Validation of the Malay version of Food Insecurity Experience Scale (M-FIES) using Rasch analysis

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ABSTRACT

Introduction: Food security can be defined as the availability of and accessibility to food, acquired in an acceptable means at any given time and place in a way that could maintain health and wellbeing. One critical dimension of food security is continued access to adequate food. To measure this dimension, the Food and Agriculture Organization (FAO) developed the latest measurement tool, namely the Food Insecurity Experience Scale (FIES), the first instrument to measure people who experience food insecurity globally. This study aimed to validate the construct validity and reliability of the Malay version of FIES (M-FIES) for Malaysians. **Methods:** This cross-sectional study was conducted among 145 households in Kuantan, Pahang. Rasch analysis was used to analyse the construct validity of FIES. **Results:** FIES met the Rasch model assumptions with all items having an infit value of between 0.7-1.3 and an outfit value of <2.0. The item and person reliability were 0.97 and 0.71, respectively; while the item and person separation were 5.59 and 1.58, respectively. The FIES item severity indicated that the items "few food", "healthy", "skipped", "ate less", and "runout" were disordered. **Conclusion**: The M-FIES is a valid and reliable measurement tool for the food insecurity situation among households based on its construct validity assessed using the Rasch model. Furthermore, the severity of item in M-FIES was different in terms of order from the original FIES, suggesting that the same items may be interpreted differently due to cultural or societal differences.

Keywords: FIES, food insecurity, Rasch measurement, reliability, validity

INTRODUCTION

Food security is a public health issue in both developed and developing countries. Food security exists "when all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy life" (FAO, 2008). While this concept is widely recognised, there is still a lack of a universal criterion for measuring the frequency and severity of

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food insecurity across nations, languages, and cultures. Moreover, measuring food security seems challenging due to the complexity of the concept and definition. The experience-based food insecurity scale is a commonly used indicator and can be considered as an accurate direct indicator (Pérez-Escamilla, 2012).

These experience-based food security measurement tools have been used for two decades (Radimer et al., 1992). The first experience-based food security scale was the United States Food Security Survey Module (USFSSM), which had been used by the U.S. government to monitor food security and guide policies. Since then, the experience-based food security scale has been widely used to assess food security at the individual and household levels in a variety of countries (Atuoye et al., 2019; Akinboade & Adeyefa, 2018; Mohammadi et al., 2011; Owino, Wesonga & Nabugoomu, 2014) because it allowed researchers to understand the determinants of food insecurity from an individual-, household-, national-, to global level (Smith, Kassa & Winters, 2017).

In 2013, the Food Insecurity Experience Scale (FIES) was developed based on USFSSM, Household Food Insecurity Access Scale (HFIAS), and Latin American and Caribbean Food Security Scale (ELCSA) (Smith et al., 2017; Ballard, Kepple & Cafiero, 2013). The FIES's real innovation is that it gives results that are comparable across countries. According to the Gallop World Poll (GWP) survey, FIES has been used by 153 countries for the purpose of Sustainable Development Goals (SDG2) (Cafiero et al., 2018; Smith, Kassa & Winters, 2017).

FIES can be used as a metric for measuring food insecurity at the household or individual level, depending on people's direct answer of a YES or NO to eight dichotomous questions regarding access to adequate food (Cafiero, Viviani & Nord, 2018). The items are based on reported behaviours and experiences of having to compromise the quality and amount to access food due to lack of financial support at various levels of severity. Besides, FIES also includes the psychological components of anxiety and uncertainty due to inability to obtain sufficient food (Ballard et al., 2013).

The advantage of FIES is that it enables measurement of food insecurity, which can then be analysed together with indicators of its determinants and consequences. The results can inform policy that allows more detailed analysis on the food insecurity situation by gender, income, age, race/ethnicity, geographic location or other policy-relevant characteristics for more effective policies and interventions.

Malaysia is ranked 39th out of 113 countries by the Global Food Security Index 2021 and is committed to improve and combat food insecurity in the country. However, the prevalence of moderate and severe food insecurity is still escalating from 15.1% in 2017 to 18.7% in 2019. The Poverty Line Index (PLI) also increased from 5.6% in 2017 to 8.4% in 2019 (World Bank, 2019). The PLI is an indicator that reflects the sufficiency of income to purchase ample amount of nutritious foods including fish, poultry, meat, cereal, bread, rice, eggs, vegetables, and milk without neglecting other basic needs such as clothing, house rental, transportation, education, and healthcare (EPU, 2019). The current PLI of Malaysia is RM2,208, which means that households in Malaysia with monthly incomes below this level are considered poor (EPU, 2019). Comparing the pattern of PLI and the prevalence of moderate and severe food insecurity, it is shown that the trend of food insecurity is sequential to PLI, which means that more households with food insecurity have been living below PLI. The unprecedented COVID-19 pandemic that spread worldwide in the late 2019 had negative implications on food security and nutrition, where it drove up food insecurity in Malaysia.

Translation of FIES into the Malay language had been done earlier (Roselawati *et al.*, 2021). However, it has not been appropriately validated in the Malaysian population. Therefore, this study aimed to assess the internal validity and reliability of M-FIES for measuring food insecurity among the Malaysian population.

MATERIALS AND METHODS
Sample and population
This cross-sectional study was carried out among 145 households, based on the Rasch sample size calculation with ±0.5 logit and confidence at 99% (Azrilah, Mohd Saidfudin & Azami, 2013), in selected urban and rural areas of Kuantan, Pahang. The list of urban and rural areas in Kuantan was obtained from the local government authority – *Majlis Perbandaran Kuantan (MPK)*. The study site was randomly selected, but the participants were selected based on purposive sampling. The inclusion criterion was married women of reproductive age between 19 and 49 years old. Women were chosen because they are responsible for food production, purchasing and preparation, and are the key person to household food security (Kardooni *et al.,* 2014). Those who were lactating and pregnant were excluded.

The Food Insecurity Experience Scale (FIES)
The FIES was translated from English to Bahasa Malaysia and these translation steps have been explained thoroughly elsewhere (Roselawati *et al.*, 2021). The FIES consisted of eight questions about the behaviours and experiences regarding food insecurity. Participants were required to answer 'yes' or 'no' to all 8 questions, which were provided with a raw score of 0 for negative response and 1 for an affirmative response. The total FIES score was the sum of scores from all 8 questions and it was then further classified into the following levels of severity: food security (0), mild food

insecurity (1-3), moderate food insecurity (4-6), and severe food insecurity (7-8) (Jones, 2017).

Statistical analysis
Rasch model
The Rasch analysis was performed to examine the psychometric properties of M-FIES. Rasch analysis was used to investigate the presence of unidimensionality, item hierarchy, and item appropriateness. The software used in data analysis was based on standard procedure and extreme raw score (0 and 8) was excluded (Bond & Fox, 2007). The Rasch assumptions were: 1) the items discriminate equally, where the items are related to latent trait; and 2) the items are independent and unidimensional, meaning the response to the item is independent and only 1 latent trait is measured (Nord, Cafiero & Viviani, 2016). Rasch transformed raw scores into continuous data with equal interval units called logit, representing the severity of the latent trait measured by the raw score (Schuttle *et al.,* 2016).

The Rasch modelling output included the infit and outfit statistics calculations. The assumption of equal discrimination, primarily the infit value and the outfit value, was used to identify the occurrence of erratic responses. The infit statistic is useful for identifying items that did not perform well in a given population. Infit of <0.7 is considered low, indicating the presence of redundant items, whereas 0.8-1.3 is considered an adequate infit and >1.3 is considered a high infit, which means weaker discrimination. An infit item value of more than 2.0 indicates misfit and an item should be considered dropped from the scale. High infit can be due to problems with translation, suggesting a question was not fully understood. Nevertheless, infit of between 1.3 to 1.5 indicates that items can still be used but need some improvements to the questions. Low infit (below 0.5) indicates item redundancy. While the interpretation of outfit is

almost similar to infit, the former is more sensitive to outliers. An outfit statistic of >2 is considered high. High outfit is due to unusual participant response patterns, for example, misunderstanding of items by respondents. If the infit statistic shows good results, high outfits are usually discarded and not usually considered as criteria for eliminating items.

Reliability in the Rasch analysis (separation index) indicated the 'reproducibility of relative measure location'. In this case, high person or item reliability indicates the likelihood that the persons or items possess high measures compared to persons and items that possess low measures. The ideal value for person reliability should be greater than 0.8 and the value for item reliability should be greater than 0.9 (Fisher, 2007). Meanwhile, the person separation index (PSI) was used to classify a person into high or low performer. A low PSI value indicates that the instrument is not sensitive enough to classify people into low or high performance. The ideal value of PSI should be greater than 2.0 (Fisher, 2007). On the other hand, item separation index (ISI) was used to confirm the existence of item hierarchy in the instrument. A low ISI value indicates a restriction in the sample size to verify the item's difficult hierarchy.

Ethical approval
Ethical approval was obtained from the IIUM Research Ethics Committee (IREC) (IIUM/504/14/11/2/REC 2019-131). In addition, consent was obtained from participants prior to answering the survey.

RESULTS

Fit statistics and overall reliability of FIES
Table 1 shows the infit and outfit statistics of M-FIES. All eight items had acceptable infits ranging from 0.7 to 1.3, generally considered to have met the Rasch assumptions that all items discriminated equally and adequately. For outfit statistic, the items in this measurement also met the assumptions of the Rasch model. All items had an outfit value of <2 (Table 1).

The ordering of the FIES items
The Rasch model analysis was based on eight items (Table 2). The severity parameter was estimated based on the overall respondents' response to the eight items, whether they affirmed or denied the items. The more severe the item, the less likely the respondent would say "YES" to it. The M-FIES item severity parameters indicated that only items 1, 7, and 8 performed as expected. Items 7 and 8 "whole day" and "hungry"

Table 1. The overall fit statistics for FIES

Items	Infit		Outfit		Point measure correlation
	MNSQ	ZSTD	MNSQ	ZSTD	
WORRIED	1.22	1.28	1.14	0.42	0.24
HEALTHY	0.78	-1.24	0.60	-0.77	0.82
FEWFOODS	1.01	0.10	1.22	0.55	0.78
SKIPPED	1.10	0.46	1.75	1.06	0.72
ATELESS	0.88	-0.50	0.57	-0.54	0.80
RUNOUT	0.92	-0.24	0.46	-0.64	0.76
HUNGRY	0.70	-0.77	0.25	-0.65	0.59
WHOLEDAY	1.28	0.59	0.83	0.04	0.17
Mean	0.99	-0.04	0.85	-0.07	

MNSQ=Mean square, ZSTD=Z-standardised

Table 2. Proportion of affirmative responses to FIES items, item severity parameter, and item order

Item order	Severity±SE	Percentage of affirmative (%)
WORRIED	-4.74±0.36	42.8
FEWFOOD	-2.80±0.32	24.8
HEALTHY	-1.94±0.33	30.3
ATELESS	-0.85±0.37	13.1
RUNOUT	0.37±0.42	18.6
SKIPPED	0.37±0.42	13.1
HUNGRY	3.20±0.59	4.8
WHOLEDAY	6.40±1.07	0.7

SE=Standard error

were the most severe items with item severity of 0.64 and 0.32, respectively. This result also indicated that the items were least likely to obtain a response of "YES" and most respondents rarely experienced both situations in the past 12 months.

The M-FIES item severity (Table 2) indicated that items "few food", "healthy", "skipped", "ate less", and "runout" were disordered. The item "healthy" was indicated as more severe than "few food", while the item "skipped" was more severe than "ate less" and "runout". Our item severity order results were consistent with the results of the response patterns; when the severity of food insecurity increased, the affirmative response decreased.

The eight items' item reliability, person reliability, and separation indexes were excellent. The item reliability was found to be 0.97, while the item separation was 5.59. High reliability showed that items with high measures were confirmed to have higher measures compared with items with low measures. Item separation index was used to verify item hierarchy. An increased item separation index indicated that the study's sample

size was adequate to assure the item difficulty hierarchy.

Person reliability and separation indices were 0.71 and 1.58, respectively, indicating good reliability. High person reliability suggested a high probability of the person with a high measure compared to a person with a low measure. The purpose of person separation was to clarify the person. However, the items were not good enough to categorise the person based on different food security statuses.

DISCUSSION

In Malaysia, adult food insecurity was estimated to be within 47% to 100%. These varied and inconsistent findings were due to the different measurement tools used (Norhasmah *et al.,* 2021). The Malaysian sub-populations vulnerable to food insecurity include adults from low-income households, indigenous people, university students, the elderly population, and migrant workers. Thus, a valid and reliable tool that can be used as a standard measurement tool is necessary. This study was among the first study to examine the construct

Table 3. Summary statistics from Rasch analysis

Questions	Reliability		Separation	
FIES	Item	Person	Item	Person
	0.97	0.71	5.59	1.58

validity of M-FIES. The findings of this study provide a significant contribution to the existing measurement tool, especially for the study of food security in Malaysia.

In this study, M-FIES has been shown to be a valid and reliable instrument to measure food security status of Malaysians, even though the tool originated from the United States. Previously, Rasch analysis has been used to validate FIES in other regions, including Sub-Saharan Africa (Na *et al.,* 2019; Sadiddin *et al.,* 2019), Latin America and the Caribbean (Smith *et al.,* 2017), United States, United Kingdom, Australia, New Zealand, as well as East and South Asia (Jones, 2017). Using the same method of Rasch analysis, FIES showed good item infit and outfit, good item and person reliability, and stability of item hierarchy (Na *et al.,* 2019; Sadiddin *et al.,* 2019), thus proving itself to be relevant for assessing food insecurity experiences.

In the present study, all items showed adequate fit, which means that all items were associated with the latent trait and discriminated equally (Argawal *et al.,* 2009), implying that the M-FIES was correctly translated (Roselawati *et al.,* 2021). In this study, the outfit values were within the acceptable range. Some countries reported a high outfit for the item "whole day" and FAO reported identical results in the global 2014 GWP data analysis. This was mainly due to an unusual respondents' response pattern and the items should be attempted through cognitive testing (FA0, 2016). However, even if an item has a high outfit, but its infit is excellent, it is not indicative of any serious violation of the Rasch model assumptions. Our results also indicated a positive point measure correlation with the latent trait that should be measured.

The fundamental feature of M-FIES is that the order of the questions along the scale cannot be considered fixed across populations or countries. In different populations or sub-populations, the severity of the eight items may vary based on the nuances of the translation that the same questions may be interpreted in different ways in different contexts. Moreover, food insecurity conditions are experienced or managed differently in different cultures. According to the severity value calculated by the Rasch model, differences in severity level are based on the affirmative response pattern. Severe item is usually denied compared to less severe item. The items of M-FIES in this study were disordered and it was noted in many countries due to its construct validity. The items "few food", "healthy", "skipped", "ate less", "runout" were disordered. The item "healthy" was indicated as more severe than "few food", while the item "skipped" was more severe than "ate less" and "runout'. This suggests that eating a few types of foods and eating less food is commonly related to the culture in Malaysia. This finding is consistent with a study done using FIES in Sub-Saharan Africa (Wambogo *et al.*, 2018). The item "worried" about food was the least severe item.

According to the list of items in Table 2, the pattern of this result implies that households that first experience food insecurity would first experience anxiety or worries about getting food. Then, the household eats the same kind of food and jeopardises quality. As the situation worsens, they reduce the quantity of food taken. When the household runs out of food as a result of food insecurity, it will be forced to drastically reduce the number of meals and food consumption, experience hunger and will eventually not be able to eat for the whole day. These findings are aligned with the theoretical framework of the experience-based food insecurity as a managed process. However, the process might differ based on cultural and other factors (Radimer *et al.* 1992; Ballard *et al.,* 2013; Coates *et al.,* 2006).

Table 4. The Food Insecurity Experience Scale

Item	Item code
You or others in your household worried about not having enough food to eat because of a lack of money or other resources? *Anda atau ahli-ahli dalam isi rumah anda risau tidak mempunyai makanan yang cukup kerana kekurangan wang atau sumber-sumber lain?*	[WORRIED]
Still thinking about the last 12 MONTHS, was there a time when you or others in your household were unable to eat healthy and nutritious food because of a lack of money or other resources? *Masih memikirkan 12 BULAN yang lepas, adakah anda atau ahli-ahli dalam isi rumah anda tidak dapat makan makanan yang sihat dan berkhasiat kerana kekurangan wang atau sumber-sumber lain?*	[HEALTHY]
Was there a time when you or others in your household ate only a few kinds of foods because of a lack of money or other resources? *Adakah anda atau ahli-ahli dalam isirumah anda makan hanya beberapa jenis makanan sahaja kerana kekurangan wang atau sumber-sumber lain?*	[FEWKINDS]
Was there a time when you or others in your household had to skip a meal because there was not enough money or other resources to get food? *Adakah anda atau ahli-ahli dalam isi rumah anda terpaksa meninggalkan satu waktu makan kerana kekurangan wang atau sumber-sumber lain untuk mendapatkan makanan?*	[SKIPPED]
Still thinking about the last 12 MONTHS, was there a time when you or others in your household ate less than you thought you should because of a lack of money or other resources? *Masih memikirkan 12 BULAN yang lepas, adakah anda atau ahli-ahli dalam isirumah anda makan kurang daripada apa yang sepatutnya anda makan kerana kekurangan wang atau sumber-sumber lain?*	[ATELESS]
Was there a time when your household ran out of food because of a lack of money or other resources? *Adakah isi rumah anda kehabisan makanan kerana kekurangan wang atau sumber-sumber lain?*	[RUNOUT]
Was there a time when you or others in your household were hungry but did not eat because there was not enough money or other resources for food? *Adakah anda atau ahli-ahli dalam isi rumah anda berasa lapar tetapi tidak makan kerana tidak mempunyai wang atau sumber-sumber lain yang cukup untuk makanan?*	[HUNGRY]
During the last 12 MONTHS, was there a time whenyou or others in your household went without eating for a whole day because of a lack of money or other resources? *Adakah anda atau ahli-ahli dalam isirumah anda tidak makan sepanjang hari kerana kekurangan wang atau sumber-sumber lain?*	[WHOLEDAY]

(Source: Roselawati *et al.*, 2021)

The limitation of this study was that the selection of study sites for both urban and rural areas was randomised, but the selection of participants was based on purposive sampling, which is not the best method of sampling for representativeness. However, the strength of this study is that it was the first study that translated and validated FIES in a rural and urban setting. The translation and validation of FIES followed the recommended and established guidelines by WHO. The use of Rasch analysis in determining the construct validity of FIES was a novel approach as the validated version can now be used as a tool to measure food insecurity among Malaysians in national surveys. Moreover, it is suggested that the validation of M-FIES should be done in other populations, including Chinese and Indian, with a larger sample size to ensure that the Malay version of FIES is valid and reliable for the Malaysian population.

CONCLUSION

In conclusion, this study revealed that the M-FIES is a valid and reliable tool for measuring the prevalence of food insecurity among households. Furthermore, the item order in evaluating the severity of food insecurity in M-FIES was fundamentally different from the original FIES, suggesting that the same item may be interpreted differently due to cultural or societal differences.

Authors' contributions
Wan Azdie MAB, principal investigator, conceptualised, designed the study and reviewed the manuscript; Roselawati MY, conducted data collection, ran the analysis and wrote the manuscript; Suriati S, Jamalludin AB, Norhasmah S, Nurul Hazirah J, Noraishah MN, provided advice on data analysis, interpretation of the results and reviewed the manuscript.

Conflict of interest
None declared.

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