

THE RELATIONSHIP BETWEEN FOOD INSECURITY AND OBJECTIVE AND SUBJECTIVE INCOME INDICATORS IN POLAND*

ŚLĄSKI
PRZEGLĄD
STATYSTYCZNY
Nr 18(24)

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ISSN 1644-6739
e-ISSN 2449-9765

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Quote as: Dudek, H. (2020). The relationship between food insecurity and objective and subjective income indicators in Poland. *Śląski Przegląd Statystyczny*, 18(24).

DOI: 10.15611/sps.2020.18.06

JEL Classification: D12; C13; C25

Abstract: The study analyses food insecurity in Poland on the basis of data from the Food and Agriculture Organization of the United Nations. This data assesses the scale of experiencing food insecurity by the respondents. It includes information obtained during 2014-2019 from 6080 people. The dependence of food insecurity on the subjective and objective income situation of individuals was examined. Typical methods of analysis were used, such as Pearson's χ^2 test, Cramer V and Kendall τ_b measures, and the logit model. It was found that the perception of food insecurity depends more on the subjective rather than objective income situation.

Keywords: Food Insecurity, measurement, dependence measures, logit model, ROC curve.

1. Introduction

According to the Food and Agriculture Organization of the United Nations (FAO), food insecurity exists when people do not have adequate physical, social, or economic access to sufficient, safe, and nutritious food meeting their dietary needs and food preferences for an active and healthy life (FAO, 2003). There are various approaches for measuring this phenomenon in the world (Coleman-Jensen, Rabbitt, Gregory, and Singh, 2017; Davis and Geiger, 2017; Dowler and O'Connor, 2012; Pinstrup-Andersen, 2009; Smith,

* The author is grateful to Ms. Meghan Miller from the FAO Food Security and Nutrition Statistics Team for her able assistance and kind support in the FIES data acquisition process.

Rabbitt, and Coleman-Jensen, 2017). However, it is widely acknowledged that food insecurity (FI) is a complex, multidimensional concept (Hart, 2009; Sisha, 2019). Thus, an array of measurement instruments is needed to account for the multidimensional nature of food and nutrition insecurity. FI measurement should take into account availability, accessibility, utilization, and stability (FAO, 2008). To capture these issues, experience-based food insecurity scales were proposed. They involve directly asking people about their experiences regarding FI resulting from limited access to food.

The concept of Food Insecurity Experience Scales (FIES) has a long history grounded in ethnographic studies. Their purpose is to understand the experience of hunger (Ballard, Kepple, and Cafiero, 2013; Saint Ville, Po, Sen, Bui, and Melgar-Quiñonez, 2019). Ethnographic research conducted in the USA at the beginning of the 1990s revealed that experiencing FI is a process characterized initially by worry about having enough food, followed by dietary changes to make limited food resources last longer, and finally, reduced consumption of food (Radimer, Olson, and Campbell, 1990; Radimer, Olson, Greene, Campbell, and Habicht, 1992). The above-mentioned research identified key elements of experiencing food insecurity, such as reduced food quantities, limited variety of the food, anxiety related to decreasing choices, and an expected lack of food in the future. Other studies regarding various populations around the world have confirmed that these aspects of food insecurity appear to be common across countries. Over time, experience-based food insecurity scales have been developed for different cultural contexts, for example since 1995 the United States Household Food Security Survey Module, and since 2007 the Latin American and Caribbean Food Security Scale have been used in several countries in North and South America (Saint Ville et al., 2019). Building on the experiences of these scales, FAO developed a scale called the Food Insecurity Experience Scale (FIES). Introduced in 2014, FIES has been used as a common metric for measuring food insecurity in most countries around the world. It has been studied by many researchers all over the world (e.g. Smith et al., 2017; Broussard, 2019; Grimaccia and Naccarato, 2019).

This study uses FIES data in the analysis of food insecurity from the perspective of Poles. As such data relies on self-reported information regarding food-related experiences or behaviour when money or other resources necessary to obtain food are limited, it seems reasonable to examine the dependence of food insecurity on both objective and subjective income indicators. While the relationship between food insecurity and indicators of the first type was analysed in many studies (Broussard, 2019; Grimaccia and Naccarato, 2019; Smith et al., 2017), the literature lacks findings on the association of food insecurity with indicators of the second type. Hence this study attempts to assess the role of the reported and perceived incomes of

respondents in experiencing food insecurity in Poland. To achieve the aim of the study, both bivariate and multivariate analyses were carried out.

2. FAO Food Insecurity Experience Scale

Food Insecurity Experience Scales have rapidly become a global reference for measuring FI data. In 2014, FAO contracted the Gallup World Poll® (GWP) as its data collection service provider. Thus since 2014, food insecurity has been monitored by including Food Insecurity Experience Scales in GWP – an annual survey conducted in over 140 countries worldwide. The GWP samples are nationally representative of the resident population aged 15 years and older in each country. In most countries the samples included about 1,000 individuals, with larger samples of 3,000 in India and 5,000 in China (FAO, 2020).

FIES consists of eight questions which describe experiences ranging in their severity, from worrying about running out of food to going without eating for a whole day because of insufficient money or other resources. Table 1 lists the eight questions of the FIES module.

Table 1. Questions in FIES

During the last 12 months, was there a time when, because of lack of money or other resources:
<ol style="list-style-type: none"> 1. You were worried you would not have enough food to eat? 2. You were unable to eat healthy and nutritious food? 3. You ate only a few kinds of food? 4. You had to skip a meal? 5. You ate less than you thought you should? 6. Your household ran out of food? 7. You were hungry but did not eat? 8. You went without eating for a whole day?

Source: (FAO, 2020).

These questions refer to different FI experiences, from less acute to more severe experiences. The respondents could answer either 1 = Yes or 0 = No.

3. Materials and methods

3.1. Data

The study uses all available FIES data for Poland. In 2014-2018 the sample size in Poland was 1,000, and in 2019 – 1,080. The survey questions presented in Table 1 were asked to a nationally representative sample through face-to-face interviews. The proportions of Poles experiencing the eight aspects of FI were calculated using sampling weights.

To investigate the relationship between food insecurity and the objective and subjective income indicators of individuals, the study used various measures. The first one referred to per capita income quintiles, and the second addressed the question: “Which one of these statements best describes your feelings about your household’s income these days?”. The following four responses were possible: living comfortably on present income, getting by on present income, finding it difficult to live on present income, or finding it very difficult to live on present income.

To control the impact of various factors on both FI and income indicators, various sociodemographic characteristics were considered. The set of these characteristics included educational level, gender, age, and household composition. These are typical variables available in the GWP database used in FI studies worldwide (Grimaccia and Naccarato, 2019; Smith et al., 2017). The educational level was classified as elementary or lower (elementary), secondary (secondary), and high or higher (tertiary). The household composition included one-person households, households of two adults, households of at least three adults, households with one child, households with two children, and households with at least three children.

3.2. Methods of analysis

The data was analysed using Stata. The Cronbach alpha coefficient was used to assess the internal consistency of FIES (Cronbach, 1951).

To investigate the relationship between food insecurity and the subjective and objective income indicators of individuals, both bivariate and multivariate analyses were carried out in the study. The first is based on typical methods, such as Pearson’s χ^2 , Cramer’s V measure and Kendall’s τ_b measure. The second applies the logit model approach in which, apart from objective or subjective income indicators, the same set of sociodemographic characteristics was used. Akaike’s Information Criterion was used to compare models, and given the set of candidate models for the data, the preferred model is the one with the minimum AIC

value (Cameron and Trivedi, 2005; Long and Freese, 2006). Moreover, as the receiver operating characteristic (ROC) curves provide a standard way of evaluating the ability of explanatory variables to predict a binary dependent variable, in the study the area under the ROC curve (AUC) was used as a summary measure of accuracy in classification (Hosmer and Lemeshow, 2000; Sączewska-Piotrowska, 2016). If a model had an AUC closer to 1 and greater than 0.5, this indicated that the model had a good predictive ability.

4. Results and discussion

The value of Cronbach's alpha coefficient was 0.885, showing good internal consistency of FIES. In order to see how the respondents answered individual questions listed in Table 1, Figure 1 presents the proportions of the respondents with positive responses.

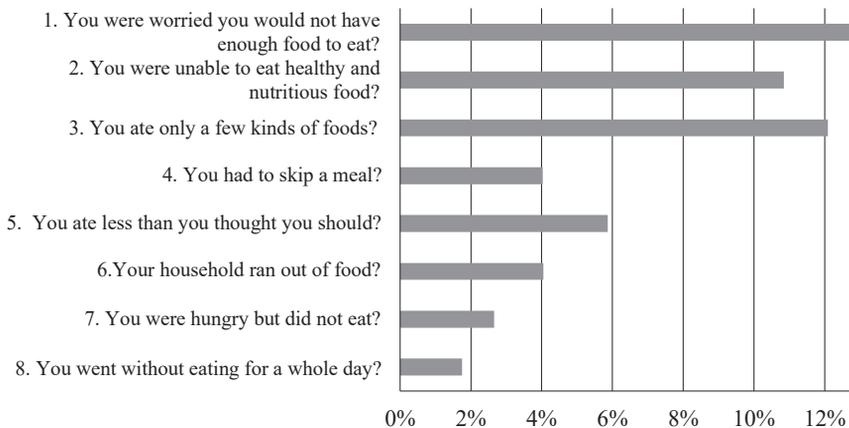


Fig. 1. The percentages of positive responses to the given FIES questions

Source: own work based on FIES data.

Results showed that:

- 1) almost 13% of the population were worried about having enough food to eat,
- 2) about 11% of the population were unable to eat healthy and nutritious food,
- 3) about 12% of the population ate only a few kinds of food,
- 4) about 4% of the population had to skip a meal,
- 5) about 6% of the population ate less than they thought they should,
- 6) about 4% of the population experienced that their household ran out of food,

- 7) almost 3% of the population were hungry but did not eat,
 8) almost 2% of the population went without eating for a whole day.

Thus, as could be expected, a smaller percentage experienced more severe FI experiences. In particular, in the period 2014-2019, fewer than 5% of Poles experienced hunger.

It might seem that FI only affects those with a low income. However, the results revealed that among those with at least one positive response, about a quarter belonged to the top two income quintile groups (see the results in Figure 2 for the fourth and fifth income quintile groups) and about a third claimed that they got by on their present income (see the right side of Figure 2). This means that the relationship with the objective as well as the subjective income indicators is complex.

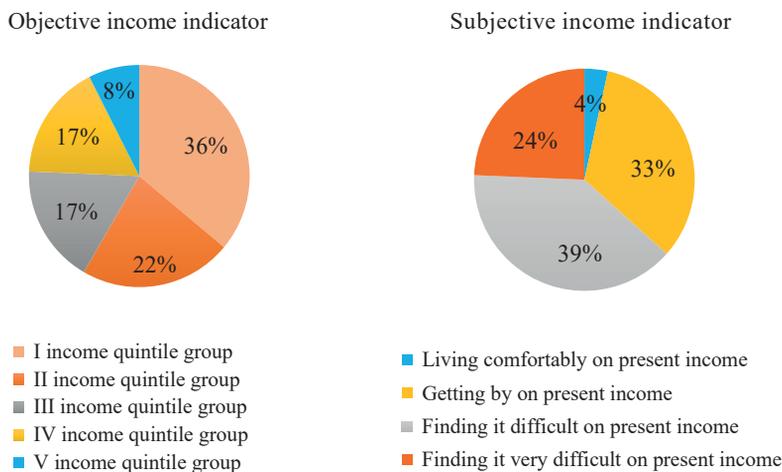


Fig. 2. Percentages of the population with at least one positive response according to income groups

Source: own work based on FIES data.

Statistical methods were used in order to obtain a deeper insight into the relationships between each FI item and the objective and subjective income indicators. In the first stage, the bivariate associations were assessed by calculating Pearson's χ^2 for each binary variable relating to the FI responses and a given income indicator. Moreover, Cramer's V and Kendall's τ_b measures were used to assess the strength of the considered associations. Table 2 shows the results for each variable corresponding response to a given FIES question.

The chi-square test for independence was used to examine if there was a relationship between two categorical variables. It was found that at 0.05

Table 2. The relationship between each FIES item and income indicators

Item	Objective income indicator				Subjective income indicator			
	χ^2	V	τ_b	SE for τ_b	χ^2	V	τ_b	SE for τ_b
1	338.332	0.236	0.202	0.011	1200	0.453	0.363	0.011
2	222.170	0.191	0.159	0.011	1200	0.435	0.339	0.012
3	243.455	0.200	0.167	0.011	1200	0.436	0.354	0.011
4	137.148	0.150	0.118	0.011	667.325	0.331	0.241	0.012
5	206.516	0.184	0.145	0.011	860.853	0.376	0.276	0.012
6	147.595	0.155	0.126	0.011	689.031	0.337	0.237	0.012
7	95.972	0.126	0.101	0.011	500.734	0.287	0.197	0.012
8	66.1494	0.104	0.089	0.010	277.039	0.214	0.156	0.012

Source: own work based on FIES data. Note: SE are asymptotic standard errors for Kendall τ_b .

there was a statistically significant association between each of the eight FI binary variables and the objective and subjective income indicators ($\chi^2(4; 0.05) = 9.488$ and $\chi^2(3; 0.05) = 7.815$, respectively). Additionally, the results of Cramer's V measure and Kendall's τ_b measure revealed that food insecurity was more associated with the subjective indicator than the objective indicator, and there is also a weaker relationship with income and items corresponding to more severe FI experiences.

In the second stage, two types of logit models were estimated. Both types included sociodemographic variables and additionally one income variable: in the first model – the objective income indicator, and in the second – the subjective income indicator. The results regarding Akaike's Information Criterion and the area under the ROC curve are presented in Table 3.

Table 3. Results obtained using the logit model approach

Item	Objective income indicator		Subjective income indicator	
	<i>AIC</i>	<i>AUC</i>	<i>AIC</i>	<i>AUC</i>
1	0.678	0.750	0.598	0.821
2	0.629	0.742	0.557	0.812
3	0.666	0.743	0.590	0.818
4	0.343	0.749	0.308	0.832
5	0.396	0.773	0.353	0.839
6	0.320	0.766	0.287	0.838
7	0.220	0.799	0.199	0.863
8	0.161	0.780	0.148	0.854

Source: own work based on FIES data.

As the lower AIC values for each food insecurity item related to the second model, it can be concluded that this type of model is preferred over the first type. This means that under the *ceteris paribus assumption*, each FI item was more dependent on the subjective indicator than on the objective indicator. Moreover, the AUC results indicate that the second type of model has a better predictive ability than the first.

Summarizing the obtained results, it should be emphasized that FAO data combines objective and subjective aspects of food insecurity. Three FIES questions may be considered as referring to the subjective perceptions (“Were you worried you would not have enough food?”; “Were you unable to eat healthy and nutritious food?”; “Did you eat less than you thought you should?”), while the other five questions ask about the objective experiences due to a lack of money or other resources (FAO, 2020). Therefore it was reasonable to investigate the dependence of each FI item on the objective and subjective income indicators. The study found that regardless of the type of questions, the second indicator played a bigger role than the first.

The results from the chosen sociodemographic correlates of FI are presented at the end of this paper. Due to the limited length of the article, the author focused on the dichotomous dependent variable with a value of 1 if the respondent positively answered at least one FIES question, and with a value of 0 otherwise (i.e. answering “no” to all eight FIES questions¹).

The results presented in Table 4 reveal the importance of such correlates of food insecurity as education, gender, age, and household composition. Specifically, it was found that:

- there was evidence that women were more likely to be food-insecure than men;
- age had a positive sign while its squared term had a negative sign, implying an inverted U-shaped effect; this means that the respondents reported experiencing less FI when they were younger and older than when they were middle-aged;
- elementary and secondary education were associated with an increased probability of FI compared to tertiary;
- as income increased, the probability of FI declined;
- people with better feelings about their household’s income were less likely to be food-insecure;
- people living in single-person households were more likely to be food insecure than those living in households of at least two adults.

This study has several strengths, including the use of FAO FIES data, which is the validated approach consistently employed almost all over the world. This data is based on people’s responses to questions about constr-

¹ More details can be found in (Dudek and Myszkowska-Ryciak, 2020).

Table 4. Estimates of logit models parameters

Variable	Model 1			Model 2		
	Estimate	SE	Z Statistics	Estimate	SE	Z statistics
Women	0.314	0.072	4.400	0.239	0.076	3.140
Age	0.064	0.011	5.660	0.038	0.012	3.230
Age-squared	-0.0007	0.0001	-5.830	-0.0004	0.0001	-3.420
Education (ref. tertiary)						
Secondary	0.717	0.110	6.490	0.494	0.494	4.320
Elementary	1.267	0.148	8.590	0.866	0.155	5.590
Household composition (ref. single-person household)						
Two-adults household	-0.699	0.092	-7.600	-0.232	0.098	-2.380
Three and more adults	-1.137	0.123	-9.260	-0.203	0.125	-1.620
H. with one child	-0.948	0.131	-7.240	0.041	0.132	0.310
H. with two children	-1.180	0.148	-7.950	0.115	0.146	0.780
H. with at least 3 children	-0.988	0.221	-4.470	0.334	0.233	1.430
Income quintile group (ref. first quintile group)						
Second quintile group	-0.679	0.104	-6.560	-	-	-
Third quintile group	-1.039	0.110	-9.440	-	-	-
Fourth quintile group	-1.205	0.112	-10.730	-	-	-
Fifth quintile group	-2.085	0.134	-15.510	-	-	-
Feelings about own household's income (ref. finding it very difficult)						
Finding it difficult	-	-	-	-1.132	0.120	-9.420
Getting by on present income	-	-	-	-2.683	0.121	-22.230
Living comfortably on present income	-	-	-	-3.537	0.203	-17.410
Constant	-1.948	0.308	-6.320	-4.221	0.340	-12.410

Note: SE are standard errors.

Source: own work based on FIES data.

ints on their ability to obtain adequate amounts of food. The analysed samples are nationally representative of the population aged 15 years and older. The study adds to the understanding of food security in Poland by examining the relationship between each FI item and the objective and subjective income indicators, and also indicates significant sociodemographic factors influencing food insecurity. Despite these strengths, several limitations should be mentioned. The study does not take into account the relationships

of FI intensity (i.e. how much a person is food insecure) and various objective and subjective characteristics. Moreover, it does not examine the role of social support in the relief of food insecurity. In particular, apart from the impact of social policy instruments, the possible help of relatives or friends could be considered. These aspects would be worth considering in future research.

5. Conclusion

Experience-based scales have increasingly been used by researchers and practitioners to measure food insecurity. They are based on reported behaviour and experiences associated with food access compromised due to limited resources. Experience-based food security scales provide a measure of access to food at different levels of severity. Such scales rely on data obtained by asking people about the occurrence of conditions and behaviour reflecting constrained access to food.

In recent years, FAO has undertaken a project aimed to develop and support a survey-based experiential measure of access to food, called the Food Insecurity Experience Scale (FIES). The FAO FIES module consists of eight questions about the individual's experience with food insecurity during the previous 12 months. As FIES data combines the objective and subjective aspects of food insecurity, it seemed reasonable to investigate the dependence of each FI item on the objective and subjective income indicators. Thus, the analysis of the relationships between these factors is a new and important contribution. Unlike many others, this paper considered not only the objective but also the subjective measures of income. The first indicator was represented by data on income quintile groups, while the second relied on the respondents' opinions on experiencing difficulties in living on their level of income. The study found that in Poland, regardless of the type of FI item, its relationship with the second indicator was closer than with the first one and it revealed the importance of correlates of food insecurity such as education, gender, age, and household composition. Thus, this paper adds to the understanding of food security in Poland. Future research could include an investigation of the role of social support in the relief of food insecurity and a comparison of food insecurity profiles among various countries.

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**ZALEŻNOŚĆ MIĘDZY BRAKIEM BEZPIECZEŃSTWA
ŻYWNOŚCIOWEGO A OBIEKTYWNĄ I SUBIEKTYWNĄ
SYTUACJĄ DOCHODOWĄ: WYNIKI DLA POLSKI**

Streszczenie: W pracy podjęto się analizy zjawiska braku bezpieczeństwa żywnościowego w Polsce na podstawie danych Organizacji Narodów Zjednoczonych ds. Wyżywienia i Rolnictwa. Dane te odnoszą się do oceny skali doświadczania niepewności żywnościowej przez respondentów. Obejmują informacje pozyskane w latach 2014-2019 od 6080 osób. W pracy badano zależność występowania braku bezpieczeństwa żywnościowego od indywidualnej obiektywnej i subiektywnej sytuacji dochodowej. Wykorzystano typowe metody analizy danych, takie jak test χ^2 Pearsona, miary V Cramera i τ_b Kendalla, jak również model logitowy. Stwierdzono, że odczuwanie braku bezpieczeństwa żywnościowego było bardziej zależne od subiektywnej niż od obiektywnej sytuacji dochodowej.

Słowa kluczowe: brak bezpieczeństwa żywnościowego, pomiar, miary zależności, model logitowy, krzywa ROC.