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Who are the World's Food Insecure? New Evidence from the Food and Agriculture Organization's Food Insecurity Experience Scale

MICHAEL D. SMITH, MATTHEW P. RABBITT and ALISHA COLEMAN- JENSEN*

Economic Research Service, United States Department of Agriculture, Washington, D.C., USA

Summary. — Until recently there was lacking a common food security measure and the necessary data to study the individual-level determinants of food insecurity around the world. In 2014, the Food and Agriculture Organization's Voices of the Hungry project developed an experiential measure of food insecurity, the Food Insecurity Experience Scale (FIES), translated it into 200 languages, and contracted Gallup, Inc. for collection of data through the Gallup World Poll. This is the first paper that identifies and examines the common determinants of food insecurity in 134 countries using this cross-country comparable experiential measure of food insecurity. We also investigate whether and to what extent the common determinants of food insecurity identified in a global model differ across rankings of economic development. Using a series of multilevel linear probability models, we find that the five characteristics associated with the largest increase in the likelihood of experiencing food insecurity around the world are: having low levels of education, weak social networks, less social capital, low household income, and being unemployed. We also find significant heterogeneity in the determinants of food insecurity over development rankings. This study is an important first step in utilizing the new FIES to document risk factors of food insecurity around the globe.
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Key words — food security, food insecurity, poverty, experiential food insecurity scale

1. INTRODUCTION

Food insecurity exists in most countries around the world, but the common determinants of food insecurity across countries have yet to be formally identified. 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, 2009, p. 1). While this definition of food security has been widely accepted, defining a common metric that can be used to identify the common determinants of food insecurity across different countries has so far been lacking. Until now. This is made possible by the Food and Agriculture Organization's (FAO) Voices of the Hungry (VoH) project, which has developed an experiential measure of food insecurity—the Food Insecurity Experience Scale (FIES). The aim of VoH is to produce annual comparable estimates of food insecurity around the world. [1] The FIES is the first survey protocol to measure people's direct experiences of food insecurity at the individual level on a global scale.

Due in part to Sen (1981) and his examination of widespread malnutrition in the developing world, the focus of food security measurement has shifted from national food supplies to include people's direct access to food. Measures of food security generated by experiential data collected through household or individual surveys offer more precision than model-based measures, as they can capture the direct experiences of food insecurity at the individual- or household-level (Coates, 2013). Prior research identifying predictors of experiential food insecurity in developing countries relied heavily on primary data collections, with small samples focused on a specific locality, and often without a robust food security instrument. Thus, consistent and comprehensive information on the determinants of global food insecurity has so far been lacking in the literature. To address this gap, we aim to identify and examine the common determinants of food insecurity in 134 countries using this new experiential food security measure with data collected through the 2014 Gallup World Poll (GWP). We also consider whether and how these determinants of food insecurity identified in global models differ across economic development rankings.

If the common determinants of food insecurity are identified from individual-level demographic and economic characteristics, the findings can assist governments and aid organizations in targeting assistance. For example, the second United Nations Sustainable Development Goal (SDG2) calls for ending hunger and achieving food security for all people by 2030. [2] To adequately meet the targets laid out under SDG2 requires an improved understanding of the determinants of food insecurity around the world. The challenges of reducing food insecurity are likely to be greater as countries begin to address the more severe and chronic cases. Knowing the characteristics, circumstances, and location of the food insecure can contribute to building political will, designing effective policies, and targeting scarce resources (Ballard, Kepple, & Cafiero, 2013). Furthermore, if respondent characteristics relate to food insecurity in similar ways around the world, the findings will provide further evidence for the validity and effectiveness of the FIES as a valid measure of food insecurity.

This paper is among the first to report the cross-country comparable estimates and common determinants of food insecurity around the world. [3] Descriptive statistics show that 27% of our global sample experiences food insecurity. As we might expect, we see that food insecurity is highest in low-income economies, followed by lower middle, upper-middle, and high-income economies. Roughly half of the population in

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low-income economies experience food insecurity; while in high-income economies only 10% of the population experience food insecurity.

Using a series of multilevel linear probability models for all 134 countries, we find that the five characteristics associated with the largest increase in the likelihood of experiencing food insecurity are: having low levels of education, weak social networks, less social capital, low household income, and being unemployed, respectively. Across all development rankings, low levels of education, weak social networks, and less social capital consistently play a large role in the likelihood of experiencing food insecurity. But, we also see numerous differences with respect to the determinants of food insecurity across development rankings. For example, GDP per capita is associated with the largest decrease in the likelihood of experiencing food insecurity for low-income economies; but is not statistically significant for lower middle and upper-middle-income economies, after controlling for other individual-, household-, and country-level characteristics. The results show that country-specific policies are crucial for addressing the needs of the food insecure and that a blanket approach to development or nutrition assistance may not be effective.

Despite heterogeneity in global populations, differences in governments and policies, variations in local economies, labor markets, and agriculture, we can identify the characteristics of the typical food-insecure person around the world. Our findings also confirm the validity of self-reported experiential measures to document the incidence of global food insecurity. We would not expect to see strong relationships between respondent characteristics and food insecurity if the FIES were not accurately measuring a similar type of food hardship across cultural contexts.

2. BACKGROUND

U.S. ethnographic research in the early 1990s showed several stages that a household goes through when living with hunger or food insecurity. Household food insecurity is initially characterized by worry about having enough food, followed by dietary changes to make available food last longer, and finally, a decrease in food consumption, first in adults followed by any children (Radimer, Olson, & Campbell, 1990; Radimer, Olson, Greene, Campbell, & Habicht, 1992). Further, research has shown that the experience of households living with hunger or food insecurity is consistent in developed and developing countries; and across languages and cultures (Coates *et al*., 2006). [4] These studies greatly influenced the current understanding of food insecurity and suggested that respondents could accurately report food insecurity experiences in a survey.

Many studies have validated experiential food insecurity scales in the United States, Canada, Mexico, and Latin America over the past few decades (Coates, Webb, & Houser, 2003; Coates, Wilde, Webb, Rogers, & Houser, 2006; Frongillo & Nanama, 2006; Nord, 2012; Pérez-Escamilla *et al*., 2004). Experiential measures capture cross-cultural aspects of food insecurity and have proven their validity across global regions (Coates, 2013; Pérez-Escamilla, 2012). FAO selected the prevalence of undernourishment to monitor the Millennium Development Goal (MDG) of halving world hunger by 2015. It performed relatively well in this regard but as an aggregate measure, was unable to identify the characteristics of the food insecure, or determine where within a country they live (Ballard *et al*., 2013). As a macro-level measure, the prevalence of undernourishment acts as a national-level proxy for food security, but requires strong assumptions about the distribution of food within a country, due to the lack of reliable food consumption survey data. [5] In contrast, as a micro-level measure, experiential food insecurity measures offer insight into the determinants of food insecurity at the individual level, making it possible to show the characteristics and geographic concentration of the food insecure (Ballard *et al*., 2013; Nord, 2014).

FAO created the Food Insecurity Experience Scale (FIES) and in 2014, contracted Gallup, Inc. to collect data in all 149 countries covered by the Gallup World Poll (GWP). Providing for the first time, cross-country comparable estimates of food insecurity on a global scale. The FIES builds upon previous research on U.S. and Latin American experiential measures. Following the initial ethnographic research (Radimer *et al*., 1990, 1992), the United States implemented the U.S. Household Food Security Survey Module (U.S. HFSSM) in 1995. This experiential measure of food insecurity captures the Radimer *et al*. (1990) latent construct of food insecurity (Bickel, Nord, Price, Hamilton, & Cook, 2000; Nord, 2003). In the early 2000s, several Latin American countries began implementing their own experiential food insecurity measures, eventually culminating in a Latin America and Caribbean food security scale called ELCSA (Escala Latinoamericana y Caribeña de Seguridad Alimentaria) (FAO, 2012; Pérez-Escamilla, Melgar-Quiñonez, Nord, Álvarez, & Segall-Correa, 2007). After extensive testing, the U.S. HFSSM and ELCSA have proven reliable "in diverse socio-cultural contexts" (Ballard *et al*., 2013, p. 10). Following this evidence of reliability, FAO built the FIES, using the methodology of the U.S. HFSSM and ELCSA and adjusted the scale to be applied globally.

Economic theory identifies certain groups of people as being more vulnerable to food insecurity. [6] Using the FIES measure, we look for the common determinants of food insecurity and identify what is distinct about the food insecure around the world. Previous research has shown that structural factors such as poverty have the largest influence on whether an individual has adequate access to food (Barrett, 2010). Food insecurity results at least in part from a lack of economic resources for food. Each question in the FIES specifies that the food-insecure condition stems from an inability to afford adequate food. The most significant improvements in reducing food insecurity have occurred in the poorest regions of the world, owing mostly to efforts to increase income, economic growth, and resources to ameliorate food insecurity (FAO & IFAD, & WFP, 2014). As discussed in the 2012 edition of the *State of Food Insecurity in the World*, economic growth is necessary for food security but is not sufficient. Other factors such as high food prices, inequality, and the unequal distribution of food within countries also affect national food insecurity prevalence rates (FAO & IFAD, & WFP, 2012). Therefore, solving food insecurity is unlikely to be fully accomplished through national income growth alone (Haddad, Alderman, Appleton, Song, & Yohannes, 2003).

3. DATA

The analyses in this paper use data from the 2014 wave of the Gallup World Poll (GWP), including FAO's FIES data. Since 2005, the GWP has conducted an annual survey of individuals age 15 years and older in over 149 countries. The GWP collects information on individual's labor force participation, income, educational attainment, opinions, experiences, future aspirations, demographic characteristics, and country- and region-identifiers. In most countries, the GWP interviews

1,000 individuals and after weighting is nationally representative.[7] Telephone interviews are conducted for medium- and high-income countries with at least 80% telephone coverage. Face-to-face interviews are administered in most developing countries.

The Food Insecurity Experience Scale Survey Module (FIES-SM) was included as a client module in the GWP for the first time in 2014 as part of the Food and Agriculture Organization's (FAO) Voices of the Hungry (VoH) project.[8] The FIES-SM was designed to measure the prevalence and severity of food insecurity experienced by individuals. Information about the adequacy of an individual's access to food is assessed using a series of questions about whether they experienced the behaviors and conditions that indicate food insecurity over the past 12 months. See Appendix A for a listing of the FIES-SM questions.

(a) *Dependent variables*

FAO uses the individual's responses to the questions in the FIES-SM to determine the severity of food insecurity experienced at the individual level. Provided the FIES data conform to the Rasch measurement model's (Rasch, 1960) assumptions, an individual's food security status can be determined by summing the number of affirmed responses (i.e., the raw score)[9] from the FIES. Raw-score-based classifications are typical of other experiential food security scales, such as the US HFFSM and the ELCSA.[10] The classification methods of these scales, however, are unable to produce cross-country comparisons, without equating, since the same raw score does not necessarily correspond to the same level of severity in other countries. To ensure the measured severity of food insecurity is comparable across countries, FAO equated the food insecurity scales for each country to a FIES Global Standard Scale (FIES-GSS).[11] FAO's equating procedure for the FIES-GSS maintains cross-country comparability by creating food insecurity thresholds that allow researchers to partition the continuum of food insecurity into meaningful and comparable ranges of food insecurity. Thus, the measured severity of food insecurity, food insecurity thresholds, and the food insecurity prevalence rates are all equivalent and comparable across countries. The equating procedures ensure that each of the food security items function similarly across countries. If an item is not well understood in any individual country, it can be dropped for that country and the remainder of the items can be used to determine food security thresholds of equivalent severity to the global standard on the Rasch scale.

Based on responses to the FIES-SM individuals are categorized by severity of food insecurity. Individuals are classified as experiencing food security if they report a raw score of zero. Individuals are classified as experiencing mild food insecurity if they report a raw score of at least one, but less than the country-specific FIES-GSS threshold for moderate food insecurity (typically a raw score of 3 or 4). Individuals are classified as experiencing moderate food insecurity if their reported raw score is greater than the FIES-GSS threshold for moderate food insecurity, but less than the country-specific FIES-GSS threshold for severe food insecurity (typically a raw score of 7). Individuals are assigned a food insecurity status of severe food insecurity if they report a raw score greater than the FIES-GSS threshold for severe food insecurity.

For the purposes of the analyses presented here, we utilize two binary measures of the individual's severity of food insecurity. The first measure, *food insecurity*, is coded as one if an individual experienced moderate or severe food insecurity within the past 12 months; zero otherwise. This measure captures experiences related to food insecurity that range in severity from reducing the quality and variety of food to experiencing hunger. Our second measure, *severe food insecurity*, captures individuals experiencing the most severe range of food insecurity per the FIES-GSS, and is coded as one if an individual experienced severe food insecurity within the past 12 months; zero otherwise.[12] Severe food insecurity is commonly associated with individuals reporting experiences related to physiological hunger (Nord, 2014).

(b) *Independent variables*

The primary explanatory variables for the analyses are common food insecurity determinants collected in the GWP that include individual-, household-, and socioeconomic-characteristics. The GWP collects information on individuals and their households which we separate across four categories—demographic, social capital, economic, and macroeconomic factors (see Appendix B for more details). Most of the variables are standard in food insecurity analyses and thus self-explanatory, but a few require clarification: *Log Household Income* is a continuous variable of the log of the individual's imputed household income. Household income is initially reported in the individual's local currency. Respondents who have difficulty answering the question are presented a set of ranges in local currency and are asked which group they fall into (Gallup, 2015). Household income is then equated across countries by converting the local currency to international dollars using the World Bank's PPP (2011) private consumption conversion factor. This measure also relies on multiple imputation methodology to replace missing values. *Social Network* is a binary variable that equals one if the individual is satisfied with their ability to make friends and *Social Capital* is a binary variable that equals one if the individual feels they can count on friends and family in times of need. We also include country-level variables (*Unemployment rate* and *Log GDP per capita*) from the World Bank's World Development Indicators.

(c) *Analyses sample*

In 2014, the GWP interviewed 154,206 individuals living in 149 countries.[13] Individuals without valid measures of food insecurity were excluded from the analyses, resulting in a sample of 152,206 individuals in 147 countries. An additional 24,016 individuals, including the entire sample from eight countries, were dropped from the sample because they failed to provide valid information on one or more of the questions used to construct the individual-level control variables from the Gallup World Poll. Finally, another 4,458 observations from five countries were dropped from the sample because they failed to provide valid information to one or more of the questions from the World Bank's World Development Indicators, resulting in a final sample of 123,732 individuals in 134 countries.[14]

The global sample of individuals was further disaggregated based on the World Bank Atlas method of ranking economic development. The rankings include low-income economies, lower middle-income economies, upper-middle-income economies, and high-income economies. Low-income economies are defined as those with a Gross National Income (GNI) per capita, of $1,045 or less in 2014; middle-income economies are those with a GNI per capita of more than $1,045 but less than $12,736; high-income economies are those with a GNI per capita of $12,736 or more. Lower middle-income and upper-

middle-income economies are separated at a GNI per capita of $4,125 (World Bank, 2016).

Table 1 shows the prevalence of food insecurity and severe food insecurity by the World Bank economic development rankings. Severe food insecurity is a subset of food insecurity, as food insecurity represents the categories moderate and severe food insecurity. Column 1 shows that 27% and 11% of our global sample experiences food insecurity and severe food insecurity, respectively. Columns 2–5 show the sample separated by development ranking. As we might expect, food insecurity and severe food insecurity are highest in low-income economies, followed by lower middle-, upper-middle-, and high-income economies. Column 2 shows that roughly half of the population in low-income economies experience food insecurity; and 30% experience severe food insecurity. In high-income economies, roughly 10% of the population experience food insecurity and only 3% experience severe food insecurity.

4. METHODOLOGY

The remaining empirical analyses use multivariate statistical methods to better understand the determinants of food insecurity. The analyses adopt a three-level linear probability model specification to consider the food security status of individuals and to mitigate bias from the clustering of individuals, within-country sub-regions, and country-level time-invariant omitted variables. [15] At the first and second levels, we have individual- and household-level characteristics, and the within-country sub-regions where the respondent lives. The third level represents the country-level information attained from the World Bank's World Development Indicators.

To ignore these relationships risks overlooking the importance of cluster effects (at the sub-region- and country-level), which may render invalid many of the traditional statistical analysis techniques (Goldstein, 2011). For example, because of this clustering, the assumption that observations are independent and identically distributed is violated. Hence, multilevel linear models are needed as they are the standard frameworks for modeling clustered data in econometric analyses (Cameron & Trivedi, 2005; Gelman & Hill, 2007; Goldstein, 2011).

The multilevel linear probability model assumes the probability of an individual being food insecure is given by

$$Y_{irc} = X'_{irc}\beta + Z'_{c}\gamma + v_{ir} + v_i + \varepsilon_{irc} \quad (1)$$

where i, r, and c are indices for individuals, within-country sub-regions, and countries, X'_{irc} consists of demographic and socioeconomic characteristic, Z'_c contains country-level features, namely, the unemployment rate and log GDP per capita, v_{ir} is the random effect at the second level (sub-region), v_i is the random effect at third level (country), and ε_{irc} represents the unobserved individual heterogeneity. The level-three subscript i is present for both v_{ir} and v_i since we do not assume an equal sample size between the number of individuals inside each sub-region, and the number of sub-regions inside each country. The error terms v_{ir}, v_i, and ε_{irc} enter the model at the sub-region-, country-, and individual-levels, respectively. The analyses assume these errors are distributed independently of each other and that they are distributed as Gaussian with means of zero and variances of σ_{ir}^2, σ_i^2, and σ_{irc}^2.

To further check the robustness of results and illustrate their stability to various model specifications, we tested whether two-level country random-effects or two-level country fixed-effects fit the data better than the three-level linear probability model. We found that the intra-class correlation coefficient (ICC) justified the use of multilevel models and that the three-level linear probability models consistently performed better than the other model specifications. [16]

5. RESULTS AND DISCUSSION

Our results confirm that despite heterogeneity in populations, we can identify key characteristics of the typical food-insecure person across 134 countries. Since the data are cross-sectional and from a single year (2014), causality cannot be inferred without strong assumptions. However, our findings confirm that it is possible to use self-reported experiential measures to document the incidence of food insecurity across different cultural contexts. We would not expect to see strong relationships between respondent characteristics and food insecurity if the FIES was not measuring a similar type of food hardship across populations. In this section, we highlight these relationships by focusing on sets of key variables presented in Tables 2 (food insecurity) and 3 (severe food insecurity).

The first column of Table 2 reports results from the global model of food insecurity, which accounts for unobservable variation at the individual-, sub-regional-, and country-level using random effects. Columns 2–5 explore the heterogeneity of the determinants of food insecurity by economic development ranking. Column 1 reports the average marginal effects for the pooled sample, of which the five largest magnitudes

Table 1. *Food insecurity and severe food insecurity by economic development ranking*

Food insecurity categories	All	Low-income economies	Lower middle-income economies	Upper-middle-income economies	High-income economies
Food insecurity	0.273	0.565***	0.319***	0.262***	0.108***
	(0.445)	(0.496)	(0.466)	(0.440)	(0.311)
Severe food insecurity	0.111	0.295***	0.125***	0.092***	0.031***
	(0.315)	(0.456)	(0.331)	(0.289)	(0.173)
Number of observations	123,732	18,211	34,165	31,826	39,530
Number of countries	134	20	35	36	43

Notes: Means calculated using unweighted individual-level data from the 2014 Gallup World Poll. Standard errors are in parentheses. Severe food insecurity is a subset of food insecurity, as food insecurity represents the categories moderate and severe food insecurity. Asterisks indicate whether the difference in means for the specific group of countries (based on the World Bank economic development rankings) is statistically significantly different from the rest of the world.

*Significance at the 0.10 level.

**Significance at the 0.05 level.

*** Significance at the 0.01 level.

Table 2. *Coefficients and standard errors for the determinants of food insecurity by economic development ranking*

Variables	All	Low-income economies	Lower middle-income economies	Upper-middle-income economies	High-income economies
Demographic characteristics					
Female	0.004*	−0.003	0.010**	0.008*	−0.001
	(0.002)	(0.007)	(0.005)	(0.004)	(0.003)
Age	0.005***	0.003***	0.004***	0.006***	0.003***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)
Age squared	−0.000***	−0.000**	−0.000***	−0.000***	−0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of adults in HH	−0.001**	−0.004**	−0.003*	0.001	−0.000
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Number of children in HH	0.014***	0.011***	0.014***	0.018***	0.016***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Single or never married	0.010***	0.006	0.009	0.008	0.015***
	(0.003)	(0.009)	(0.006)	(0.006)	(0.004)
Separated, widowed, or divorced	0.037***	0.045***	0.037***	0.034***	0.039***
	(0.003)	(0.011)	(0.008)	(0.007)	(0.004)
Elementary education	0.146***	0.180***	0.177***	0.172***	0.088***
	(0.004)	(0.019)	(0.008)	(0.008)	(0.005)
Secondary education	0.051***	0.094***	0.071***	0.077***	0.031***
	(0.003)	(0.019)	(0.008)	(0.007)	(0.003)
Reside in rural area or on a farm	0.017***	0.090***	0.025***	0.017**	−0.019***
	(0.004)	(0.014)	(0.008)	(0.007)	(0.005)
Reside in small town	0.008**	0.044***	0.017**	0.005	−0.001
	(0.003)	(0.014)	(0.008)	(0.006)	(0.004)
Reside in suburban area	0.014***	0.061***	0.016	0.012	0.005
	(0.005)	(0.020)	(0.012)	(0.009)	(0.005)
Social capital characteristics					
Social network	−0.053***	−0.054***	−0.042***	−0.063***	−0.053***
	(0.003)	(0.007)	(0.005)	(0.005)	(0.004)
Social capital	−0.117***	−0.092***	−0.125***	−0.126***	−0.112***
	(0.003)	(0.007)	(0.005)	(0.006)	(0.005)
Economic characteristics					
Log HH income	−0.044***	−0.039***	−0.048***	−0.059***	−0.032***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
Self-employed, full-time	−0.011***	0.014	−0.036***	−0.008	0.004
	(0.004)	(0.012)	(0.008)	(0.007)	(0.006)
Employed, part-time	0.029***	0.047***	0.009	0.036***	0.039***
	(0.003)	(0.012)	(0.008)	(0.007)	(0.005)
Unemployed	0.042***	0.067***	0.017*	0.062***	0.032***
	(0.004)	(0.013)	(0.009)	(0.009)	(0.006)
Out of the labor force	−0.004	0.017	−0.018***	−0.002	0.004
	(0.003)	(0.012)	(0.007)	(0.006)	(0.004)
Country characteristics					
Unemployment rate	−0.000	0.004	−0.002	0.001	−0.002
	(0.002)	(0.017)	(0.004)	(0.003)	(0.002)
Log GDP per capita, US $	−0.040**	−0.267**	−0.003	−0.039	−0.037***
2005	(0.019)	(0.117)	(0.059)	(0.040)	(0.010)
Error components					
σ_i^2	0.133***	0.167***	0.147***	0.137***	0.050***
	(0.009)	(0.029)	(0.019)	(0.017)	(0.006)
σ_{ir}^2	0.117***	0.194***	0.135***	0.089***	0.053***
	(0.002)	(0.008)	(0.005)	(0.004)	(0.003)
σ_{irc}^2	0.353***	0.406***	0.393***	0.367***	0.267***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Log-likelihood	−49,033.08	−9,873.38	−17,214.99	−13,654.04	−4,274.81
Number of observations	123,732	18,211	34,165	31,826	39,530
Number of countries	134	20	35	36	43

Notes: Models estimated using unweighted individual-level data from the 2014 Gallup World Poll. Dependent variable is Food Insecurity. Standard errors are in parentheses. The models estimated using the pooled sample also include controls for low-income, lower middle-income, and upper-middle-income economies.

* Significance at the 0.10 level.
** Significance at the 0.05 level.
*** Significance at the 0.01 level.

Table 3. *Coefficients and standard errors for the determinants of severe food insecurity by economic development ranking*

Variables	All	Low-income economies	Lower middle-income economies	Upper-middle-income economies	High-income economies
Demographic characteristics					
Female	−0.001	0.001	0.000	−0.001	−0.004**
	(0.002)	(0.006)	(0.003)	(0.003)	(0.002)
Age	0.002***	0.000	0.002***	0.003***	0.001***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
Age squared	−0.000***	0.000	−0.000***	−0.000***	−0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of adults in HH	−0.001	−0.004**	−0.001	−0.001	0.001**
	(0.000)	(0.002)	(0.001)	(0.001)	(0.000)
Number of children in HH	0.007***	0.007***	0.005***	0.009***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Single or never married	0.009***	0.008	0.004	0.018***	0.010***
	(0.002)	(0.009)	(0.005)	(0.004)	(0.002)
Separated, widowed, or divorced	0.024***	0.056***	0.032***	0.019***	0.018***
	(0.002)	(0.010)	(0.006)	(0.005)	(0.002)
Elementary education	0.063***	0.076***	0.083***	0.072***	0.028***
	(0.003)	(0.018)	(0.006)	(0.005)	(0.003)
Secondary education	0.009***	0.015	0.027***	0.015***	0.005***
	(0.002)	(0.018)	(0.006)	(0.005)	(0.002)
Reside in rural area or on a farm	0.010***	0.073***	0.012**	0.002	−0.007**
	(0.003)	(0.013)	(0.006)	(0.005)	(0.003)
Reside in small town	0.004	0.046***	0.007	0.002	−0.002
	(0.002)	(0.013)	(0.006)	(0.004)	(0.002)
Reside in suburban area	0.007**	0.101***	−0.004	0.001	0.001
	(0.003)	(0.019)	(0.009)	(0.006)	(0.003)
Social capital characteristics					
Social network	−0.027***	−0.040***	−0.021***	−0.034***	−0.020***
	(0.002)	(0.007)	(0.004)	(0.003)	(0.002)
Social capital	−0.067***	−0.097***	−0.070***	−0.057***	−0.041***
	(0.002)	(0.007)	(0.004)	(0.004)	(0.003)
Economic characteristics					
Log HH income	−0.026***	−0.027***	−0.029***	−0.033***	−0.014***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Self-employed, full-time	−0.011***	−0.009	−0.024***	−0.010*	0.012***
	(0.003)	(0.011)	(0.005)	(0.005)	(0.003)
Employed, part-time	0.012***	0.021*	0.001	0.022***	0.010***
	(0.003)	(0.011)	(0.006)	(0.005)	(0.003)
Unemployed	0.015***	0.026**	0.000	0.030***	0.009**
	(0.003)	(0.012)	(0.007)	(0.006)	(0.004)
Out of the labor force	−0.006***	−0.001	−0.013***	−0.004	0.001
	(0.002)	(0.011)	(0.005)	(0.004)	(0.002)
Country characteristics					
Unemployment rate	0.001	0.005	−0.001	0.003	−0.001
	(0.002)	(0.017)	(0.003)	(0.002)	(0.001)
Log GDP per capita, US $	−0.002	−0.157	−0.025	0.031	−0.010**
2005	(0.014)	(0.119)	(0.038)	(0.024)	(0.004)
Error components					
σ_i^2	0.099***	0.173***	0.093***	0.081***	0.020***
	(0.007)	(0.029)	(0.012)	(0.010)	(0.003)
σ_{ir}^2	0.089***	0.148***	0.107***	0.057***	0.034***
	(0.002)	(0.007)	(0.004)	(0.003)	(0.001)
σ_{irc}^2	0.260***	0.380***	0.286***	0.252***	0.152***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Log-likelihood	−11,353.97	−8,623.31	−6,351.00	−1,647.22	17,925.39
Number of observations	123,732	18,211	34,165	31,826	39,530
Number of countries	134	20	35	36	43

Notes: Models estimated using unweighted individual-level data from the 2014 Gallup World Poll. Dependent variable is Severe Food Insecurity. Standard errors are in parentheses. The models estimated using the pooled sample also include controls for low-income, lower middle-income, and upper-middle-income economies.

* Significance at the 0.10 level.
** Significance at the 0.05 level.
*** Significance at the 0.01 level.

come from the *elementary/secondary education*, *social capital, social network, log household income,* and *unemployed* characteristics, respectively. These results show that individuals with more education, stronger social connections, higher incomes, and employment are less likely to be food insecure. For example, having only an elementary education is associated with a 14.6 percentage point higher probability of experiencing food insecurity, compared to having a college degree, holding all other characteristics constant. A high level of social capital is associated with an 11.7 percentage point lower probability of experiencing food insecurity. A 10% increase in household income ($1,900 on average) is associated with a 0.4 percentage point lower probability of experiencing food insecurity, and being unemployed is associated with a 4.2 percentage point lower probability of experiencing food insecurity. These results reinforce the importance of education and social capital as determinants of food insecurity, as well as economic factors such as household income and employment.

The first column of Table 3 reports the results of the global model with severe food security as the dependent variable. Columns 2–5 explore the heterogeneity of the determinants of severe food insecurity by economic development ranking. The global model of severe food insecurity (Table 3) shows that the primary determinants of severe food insecurity are somewhat different than those of food insecurity (Table 2). Column 1 shows that the five largest magnitudes of the determinants of severe food insecurity come from the *social capital, elementary education, social network, log household income,* and *separated, widowed, or divorced* characteristics, respectively. For example, holding all other characteristics constant, a high level of social capital is associated with a 6.7 percentage point lower probability of experiencing severe food insecurity. Having only an elementary education is associated with a 6.3 percentage point higher probability of experiencing severe food insecurity, compared to having a college degree. Having a strong social network is associated with a 2.7 percentage point lower probability of experiencing severe food insecurity, and a 10% increase in household income ($1,900 on average) is associated with a 0.3 percentage point lower probability of experiencing severe food insecurity. Again, we see the importance of social factors and their relationship for both food insecurity and severe food insecurity.

Looking at the determinants of both food insecurity and severe food insecurity (column 1 of Tables 2 and 3), we find that age, the number of children in the household, being unmarried, living in a rural area, and being unemployed are all associated with a higher probability of experiencing food insecurity and severe food insecurity around the world. For example, an additional child in the household is associated with a 1.4 percentage point higher probability of experiencing food insecurity, and a 0.7 percentage point higher probability of experiencing severe food insecurity. There are some differences in the results between food insecurity and severe food insecurity. For example, being female is associated with a 0.4 percentage point higher probability of experiencing food insecurity, compared to being male (Table 2). However, for severe food insecurity in Table 3, gender is not statistically significant.

Across the development rankings, again the *elementary education*, *social network,* and *social capital* characteristics play a large role in the likelihood of experiencing food insecurity and severe food insecurity. For example, having only an elementary level of education, compared to a college degree, is associated with a significantly higher probability of experiencing food insecurity (Table 2) across development rankings: by 18.1 percentage points in low-income economies, 17.7 percentage points in lower middle-income economies, 17.2 percentage points in upper-middle-income economies, and 8.8 percentage points in high-income economies. Likewise, we find in all four economic development rankings an increase in household income, a larger social network, and more social capital are all associated with significantly lower probabilities of food insecurity.

We also see numerous differences with respect to the determinants of food insecurity and severe food insecurity across development rankings. Table 2 shows gender is only statistically significant in the lower middle-income economies and weakly statistically significant in the upper-middle economies. This implies that in low-income and high-income economies the association between gender and an individual's food security status is being completely captured by the other covariates. Similarly, at the country level, GDP per capita is only statistically significant in the high-income and low-income economies. For food insecurity (Table 2), the largest average marginal effect for low-income economies (Column 2) is log GDP per capita. A 10% increase in GDP per capita ($142 per capita on average) is associated with a 2.7 percentage point lower probability of experiencing food insecurity; but is not statistically significant for lower middle- and upper-middle-income economies. Nor is GDP per capita statistically significant for severe food insecurity (Table 3) in low-income economies. This implies that in the middle-income countries, GDP per capita and economic growth may not be as closely associated with food insecurity as in lower middle- and upper middle-income economies. More research is needed to understand how macroeconomic indicators relate to food insecurity at the individual-level across countries. Our results are consistent with the hypothesis that developmental heterogeneity is crucial to understanding the determinants of food insecurity around the world.

The findings are largely consistent with previous research from more limited data sources. For example, the importance of social networks and social capital found here is consistent with previous literature. Martin, Rogers, Cook, and Joseph (2004) found that social capital—measured by trust, reciprocity, and social networks—is positively associated with household food security in the United States. Similarly, research in the United States on the impact of household income on food insecurity has consistently found that households with lower incomes have higher rates of food insecurity (Coleman-Jensen, Rabbitt, Gregory, & Singh, 2015). We also find that lower household income is associated with significantly higher rates of food insecurity. However, Davis *et al.* (2010) show that in the developing world, poor households often rely on informal labor markets such as subsistence agriculture, seasonal agricultural wage labor, and various forms of off-farm self-employment. These activities act as an informal social safety net to ensure food security. We find that being self-employed, compared to being employed fulltime for someone else, is associated with a decrease in food security (Table 2) and severe food insecurity (Table 3).

Previous research has found a significant relationship between gender and food insecurity in the developing world. For example, Sraboni, Malapit, Quisumbing, and Ahmed (2014) find that women's empowerment in Bangladesh is positively associated with calorie availability and dietary diversity. Table 2 shows that women are more likely to be food insecure, holding all other characteristics constant. However, this relationship does not hold for every development ranking. Interestingly, we also find the women are *less* likely to be severely food insecure in high-income economies (Column 5 Table 3). Our findings also show that residing in a rural area, compared

to living in a large city, is associated with an increase in the probability of experiencing food insecurity and severe food insecurity. This is consistent with previous research that demonstrates that rural food insecurity is often much higher than urban food insecurity (Smith, Ruel, & Ndiaye, 2005; Weber, Staatz, Crawford, Bernsten, & Holtzman, 1988).

Our findings on the relationship between GDP and food security is largely consistent with prior research, although we see some differences across development rankings. Ruel, Alderman, Maternal, and Group (2013) review evidence of nutritional programs in several developing countries and find that a 10% increase in GDP per capita is associated with a 6% decrease in child stunting. While we find that a 10% increase in GDP per capita (nearly $1,100 per person on average) is associated with a 0.40 percentage point lower probability of experiencing food insecurity (Table 2). This difference is likely attributable to the fact that child stunting is a more severe outcome. Using a different measure of food insecurity from the GWP, Headey (2013) found changes in GDP per capita significantly explained changes in food insecurity. However, we do not find a consistent relationship between GDP per capita over the development rankings. This may speak to the effectiveness of the FIES, in that it captures more detailed experiential information at the individual level.

6. CONCLUSION

Prior research identifying the determinants of food insecurity in developing countries relied heavily on primary data collections with small samples focused on a specific locality and often without a robust survey instrument. This paper is the first to utilize the new FIES measure with the aim of identifying and examining the common determinants of food insecurity in 134 countries around the world. Using a series of multilevel linear probability models, we find that the five characteristics that are most strongly associated with the likelihood of experiencing food insecurity are: having low levels of education, less social capital, weak social networks, low household income, and being unemployed.

Our results also reveal significant heterogeneity in the determinants of food insecurity over economic development rankings. Across the development rankings, low levels of education, weak social networks, and less social capital, all play a large role in the likelihood of experiencing food insecurity. But we also see numerous differences in the determinants of food insecurity across development rankings. For example, the associations between food insecurity and gender, the number of adults in the household, rural status, employment status, and GDP per capita all vary by development ranking. This reveals the need for country-specific development policies and that a blanket approach to development assistance may not be effective.

Sensitivity analyses indicate that our results are robust to various model assumptions; however, there are limitations worth discussing. First, causality cannot be inferred from our results because we do not attempt to correct for the potential endogeneity of the determinants of food insecurity. However, our results do suggest the presence of strong correlations between our analyses variables and food insecurity. Understanding these correlations is an important first step in understanding the global determinants of food insecurity. Further work should extend the analyses here to address potential endogeneity. Second, our analyses are limited by the information available in the Gallup World Poll. For example, we are unable to control for additional characteristics known to be related to food insecurity, such as the receipt of public and private food assistance. Controlling for the receipt of food assistance in a global model is particularly challenging because the form of assistance is likely to be country specific (e.g., cash assistance, in-kind transfers, etc.).

Our results provide further validation for the FIES and confirms the virtues of self-reported experiential measures of food insecurity. Despite heterogeneity in global populations, differences in governments and policies, variations in local economies, labor markets, and agriculture, we can identify the characteristics of the typical food-insecure person around the world. The FIES represents an important complement to existing model-based measures of food security and other initiatives that quantify the magnitude of food insecurity within countries. Rather than duplicating model-based estimates of food insecurity, this research extends the field by developing a greater understanding of the food access dimension of global food insecurity among different populations.

NOTES

1. The actual number of countries depends on the number of countries covered by the GWP in each year, and possibly on the fact that additional countries might collect experiential data, independently from the GWP. One of the virtues of the FIES is that it is based on a Rasch measurement model. Therefore, any countries that ask food security questions that overlap with the FIES may have their food security scales equated to the FIES global standard.

2. See https://sustainabledevelopment.un.org/sdg2 particularly target 2.1.

3. The first cross-country comparable estimates of food insecurity were reported in FAO (2016); found here: http://www.fao.org/3/a-i4830e.pdf.

4. For a more comprehensive review of the evolution of food insecurity measurement, see Coates (2013), Jones, Ngure, Pelto, and Young (2013), and Marques, Reichenheim, de Moraes, Antunes, and Salles-Costa (2015).

5. For more information regarding the FAO Prevalence of Undernourishment methods see Cafiero, Melgar-Quiñonez, Ballard, and Kepple (2014).

6. For theoretical models of food insecurity, see Barrett (2002), Caswell and Yaktine (2013), Duffy and Zizza (2016), Gundersen and Oliveira (2001), Meyerhoefer and Yang (2011), and Ribar and Hamrick (2003).

7. The GWP typically interviews 1,000 individuals per country, but increases the sample size per the population size of the country for some of the largest countries (Gallup, 2015). For example, 3,000 and 5,000 individuals were interviewed in India and China, respectively, in 2014.

8. For more information, see http://www.fao.org/in-action/voices-of-the-hungry.

9. Under the Rasch measurement model (Rasch, 1960) the raw score is a sufficient statistic for the latent trait that is being measured.

10. The food insecurity thresholds used by FAO may differ in severity from the thresholds used by other countries in their own food insecurity measurement and reporting. This difference in threshold severity results in differences in prevalence rates of food insecurity between FAO and other country's own food insecurity statistics.

11. To illustrate the comparability of each country's food security scale after equating, consider the simplest case where there are only two countries. Application of the Rasch model to each country's food security data produces estimates of the model parameters, which represent item and person locations on the latent construct of food insecurity. For the two country's food security scales to be comparable, they must be equated using the mean and standard deviation of each country's set of food security item parameters, which may be used to produce a common metric. After equating, the severity of the food security items for the two countries are comparable and may be used to construct thresholds (based on the raw scores) for the food security status categories that represent the same level of severity of food insecurity in each country. For a more in depth discussion of the equating methodology and how it was used by FAO to construct the FIES-GSS, see (FAO, 2016).

12. Alternatively, for computing the prevalence rates of food insecurity each respondent could be assigned a probability of membership in each of the two food insecurity categories, based on the estimated person parameter and corresponding standard error associated with the reported raw score. For more details on probabilistic assignment of respondents to food security status, see FAO (2016, section 6, pp.17–19).

13. GWP also includes territories such as Northern Cyprus and Palestine, but for the sake of this paper we refer to them as "countries".

14. An analysis of the missing observations suggests that there is no systematic difference with respect to food security in those failing to answer questions used to construct the control variables.

15. The linear probability model for discrete choice is motivated in Heckman and Snyder (1997). We also found very similar results using a three-level logistic regression specification. These results are available from the authors upon request.

16. Results not shown but available from the authors upon request.

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APPENDIX A. FAO FOOD INSECURITY EXPERIENCE SCALE SURVEY MODULE (FIES-SM)

1. "You were worried you would run out of food because of a lack of money or other resources? (**Yes**/No)"
2. "You were unable to eat healthy and nutritious food because of a lack of money or other resources? (**Yes**/No)"
3. "You ate only a few kinds of foods because of a lack of money or other resources? (**Yes**/No)"
4. "You had to skip a meal because there was not enough money or other resources to get food? (**Yes**/No)"
5. "You ate less than you thought you should because of a lack of money or other resources? (**Yes**/No)"
6. "Your household ran out of food because of a lack of money or other resources? (**Yes**/No)"
7. "You were hungry but did not eat because there was not enough money or other resources for food? (**Yes**/No)"
8. "You went without eating for a whole day because of a lack of money or other resources? (**Yes**/No)"

Note: "Affirmative" responses are indicated in bold.

APPENDIX B. CHARACTERISTICS OF ANALYSIS INDIVIDUALS

Table 4. *Means of analysis variables by economic development ranking.*

Variables	All	Low-income economies	Lower middle-income economies	Upper-middle-income economies	High-income economies
Food insecurity categories					
Food insecurity	0.273	0.565	0.319	0.262	0.108
	(0.445)	(0.496)	(0.466)	(0.440)	(0.311)
Severe food insecurity	0.111	0.295	0.125	0.092	0.031
	(0.315)	(0.456)	(0.331)	(0.289)	(0.173)
Demographic characteristics					
Female	0.510	0.508	0.506	0.512	0.512
	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
Age	39.12	33.675	36.168	38.702	44.512
	(17.52)	(15.491)	(16.179)	(17.216)	(18.314)
Number of adults in HH	3.462	4.208	3.876	3.510	2.720
	(2.020)	(2.478)	(1.941)	(1.688)	(1.856)
Number of children in HH	1.361	2.683	1.682	1.112	0.675
	(1.896)	(2.581)	(1.920)	(1.586)	(1.252)
Single/never married	0.323	0.340	0.333	0.352	0.281
	(0.467)	(0.474)	(0.471)	(0.477)	(0.450)
Separated/widowed/divorced	0.105	0.093	0.086	0.099	0.132
	(0.307)	(0.290)	(0.280)	(0.299)	(0.339)
Married (ref)	0.572	0.567	0.581	0.549	0.586
	(0.495)	(0.496)	(0.493)	(0.498)	(0.493)
Elementary education	0.406	0.747	0.475	0.390	0.201
	(0.491)	(0.435)	(0.499)	(0.488)	(0.401)

(*continued on next page*)

Table 4 (*continued*)

Variables	All	Low-income economies	Lower middle-income economies	Upper-middle-income economies	High-income economies
Secondary education	0.472	0.233	0.444	0.497	0.586
	(0.499)	(0.423)	(0.497)	(0.500)	(0.493)
Post-secondary education (ref)	0.122	0.020	0.081	0.113	0.213
	(0.328)	(0.139)	(0.274)	(0.316)	(0.409)
Reside in rural area or on a farm	0.285	0.468	0.402	0.232	0.143
	(0.452)	(0.499)	(0.490)	(0.422)	(0.350)
Reside in small town	0.352	0.354	0.322	0.328	0.397
	(0.478)	(0.478)	(0.467)	(0.469)	(0.489)
Reside in suburban area	0.0867	0.058	0.050	0.102	0.119
	(0.281)	(0.234)	(0.219)	(0.303)	(0.324)
Reside in urban area (ref)	0.276	0.120	0.226	0.338	0.341
	(0.447)	(0.325)	(0.418)	(0.473)	(0.474)
Social capital characteristics					
Social network	0.769	0.703	0.768	0.752	0.813
	(0.422)	(0.457)	(0.422)	(0.432)	(0.390)
Social capital	0.806	0.695	0.756	0.817	0.893
	(0.395)	(0.460)	(0.429)	(0.387)	(0.309)
Economic characteristics					
Log HH income	8.873	7.210	8.278	8.981	10.068
	(1.748)	(1.933)	(1.530)	(1.216)	(1.274)
Self-employed, full-time	0.145	0.256	0.173	0.140	0.073
	(0.352)	(0.436)	(0.378)	(0.347)	(0.259)
Employed, part-time	0.154	0.196	0.152	0.154	0.137
	(0.361)	(0.397)	(0.359)	(0.361)	(0.344)
Unemployed	0.0780	0.135	0.079	0.069	0.058
	(0.268)	(0.342)	(0.269)	(0.254)	(0.234)
Out of the labor force	0.376	0.325	0.425	0.383	0.352
	(0.484)	(0.468)	(0.494)	(0.486)	(0.478)
Employed, full-time (ref)	0.247	0.088	0.171	0.253	0.380
	(0.431)	(0.283)	(0.377)	(0.435)	(0.485)
Country characteristics					
Unemployment rate	8.377	4.515	8.286	10.904	8.192
	(5.986)	(2.605)	(6.431)	(7.263)	(4.326)
Log GDP per capita, US $ 2005	8.192	5.973	7.169	8.338	9.978
	(1.562)	(0.380)	(0.426)	(0.612)	(0.863)
Number of observations	123,732	18,211	34,165	31,826	39,530
Number of countries	134	20	35	36	43

Notes: Means and standard deviations (in parentheses) estimated using individual-level data from the 2014 Gallup World Poll.