factor analysis also revealed acceptable goodness-of-fit indices for the two-factor model. The scale had very good internal consistency (Cronbach's α=0.92). *Conclusion:* The HFIAS tool has showed good validity and reliability to measure household food insecurity among TB households in South India.

Key words: Food Insecurity, Household Food Insecurity Access Scale, Tuberculosis, Validation Studies

Introduction

Undernutrition is an important public health problem, making people vulnerable to serious morbidity and mortality. World health Organization (WHO) has reported that almost half of the deaths amongst under-five children are linked to undernutrition (1). WHO report has also mentioned that nearly 462 million adults around the world suffer from undernutrition (1). To combat this problem, several agencies around the world such as WHO, Food and Agriculture Organization (FAO) of United Nations (UN) have called for action across key actionable areas to reduce undernutrition (1). Sustainable Development Goal (SDG) has a separate goal (goal 2) dedicated to end hunger and achieve food security in order to reduce the burden of undernutrition (2).

Food security is a complex and multi-dimensional issue, based on economic, social and physical access, amount, availability, security, preferences to certain group of foods and time (3). Measuring food security can provide information about one of the three dimensions at

any given point of time: utilization, availability and access. Scales/questionnaires measuring food insecurity mostly concentrate on the availability dimension, whereas the anthropometric indicators help in measuring the utilization dimension (4). However, a limited number of scales measure the access component of food security.

Food access is one of the major contributors to food insecurity as it represents the demand side of it (5). To identify this important dimension of food insecurity, USAID-funded Food and Nutrition Technical Assistance Project (FANTA) has developed a tool called "Household Food Insecurity Access Scale (HFIAS)" through its Academy of educational development. This tool is simple and easy-to-use, applicable with minor adaptations to various sociocultural or socioeconomic contexts (6).

The HFIAS scale has been validated for measuring food insecurity in various low middle-income countries (7-10). It has also been extensively studied in various parts of India such as Mizoram (11), Karnataka (12), Odisha (13), Delhi (14) and Maharashtra (15). However, all of these studies were conducted in the general population and the performance of this tool in capturing the access part of food insecurity in special or vulnerable groups like caregivers of patients with chronic conditions, urban poor settlements etc., is yet to be explored. Tuberculosis (TB) patients are one such vulnerable groups, as the disease disproportionately affects the poorer families & communities (16). Using a valid scale to measure food insecurity amongst households of TB patients is important, as it helps in identifying the vulnerable households requiring additional assistance in terms of socioeconomic benefits. Furthermore, it has been shown that undernutrition is linked to poor outcomes for TB patients (17). Hence, we conducted this analysis to assess the construct validity and internal consistency of HFIAS (Tamil version) among households with TB patients in Puducherry and Tamil Nadu.

Methods

Study setting and participants

We conducted this construct validation and reliability assessment using data from a large-scale cohort study under "Regional Prospective Observational Research for Tuberculosis (RePORT)-India Consortium". Under RePORT-India consortium, five teams are operating throughout the country. One of the team is based at Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER) in collaboration with Boston University, Boston Medical Center, and Rutgers University.

The cohort for this site was recruited from three districts of South India (Pondicherry district in Puducherry, Villupuram and Cuddalore in Tamil Nadu). Under the National Tuberculosis Elimination Programme, each of these districts has a TB unit, acting as nodal point for free provision of TB diagnostic and treatment services (through designated microscopy and peripheral health centres). Newly diagnosed smear positive TB patients aged ≥6 years diagnosed and enrolled under these centres and their household contacts were recruited for our study from 2014 to 2019. Details on the data collection process and procedure have been reported previously (18-21).

Study tool

HFIAS is a scale widely used to assess the food insecurity among the households in the past four weeks and was created for use in developing countries (6). This scale consists of nine questions under three domains: anxiety/uncertainty related to household food availability, insufficient food quality, and insufficient food quantity and its consequences. Each question is graded based on the frequency of occurrence over the past 28 days from 1-2 times to >10 times. Score ranges from 0 to 3 for each question and total scores ranges from 0 to 27. Higher score indicates increasing level of food insecurity with the final scores categorized into four groups ranging from food secure to mild, moderate, and severe food insecurity (6).

Translation

We adopted a two-step procedure to translate the HFIAS questionnaire into Tamil. First, two independent language experts (native Tamil speakers with English expertise) performed forward translation

of the standard English version of the scale into Tamil. They did not have any prior knowledge about the content, purpose or interpretation of the scale. Next, back-translation to English was done by a third native Tamil speaker with English expertise to construct the corrected version. This was further verified by native Tamil-speaking medico-social workers working under the institute and the final version was obtained. Grammatical and language-related errors in the final translated version were rectified by these experts.

Data collection

Ethic approval for the study was obtained from the JIPMER scientific advisory and ethics committee, institute review boards at Boston University, Boston Medical Center and Rutgers-New Jersey medical school. Data collection was started after obtaining informed written consent from the respondents in all the included households. Study teams interviewed participants and completed a pre-tested semi structured questionnaire with basic sociodemographic characteristics and HFIAS. Filled questionnaires were scanned and transferred to Boston University using "Verity Tele Form Information Capture System" software version 10.8 and it was then read into Microsoft Access database. Errors during the data entry process were reviewed and duly corrected by the on-site team in India.

Statistical analysis

Data were extracted from the RePORT-India consortium project database for the JIPMER site and analysis was performed using STATA version 14.2 software (StataCorp, College Station, TX, USA). First, the baseline demographic characteristics were summarized using descriptive statistics based on the type of variables. Continuous variables such as age were summarized as mean and standard deviation (SD), and categorical variables were summarized as proportions. Household food insecurity was reported as proportion with 95% confidence interval (CI).

Before performing the construct validation, two basic assumptions related to intercorrelation and sampling adequacy should be satisfied. First, Bartlett's test of sphericity was performed to check the intercorrelation of items in HFIAS followed by Kaiser Meyer Olkin (KMO) measures of sampling adequacy for factor analysis. Since both these assumptions were satisfied, we proceeded to perform the exploratory factor analysis (EFA) using principal component extraction with varimax rotation. Factors with eigenvalue (amount of variance explained by each factor) more than one were retained and interpreted as factor models. Factor loadings with values more than 0.4 were taken for the characterization of its factor model.

Further confirmatory factor analysis (CFA) was performed using structural equation modelling (SEM). It was done to test the results acquired from EFA and determine the goodness-of-fit of the obtained factor models. The following fit indices were used for evaluation of goodness-of-fit: comparative fit indices (CFIs), Tucker-Lewis Index (TLI), and standardized root mean square residual (SRMR). Acceptable cut-off for these indices were as follows: CFI ≥0.90, SRMR ≤0.10, and TFI≥0.90 (22). Internal consistency or reliability assessment of HFIAS was done using Cronbach's alpha coefficient.

Results

Sociodemographic characteristics

In total, 804 households with TB patients completed the study questionnaire. The mean age of the TB patients was 44.2 (14.2) years. Sociodemographic characteristics of the participants are presented in Table-1. The majority of the participants (79.1%) were males; nearly three-fourth (72.6%) of the participants were employed; about 16.8% had no formal education; almost three-fourth were currently married; more than one-fourth (27.2%) belonged to scheduled caste/scheduled tribe category.

In total, 269 households with TB patients (33.4%; 95%CI: 30.2%-36.8%) had food insecurity. Most of them (179/269) had severe food insecurity (66.5%) followed by moderate (72/269; 26.8%) and mild food insecurity (18/269; 6.7%).

Table 1. Socio-demographic characteristics of the study participants (N=804).

Characteristics	Frequency (%)
Age category (in years)	
<19	45 (5.6)
20-29	90 (11.2)
30-39	145 (18.0)
40-49	227 (28.2)
50-59	180 (22.4)
>60	117 (14.5)
Gender	
Female	168 (20.9)
Male	636 (79.1)
Educational status	
No formal education	135 (16.8)
Primary school	170 (21.2)
Secondary school	337 (42.0)
Higher Secondary	161 (20.0)
Marital status	
Currently married	598 (74.4)
Never married	141 (17.5)
Widowed/Divorced/Separated	65 (8.1)
Religion	
Hindu	716 (89.3)
Christian	54 (6.7)
Islam	32 (4.0)
Employment status	
Unemployed	91 (11.3)
Employed	583 (72.6)
Others	129 (16.1)
Caste	
OBC	579 (72.8)
SC / ST	216 (27.2)

OBC – Other Backward Class; SC – Scheduled Caste; ST – Scheduled Tribe;

Psychometric properties

Construct validity

Bartlett test showed very high significance (Chi-square 5220.30, p value < 0.001) indicating good intercorrelation between the items in HFIAS. KMO value was 0.877 indicating that almost 88% of the variance is likely to be explained by the two-factor model. This ensures the sampling adequacy to perform EFA as anything less than 0.5 is unacceptable. Table-2 displays the pattern from EFA conducted with PCA method. Two factors were retained as they had eigenvalue more than one (5.51 and 1.11) and the factor loadings were generated using varimax rotation. Factor 1 consisted of six questions (Item 4, Item 5, Item 6, Item 7, Item 8, and Item 9, related to insufficient food quantity) accounting for 48.03% of variance, whereas Factor 2 had remaining three items (Item 1, Item 2, Item 3, focusing on anxiety about food and insufficient food quality) explaining 25.60% of variance. Thus, together the two factors explained 73.63% of the variance.

The model obtained through EFA was further analysed by CFA. The two-factor models were generated using structural equation modelling as shown in Figure 1. CFA showed that the two-factor model had Chi-square value of 677.79 with p value < 0.001. This significant p-value is mainly due to the larger sample size, and a significant chi-Square statistic does not mean a bad fit necessarily, and should be seen as a consequence of higher sample size. Other goodness-of-fit indices revealed acceptable CFIs of 0.87, TLI of 0.83, and good SRMR of 0.07. Thus, the two-factor model revealed in the EFA showed adequate model fit in confirmatory analysis.

Reliability (internal consistency)

The reliability coefficient (Cronbach's alpha) for the HFIAS questionnaire was 0.92 indicating very good internal consistency.

Discussion

In this study, we applied the HFIAS to the newly diagnosed TB patients and checked its construct validity and reliability. Existing evidence on the use of HFIAS in India focuses primarily on the general population (11-15). Applying the scale to a vulnerable subset of the population is important, but transferability

Table 2. Factor loadings for rotated component matrix and internal consistency (Cronbach's alpha) for households' responses to nine questions from HFIAS (n=804).

HFIAS items	Factor - 1	Factor - 2
Item 1: Worry that the household would not have enough food	**0.5374**	**0.5837**
Item 2: Any household member not able to eat the kinds of foods preferred because of lack of resources	**0.3348**	**0.8483**
Item 3: Eat a limited variety of foods due to a lack of resources	**0.1159**	**0.9017**
Item 4: Any household member have to eat some foods that really did not want to eat because of a lack of resources to obtain other types of food	**0.7327**	**0.3519**
Item 5: Any household member have to eat a smaller meal than needed because there was not enough food	**0.8425**	**0.2279**
Item 6: Eat fewer meals in a day because there was not enough food	**0.8438**	**0.1863**
Item 7: There ever no food to eat of any kind in your household because of lack of resources to get food	**0.8099**	**0.2196**
Item 8: Any household member go to sleep at night hungry because there was not enough food	**0.8185**	**0.2863**
Item 9: Any household member go a whole day and night without eating anything because there was not enough food	**0.7900**	**0.3001**
Eigenvalue	**5.52**	**1.11**
Percentage of variance explained	**48.03%**	**25.60%**
Cronbach's alpha	**0.92**	

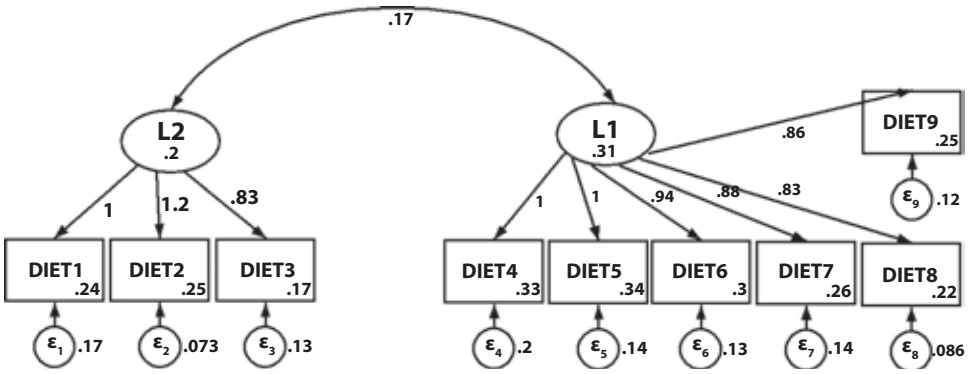

Figure 1. Evaluated model of HFIAS structure generated through structural equation modelling. L1: Latent variable 1 (Factor 1), L2: Latent variable 2 (Factor 2), diet1–diet9: nine items from HFIAS.

of these findings to a regional language is challenging. The Tamil version of HFIAS, more specifically, to assess the level of food insecurity among patients with TB, is currently not in use. Hence, we evaluated the HFIAS scale in Tamil language (native language in the study setting) and checked whether the scale is internally valid and reliable.

The factor analysis in this study found two-component model for HFIAS, representing insufficient food quality and insufficient food quantity. Similar two-component model was found in previous studies conducted in low middle-income countries such as Iran (7), Tanzania (9) and Ethiopia (23). However, the main difference across the studies is that our

study found last six items loaded on factor 2 in the model, whereas the study conducted in Iran7 reported last four item on factor 2 and in Ethiopia (23), last three items loaded on factor 2. In addition, previous study conducted by Coates et al (24) described the first item as a separate domain (anxiety about food availability), while our study did not find it as a separate domain and was loaded under the first principal component (insufficient food quality). This difference in the factor model between different countries has certain important implications. It indirectly indicates the perception of the people across various settings regarding the various components of food security. Study conducted in high income countries like USA have reported anxiety about food availability as a separate domain indicating its importance in such settings (24). In low and low middle-income countries, it is merged with the insufficient food quality or quantity (7,9,23).

In our two-factor model that evolved, all the factor loadings had high and statistically significant values. Furthermore, CFA findings to compare and evaluate the goodness-of-fit of two-factor structure also showed acceptable to good CFI, TFI, SRMR and RMSEA. The reliability assessment showed a Cronbach's alpha value of 0.92 for HFIAS. This finding was also comparable with the previous regionally translated versions of HFIAS and other similar scales across the world (7,9,23-26). This highlights the fact that the scale had very good internal consistency similar to other regional forms of the questionnaire, despite the lingual, regional and cultural differences.

One major reason for such consistent findings across the various studies conducted around the world is the similarity in food insecurity experiences by the households. Experiences, ranging from worrying or anxiety to coping or adapting to the food quality and quantity makes the tool easily adjustable to wider audience across the world (23). However, most of the evidence studying the validation of HFIAS has indicated that further changes with respect to the order of questions are required to improve the use of this instrument (7,23). This was mainly because people tend to answer questions depending on the order, and the scale has certain questions that are not in the optimal sequence. For example, households first tend to suffer from fewer meals followed by smaller meals (24). However, HFIAS asks questions related to smaller meals before asking about fewer meals. Further studies based on the order of households' experience with respect to the nine items in HFIAS and its response towards progression of food insecurity is warranted.

Our study has the following strengths. To the best of our knowledge, this was the first study to validate the Tamil version of HFIAS among TB patients in an Indian setting. Further, this study was conducted with a large sample size of TB patients, which makes the generalizability of study findings better than some other studies. Still, our study also had certain limitations. We were not able to assess the test and retest reliability as the study was done at a single cross-sectional point of time. The results obtained in this study might have also been influenced by the participants' understanding of the questions and their expectations of possible support from the data collectors. In addition, the patients seeking treatment from public health facilities were only included in this study, and therefore our sample may not be representative of all the TB individuals present in the community.

Many countries around the world have developed considerable interest in the use of HFIAS as their national food insecurity assessment tool, with some countries already having adapted the same (25). Such a simple, rapid and low-cost scale can be of great use for screening for household food insecurity to provide valuable information on the food-insecure, especially among a vulnerable population like TB patients. This will help policymakers to make decisions based on evidence and advocate for formation and implementation of policies and programmes improving the food security and nutritional aspect of TB patients. Further research is warranted to establish the construct validity of the instrument, as it is a continuous process of evaluation, re-evaluation, refinement, and development. Future directions in research need to be considered for tackling the cross-cultural measurement invariance among TB patients.

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Ethical Approval: The study protocol was approved by the Institute Ethics Committee and Scientific Advisory Committee of JIPMER, and the Institutional Review Boards at Boston University Medical Campus and Rutgers-New Jersey Medical School.

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