Jordan Journal of Agricultural Sciences, Volume **20**, No.**3 2024**
DOI :https://doi.org/10.35516/jjas.v20i3.1662

Is the Food Insecurity Experiences Scale (FIES) A Valid Tool for Assessing Food Insecurity in Sudan?

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Received on 27/8/2023 and Accepted for Publication on 14/2/2024.

ABSTRACT

Food insecurity is a widespread issue globally, and the Food and Agriculture Organization (FAO) developed the Food Insecurity Experience Scale (FIES) to measure different levels of food insecurity severity. The FIES includes eight questions that assess people's access to sufficient and quality food. This study aims to examine the reliability and validity of using the FIES as a measurement tool for food insecurity and to provide guidance for policymakers to address hunger and ensure food security in Sudan. A sample of 330 households from the White Nile State in Sudan was chosen to complete the FIES questionnaire. The collected data was then analyzed using descriptive statistics, Alpha Cronbach's, and exploratory factor analysis (EFA). The FIES results indicate that approximately 33.6% of households are moderately affected by food insecurity, while 37.9% experience severe food insecurity. The Alpha Cronbach's coefficient confirms that the FIES questions display acceptable internal consistency. Moreover, the EFA results reveal two main components that account for about 60.7% of the total variance in the FIES questions. Consequently, this study recommends the FIES as a reliable and valid tool for assessing food insecurity in Sudan.

Keywords: Food Insecurity Experience Scale (FIES), Alpha Cronbach's, Exploratory Factor Analysis (EFA), Food insecurity, Sudan.

INTRODUCTION

Food insecurity arises when individuals face challenges in accessing or acquiring food due to limited resources. In this situation, people experience restricted physical, and socioeconomic means to obtain sufficient, safe, and nutritious food necessary for a healthy and active lifestyle (FAO, 1996). Various interconnected factors contribute to this issue. Firstly, inadequate food consumption stemming from poor diet quality impacts food insecurity (Bocquier et al., 2015; Ranjit et al., 2021). Secondly, low household income exacerbates food insecurity (Shinwell and Defeyter, 2021). Thirdly, poverty increases the risk of food insecurity (Pirrie et al., 2020; Headey et al., 2022). Fourthly, unemployment and job losses make individuals more susceptible to food insecurity (Raifman et al., 2021; Ebrahim and Andualem, 2022). Consequently, those affected by food insecurity also face inadequate access to health care and suffer from poor health (Pruitt et al., 2016). However, the severity and frequency of these factors contribute to different forms of food insecurity. Thus, an individual can be classified as food insecure if they lack regular access to enough safe and nutritious food for normal growth, development, and

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a healthy and active life (FAO, IFAD, UNICEF, WFP, and WHO. 2023).

In 2021, approximately 924 million people, or 11.7% of the global population, experienced severe food insecurity, while nearly 2.3 billion people, or 29.3%, were moderately or severely food insecure. Additionally, almost 3.1 billion individuals were unable to afford a healthy diet (FAO, IFAD, UNICEF, WFP, and WHO, 2022). These statistics indicate a growing number of people without access to safe and nutritious food. To measure the severity of food insecurity, the Food Insecurity Experiences Scale (FIES) was developed by the FAO. This scale consists of eight questions that capture experiences related to lack of access to food procurement (FAO, 2018; FAO, IFAD, UNICEF, WFP, and WHO, 2017). The FIES is unique in its aim to ensure equivalence and validity across different countries and populations (FAO, IFAD, UNICEF, WFP, and WHO, 2017). It can provide comparable indicators of food insecurity with varying degrees of severity. Many recent studies have utilized the FIES to assess food insecurity in different countries (Helmi et al., 2018; Wambogo et al., 2018; Alvarez et al., 2021; Sheikomar et al., 2021).

Sudan is facing significant challenges when it comes to food security, making it one of the most food-insecure countries globally. This issue is widespread throughout the nation and has resulted in serious problems like chronic hunger and malnutrition. The World Food Programme (WFP, 2022) has identified multiple factors that contribute to the difficulty in accessing food for the Sudanese population, including wars, conflicts, climate change, poor harvests, and economic instability, such as high inflation and *low purchasing power of the local currency*. As a consequence, more than 15 million Sudanese people are currently experiencing food insecurity. According to the Global Hunger Index, Sudan has a serious level of hunger, scoring approximately 28.8 in 2022 (*Klaus* et al., 2022). Consequently, accurately assessing the food insecurity situation in Sudan is crucial for policymakers, international organizations, and food relief agencies. To this end, various recent studies have been conducted in Sudan using different tools and measurements to determine the extent of food insecurity (Bushara and Ibrahim, 2017; Nour and Abdalla, 2021; WFP, 2021; Elzaki et al., 2022).

This study aims to demonstrate the effectiveness of using FIES as a quick and efficient method for evaluating food insecurity within households. The use of FIES in Sudan to monitor and measure food insecurity has not been extensively studied in recent years. Therefore, this research seeks to *examine the reliability and validity of using FIES as a measure of food insecurity in Sudan*. By doing so, policymakers and food aid organizations can make informed decisions to ensure household food security.

Research Methodology

Study Area and Sampling:

The White Nile State, situated in the southern region of Sudan, is comprised of nine localities and had an estimated population of 2,493,880 individuals in 2018(CBS, 2018). A sample of *approximately* 330 households was randomly chosen from two locations, Al Gutaina and Ed Dueim. WFP (2021) states that the White Nile State is characterized by high expenditure on food and inadequate food consumption. Additionally, the state is home to a significant number of refugees, around 275,500, and approximately 124,000 people in the state suffer from malnutrition (OCHA, 2022). Therefore, the White Nile State was selected as the study area due to these factors.

Questionnaire Design:

The FAO Food Insecurity Experience Scale (FIES) is a tool designed to assess experiences of food insecurity. It is a simple and quick self-reporting method that measures food-related behaviors and experiences. A series of specific questions are asked of households to understand their access to food over 12 months. The FIES comprises eight questions that inquire about people's ability to obtain adequate food in times of limited income or resources. These questions elicit yes or no responses to determine the severity of food insecurity (*INDDEX project, 2018*). The FIES questionnaire was translated

into Arabic to examine whether households lacked money or resources in the last 12 months. Table 1 provides a list of the FIES questions and their corresponding references. Each question is answered with a yes or no, with a score of 1 or 0 assigned accordingly. The total score is calculated by summing up the raw scores for each answered question. This total score is then used to determine the level of food insecurity. The data was analyzed using SPSS version 26.

Table 1: FIES questions and short references

During the last 12 months, was there a time when…., because of lack of money or other resources		Quick references
1	You were worried you would not have enough food to eat? (Yes/No)	WORRIED
2	Are you unable to eat healthy and nutritious food? (Yes/No)	HEALTHY
3	Did you eat a few kinds of foods? (Yes/No)	FEWFOOD
4	You had to skip a meal? (Yes/No)	SKIPMEAL
5	You ate less than you thought you should? (Yes/No)	ATELESS
6	You ran out of food? (Yes/No)	RANOUT
7	You were hungry but did not eat? (Yes/No)	HUNGRY
8	Did you go without eating for a whole day? (Yes/No)	WHOLDAY

Data Analysis:

Internal Consistency of the FIES Questionnaire with Alpha Cronbach's

The Alpha Cronbach test of internal consistency describes the extent to which all questions in the FIES measure the same underlying construct of food insecurity. This reflects the context of the questions within the FIES. The Alpha Cronbach is used to reflect the interrelationship and dimensionality of the FIES questions. Tavakol and Dennick (2011) suggest that a value between 0.70 and 0.95 for Alpha Cronbach indicates acceptable internal consistency among the questions.

Exploratory Factor Analysis (EFA)

Exploratory factor analysis (EFA) is a statistical method commonly used to evaluate the construct validity of self-report scales (Williams et al., 2010). Numerous studies have applied EFA to examine food insecurity issues (Ahmed et al., 2014; Helmi et al., 2018; Grimaccia and Naccarato, 2020). A sample size of approximately 330 households is considered sufficient for conducting EFA (Gorsuch, 1983; Pett et al., 2003). The mean and standard deviation of each question were calculated, and a factor analysis correlation matrix was utilized to assess variable relationships. Before factor extraction, Kaiser's Meyer Olkin (KMO), Measure of Sampling Adequacy (MSA), and White Bartlett's Test of Sphericity were employed to determine if the data were suitable for EFA (Williams et al., 2010). A KMO value of 0.50 or higher indicates an acceptable MSA. Moreover, the identity matrix was assessed using the White Bartlett's test; a p-value less than 0.05 signifies acceptable Sphericity. Principal component analysis (PCA) is a common method for factor extraction, aimed at reducing the number of factors. Approaches like Kaiser's criteria and the SCREE test help determine the number of factors to extract. The cumulative variance percentage can also serve as an extraction method, representing how much of the total variance in FIES questions is explained by the extracted factors. Finally, Promax is utilized as a rotation method to generate correlated factors and provide a more accurate and meaningful solution (Costello and Osborne 2005).

Results and Discussion

Results of FIES

Table 2 displays the questions and corresponding positive responses from the FIES survey. Approximately 68.2% of households indicate experiencing food shortages (ran out of food) within the past year due to insufficient funds and other limitations. Similarly, 66.4% of households mention consuming small portions of food due to financial restraints. Conversely, 64.2% of households confess their inability to maintain a balanced and nourishing diet due to financial constraints. Additionally, around 47.6% of households report going

without any meals for a full day due to financial limitations

Table 2: Questions of the FIES and affirmative responses by the sample households in the White Nile State, Sudan

	FIES questions	Frequency	Percentages
1	WORRIED	209	63.3
2	HEALTY	212	64.2
3	FEWFOOD	219	66.4
4	SKIPMEAL	197	59.7
5	ATELESS	219	66.4
6	RANOUT	225	68.2
7	HUNGRY	196	59.4
8	WHOLDAY	157	47.6

Note: Sample size (N)=330 households

Households were categorized into four groups based on their total score on the FIES questions. If the FIES total score is zero, the first group is considered to have food security. The second group is classified as having a lesser degree of food insecurity if their total FIES score falls between 1 and 3. The third group is identified as moderately food insecure if their score on the FIES falls between 4 and 6. The fourth group is labeled as severely food insecure if their FIES total score is between 7 and 8. Similarly, a study focusing on food insecurity in sub-Saharan Africa divided individuals into three groups based on their FIES score: food insecurity score (0 to 3), moderate food insecurity score (4 to 6), and severe food insecurity score (7 to 8) (Wambogo et al., 2018).

The graph depicted in Figure 1 illustrates the rate of food insecurity in households. Approximately 18.5% can be categorized as having a mild level of food insecurity. Around 33.6% of the surveyed households experience moderate food insecurity, meaning they face challenges in accessing sufficient and nutritious food due to financial limitations or lack of resources. This moderate food insecurity can lead to various health issues, such as malnutrition in children, deficiencies in essential nutrients, or obesity in adults (FAO, IFAD, UNICEF, WFP, and WHO, 2022). Conversely, a significant proportion of households, roughly 37.9%, suffer from severe food insecurity. This indicates that these households run out of food and may even go without meals for several days, highlighting the gravity of their situation. The FAO, IFAD, UNICEF, WFP, and WHO (2022) refer to this group as hunger-stricken individuals. Consequently, when combining the food insecurity categories, the overall prevalence of food insecurity in the surveyed households reaches approximately 90%

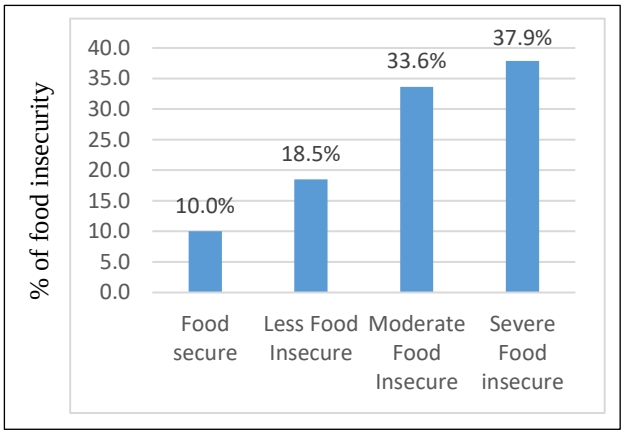

Figure 1: the prevalence of food insecurity among the households in the White Nile State of Sudan, 2020

Internal Consistency of FIES Questions:

Alpha Cronbach's coefficient was utilized to assess the internal consistency and reliability of the FIES questionnaire for measuring food insecurity in Sudan. The results, displayed in Table 3, indicated a coefficient of approximately 0.833, which falls within the acceptable range of 0.7 to 0.9 according to previous research (Tavakol and Dennick, 2011; Taber, 2018). This shows that the FIES questions are reliable and that no questions need to be removed. These findings support the effectiveness of the FIES as a tool to assess the food insecurity of the Sudanese population. A similar study by Helmi et al. (2018) found consistent results when testing the internal consistency of the FIES questionnaire in Malesia.

Table 3: Results of internal consistency for the quick references of the FIES questions using Cronbach's Alpha

	FIES questions	Cronbach's Alpha if Item Deleted	Cronbach's Alpha coefficient
1	WORRIED	0.805	0.833
2	HEALTY	0.808	
3	FEWFOOD	0.808	
4	SKIPMEAL	0.808	
5	ATELESS	0.803	
6	RANOUT	0.810	
7	HUNGRY	0.815	
8	WHOLDAY	0.849	

The Results of the Exploratory Factor Analysis (EFA)

To analyze the self-report questionnaires, the researchers used exploratory factor analysis (EFA). They conducted several assessments, including matrix assessment, determinant assessment, KMO Measure of Sampling Adequacy (MSA), identification matrix assessment using the sphericity test, and principal component analysis (PCA), to validate the structure underlying the FIES. The determinant value obtained from the exploratory factor analysis for the FIES was 0.078, which falls within the acceptable range of 0 to 1. This indicates that the quick references for the FIES questions are suitable for conducting an exploratory factor analysis (Helmi et al., 2018). Additionally, Bartlett's test for sphericity yielded a significant result, as the p-value was less than 0.01. This suggests that the matrix is not identified, allowing for the performance of EFA. Furthermore, the KMO test value displayed in Table 4 was approximately 0.885, indicating that the data were sufficient for exploratory factor analysis. This finding aligns with the assertion made by Pett et al. (2003) that a KMO score above 0.7 indicates adequate data for EFA.

Table 4: The Results of Kaiser –Meyer Olkin (KMO) Measure of Sampling Adequacy (MSA) and Bartlett's Test of Sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.885
Bartlett's Test of Sphericity	Approx. Chi-Square	831.764
	df	28
	p-value	0.000

Note: P-value significant at level 1%

Principal component analysis (PCA) was employed in exploratory factor analysis to demonstrate the different components in the FIES questions. The PCA results indicate that there are two main components in the FIES questions: the inadequate quantity of food and the change in the quality of food consumed. Various methods, such as Kaiser's criteria, the scree test, and the cumulative percentage of extracted variance, were used to extract these components. The eigenvalue for each component was found to be greater than 1, validating the presence of these components (Williams, 2010). Kaiser's value was preferred to retain the extraction factors as it is regarded as the most accurate criterion for achieving the desired outcome.

Furthermore, Figure 2 displays the scree test, which depicts the graph of the eigenvalues. Consequently, there are two discerned factors for the FIES that possess an eigenvalue exceeding .This can be evidenced by the presence of the two extracted factors displayed above the flattened curve (see Figure 2)

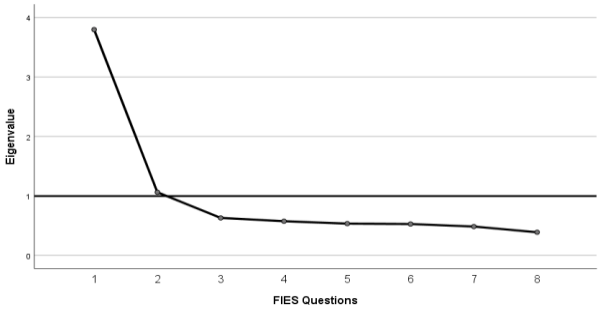

Figure 2: The Scree plot of extracted factors of FIES questions

Furthermore, when examining the cumulative percentage of variance, it is evident from Table 5 that the two factors identified account for approximately 60.7% of the overall variance in the eight FIES questions. This aligns with previous research by Helmi et al. (2018), who similarly found that two factors representing FIES questions in Malaysia explained 55.5% of the total variance in eight questions. Pett et al. (2003) suggest that any cumulative percentage of variance falling within the 50% to 90% range is satisfactory for determining which factors to extract.

Table 5: Factor loading of the quick references for the FIES questions and cumulative percent of variance of extracted factors

FIES questions	Factor loading of the quick references for the FIES questions
WORRIED	0.569
HEALTY	0.584
FEWFOOD	0.581
SKIPMEAL	0.544
ATELESS	0.625
RANOUT	0.499
HUNGRY	0.625
WHOLDAY	0.826
% Variance	60.663

Note: Extraction Method: Principal Component Analysis (PCA)

Conclusion and Recommendations

The findings suggest that the FIES questionnaire is a valuable tool for assessing the level of food insecurity in both the study area and Sudan overall. Consequently, they could be employed as an effective tool to detect and address this problem at an early stage. Moreover, the findings of Alpha Cronbach's exploratory factor analysis (EFA) demonstrate that the FIES is a reliable and valid tool for measuring food insecurity in Sudanese households. Therefore, the government should utilize the FIES extensively to efficiently and swiftly assess the severity of food insecurity. Consequently, these findings will assist policymakers in shaping development initiatives aimed at attaining food security at the household level. Additionally, this study suggests future research that focuses on utilizing the FIES alongside other food insecurity indicators, as this will yield accurate results regarding dietary behaviors and experiences of food insecurity in Sudan. Additionally, employing various methods to assess food insecurity would a policymakers and food aid organizations in determining the true extent of hunger and malnutrition, enabling them to make informed decisions in achieving food security.

Acknowledgments

The author wishes to express gratitude to all individuals who provided contributions to the survey.

Funding

The author did not receive any monetary assistance for the research and release of this article.

Conflict of Interest

The author declares no conflict of interest.

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هل يعد مقياس تجارب انعدام الأمن الغذائي (FIES) أداة صالحة لتقييم انعدام الأمن الغذائي في السودان؟

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تاريخ استلام البحث: 2023/8/27 وتاريخ قبوله: 2024/2/14.

ملخص

يعد انعدام الأمن الغذائي قضية واسعة الانتشار على مستوى العالم، وقد طورت منظمة الأغذية والزراعة (الفاو) مقياس تجربة انعدام الأمن الغذائي (FIES) لقياس المستويات المختلفة لشدة انعدام الأمن الغذائي. ويتضمن FIES ثمانية أسئلة تقيم حصول الناس على الغذاء الكافي والجيد. تهدف هذه الدراسة إلى فحص موثوقية وصحة استخدام مقياس تجربة انعدام الأمن الغذائي كمقياس لانعدام الأمن الغذائي ولتوفير التوجيه لصانعي السياسات لمعالجة الجوع وضمان الأمن الغذائي في السودان. وقد تم اختيار عينة من 330 أسرة من ولاية النيل الأبيض في السودان لاستكمال استبانه ال (FIES). ثم تم تحليل البيانات التي تم جمعها باستخدام الإحصاء الوصفي، ألفا كرونباخ، وتحليل العاملي الاستكشافي. وتشير نتائج مقياس تجربة انعدام الأمن الغذائي إلى أن ما يقرب من 33.6٪ من الأسر تعاني بشكل معتدل من انعدام الأمن الغذائي، في حين أن 37.9 ٪ يعانون من انعدام الأمن الغذائي الحاد. يؤكد معامل ألفا كرونباخ أن أسئلة مقياس تجربة انعدام الأمن الغذائي (FIES) تظهر اتساقا داخليا مقبولا. علاوة على ذلك، تكشف نتائج التحليل العاملي الاستكشافي (EFA)عن مكونين رئيسيين يمثلان حوالي 60.7 ٪ من إجمالي التباين في أسئلة مقياس تجربة انعدام الأمن الغذائي. بناء على ذلك، توصي هذه الدراسة بأن يكون مقياس تجربة انعدام الأمن الغذائي(FIES) أداة قياس موثوقة وصالحة لتقييم انعدام الأمن الغذائي في السودان.

الكلمات الدالة: مقياس تجربة انعدام الأمن الغذائي، ألفا كرونباخ، التحليل العاملي الاستكشافي، انعدام الامن الغذائي، السودان.

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