Economic and social factors of food insecurity: A study of individual vulnerability at the global level

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Summary

Food insecurity is one of the most important issues in determining a country's level of development, being at the core of sustainable growth. It affects all countries in the world, because even in countries with high current levels of income or food availability, the stability of food access and utilization may change over time.
Comparisons of food insecurity in different economic and demographic subpopulations across countries provide a better understanding of the complex phenomenon and support policies aimed at improving the well-being of populations and alleviating hunger.
Even though definitions and measures of food insecurity have been widely debated, both in the political and scientific spheres, for decades, until very recently data referring to a univocal measure of food insecurity was lacking at the global level. Only beginning in 2014 was the FAO Food Insecurity Experience Scale (FIES) used to perform a global survey, in 147 countries, with a sample of more than 150,000 individuals.
This study presents an analysis of food insecurity based on information relating to individuals' own experience of their food insecurity, measured by FIES, together with other meaningful personal and household characteristics. The objective of this work is to assess which factors can determine individual food insecurity.
Food insecurity presents marked differences depending on the level of development of the country under consideration. To take these factors into account, countries have been grouped together using a cluster analysis, based on the indicators forming the UN Human Development Index.
The model, estimated both at the global level and for each group of countries, allows us to identify the economic, social, and demographic characteristics related to food insecurity, adding further evidence to the existing literature.
Overall, the factors that have a significant impact on the risk of food insecurity include level of education, number of children in the household, and location of the household.

Keywords: food insecurity, self-reported scale, cluster analysis, ordered logistic regression, economic development

JEL Classification codes: Q18, F63, C35, C38

Economic and social factors of food insecurity: A study of individual vulnerability at the global level

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1. INTRODUCTION

Food insecurity is at the core of sustainable development and one of the UN Sustainable Development Goals (SDGs) stated in its 2030 Agenda as SDG2: "End hunger, achieve food security, and promoting sustainable agriculture" (UN 2015). It involves people all over the world, even in richer and more developed countries, where food is currently available, because even in those countries the stability of access to food may change over time. Food insecurity is a concern in most developing countries, particularly in Africa, where one out of four people remain undernourished (FAO, 2017). It is estimated that in 2016 the number of chronically undernourished people in the world increased to 815 million, from 777 million in 2015, after a decade of decline.

This research extends our understanding of social and personal vulnerability to food insecurity. The analysis is carried out at the micro level to expand our knowledge of individual experience and personal and familiar characteristics associated with food insecurity.

The study employs an innovative measure of food insecurity based on self-reported information; the Food Insecurity Experience Scale (FIES) of the UN Food and Agriculture Organization (FAO) has been used to investigate factors related to the level and severity of food insecurity within and across the 147 countries surveyed in the Gallup World Pool (GWP). The survey was endorsed in the recent Atkinson Commission Report (World Bank, 2017), where the survey was recommended because it permits the analysis of poverty in most countries of the world, including more than two dozen countries in Africa, using identical questions throughout the world.

The objective of this work, thus, is to assess which economic, social, and demographic factors can determine individual food insecurity. Furthermore, the comparisons of food insecurity in different economic and demographic subpopulations across countries allow a better understanding of the complex phenomenon and can support policies aimed at meeting the SDG on food, improving the level of development and the well-being of populations.

In Section 2 we describe the FIES data, with particular regard to the scale used to represent the experience of food insecurity, the resulting measures, and the characteristics of the survey; in Section 3 we present the results of a cluster analysis, based on the indicators comprising the UN Human Development Index, applied in order to group the available countries by level of development; and we present the model in Section 4 and its results in Section 5. Finally, we present our conclusions and policy remarks.

2. DATA AND METHODS

Definitions and measures of food insecurity have been widely debated, both in the political and scientific spheres, for decades. Since the World Food Conference in 1974, the concept of food insecurity has evolved and diversified (Maxwell, 1996). The topic is widely discussed in the literature, especially after the food crisis of 2008 (Burchi and De Muro, 2016; Grobler, 2016; Misselhorn et al., 2012; Frongillo, 1999), and there are many different definitions and measures of the phenomenon (Cafiero et al., 2014; Allen, 2013; Jones et al., 2013; Coates, 2013), as there are different types of surveys for its detection and a wide variety of indicators used for synthesis and evaluation (Carletto et al., 2013).

Data referring to a univocal, individual measure of food insecurity at the global level has not been available until very recently. Only beginning in 2014 was the FAO FIES used to perform a global survey, in 147 countries, with a sample of more than 150,000 individuals, giving scholars the opportunity to study individual determinants of food insecurity (Smith, Kassa and Winters, 2017Smith, Rabbitt and Coleman-Jensen2017).

The FIES consists of a set of eight short questions asked directly to individual adults[1]. The questions ask people directly whether they have to compromise the quality and quantity of the food they eat due to limited money or other resources to obtain food. Information is collected at the individual level, response categories are only "Yes" or "No" rather than ordinal variables, and a reference period of 12 months is used to ensure comparability of surveys conducted in different months (Ballard et al. 2013, Ballard et al. 2014).

The survey adopted a three-stage sampling procedure to select the sample (Gallup, 2017). The linguistically and culturally adapted FIES questions were directed to adult individuals randomly selected at the third stage who reside in sample households randomly selected in the second stage from primary sampling units, which were in turn either randomly selected or selected based on probabilities proportional to population size (first stage). Surveys were conducted on nationally representative samples of 1000 adult individuals, representative of the male and female resident population aged 15 and over (in very large countries such as India and China, sample sizes increased up to 5000 individuals).

Inclusion of the FIES in the annual GWP enables the collection of cross-culturally comparable information from individual respondents at a relatively low cost and provides country-level estimates of food insecurity severity.

[1] FAO FIES survey module

Now I would like to ask you some questions about your food consumption in the last 12 months. During the last 12 MONTHS, was there a time when:

Q1. You were worried you would run out of food because of a lack of money or other resources?

Q2. You were unable to eat healthy and nutritious food because of a lack of money or other resources?

Q3. You ate only a few kinds of foods because of a lack of money or other resources?

Q4. You had to skip a meal because there was not enough money or other resources to get food?

Q5. You ate less than you thought you should because of a lack of money or other resources?

Q6. Your household ran out of food because of a lack of money or other resources?

Q7. You were hungry but did not eat because there was not enough money or other resources for food?

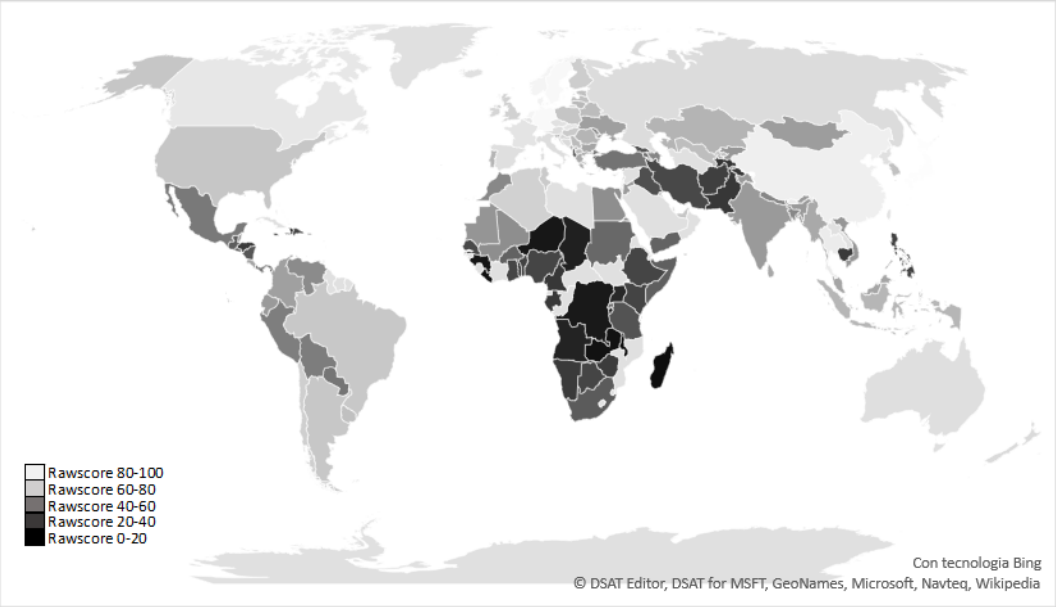
Q8. You went without eating for a whole day because of a lack of money or other resources?

Since the FIES data are based on the Rasch measurement model's assumptions (Nord, 2014), the individual FIES score can be analysed as an ordinal variable, with values ranging from 0 (no symptoms of food insecurity) to 8 (all symptoms of insecurity), because it is a sufficient statistic for the latent trait that is being measured.

3. EMPIRICAL ANALYSIS

Food insecurity presents marked geographical differences related to the level of development of the country under consideration (Figure 1).

Figure 1. Share of population with no symptoms of food insecurity (FIES score = 0)

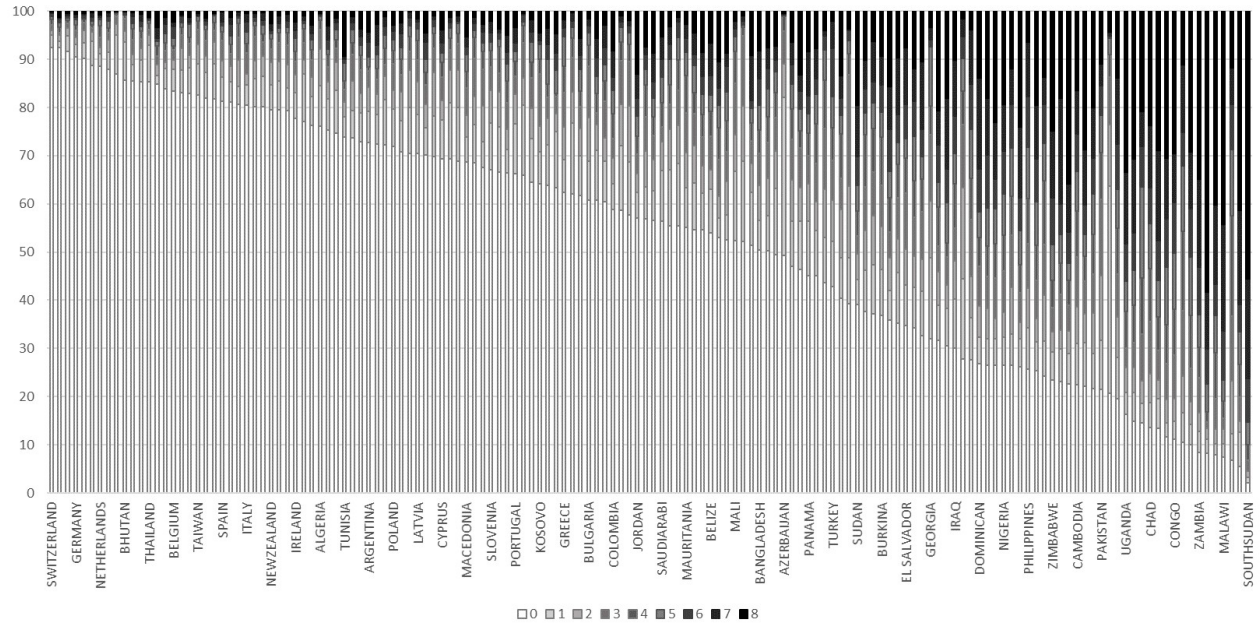


Source: Authors' elaboration on FIES GWP data

Food insecurity is worst in parts of sub-Saharan Africa and south-eastern and western Asia. This was most notable in situations of conflict, in particular where the food security impacts of conflict were compounded by droughts or floods, linked in part to the El Niño phenomenon and climate-related shocks (FAO, 2017).

The distribution of the FIES score in the available countries shows that the share of individuals with zero symptoms of food insecurity ranges from 92.5% in Switzerland and Singapore to 2.1% in South Sudan (Figure 2).

Figure 2: FIES score distribution in 147 countries



Source: Authors' elaboration on FIES GWP data

The indicator captures the phenomenon also in rich and very rich countries. Food insecurity is more severe in Africa, both using the measure based on FIES data as well as other, more established metrics and with the theoretical knowledge of the phenomenon.

We have thus shown that the individual conditions are affected by the economic and social situation of the country or the specific territorial area where individuals live. Therefore, in our analysis, we have taken into account the specificity of countries, including clusters based on the UN Human Development Index (HDI).

To analyse this relationship and take it into account in the model, countries have been grouped together using a cluster analysis (Benassi and Naccarato, 2017; Benassi and Naccarato, 2018), based on the indicators composing the HDI (Anand and Sen, 1997, Ul Haq, 1996).

Following the existing literature and the availability of data, we analyse food insecurity in relation to observable individual characteristics (gender, age, marital status, level of education), household economic and social covariates, urban/rural location, and clusters indicating the level of development. In this way, we have improved the understanding of how household and individual factors affect food insecurity across countries. Moreover, comparisons of food insecurity in different economic and demographic subpopulations across the world indicate the groups of populations that are best targeted with effective policies.

Studies on the determinants of food insecurity at the global level are lacking. However, some studies have analysed food insecurity determinants in specific countries or areas. For example, Asenso-Okyere et al. (2013) studied the determinants of food security in selected agro-pastoral communities in south-eastern Ethiopia. Only recently, thanks to the availability of FIES data in the GWP, some results have been available at the worldwide level (Smith, Rabbitt, and Coleman-Jensen, 2017; Smith, Kassa, and Winters, 2017).

In the literature, the most important and frequently reported factor related to food security is gender. Brunelli and Viviani (2014) reported the study of Nord (2011) on data from the National Health and Nutrition Examination Survey, in which he proved that American women are more likely to experience food insecurity than American men in households with the same food insecurity and income. Results were similar in a study conducted by Hadley et al. (2008); girls were more likely than boys to report being food insecure,

also controlling for their households' food insecurity level. Aurino (2016) showed similar results for India; a wide pro-boy gap emerged in the middle of adolescence, with 15-year-old girls less likely to consume quality food. In South Africa, vulnerability to food insecurity appears to be more pronounced in female-headed households in comparison to male-headed households (DOA, 2002). Furthermore, male-headed small-scale farm households are more food secure than female-headed households, and this finding is consistent under subjective and objective measures of food security (Tibesigwa and Visser, 2016).

Our analysis shows that women experience food insecurity in a significantly larger share than men: 45.3% of the female population presents at least symptoms of food insecurity, compared with 43.3% of men. If we consider two or more symptoms, women are food insecure in almost 40% of the population, against 32% among men.

As in previous research (Strickhouser et al., 2015; Nord, 2003), also in our study younger people present higher rates of food insecurity. The share of people younger than 35 years old that are food insecure is around 40%, while among elderly people 30% present symptoms of food insecurity. This result could be related to a lower need of food intake for older people (Smith, Rabbitt, and Coleman-Jensen, 2017).

With regard to determinants related to household characteristics, our analysis confirms that, generally, married individuals are less likely to experience food insecurity (Smith, Rabbitt, and Coleman-Jensen, 2017), while being widowed, divorced, or separated constitutes a factor of vulnerability toward food insecurity.

The number of children in the household is another factor of interest in the analysis of food insecurity at the household level (Asenso-Okiere et al., 2013). Our study shows a significant relationship of food insecurity with the number of children in the family.

The level of education of the interviewee is an important factor in food insecurity (Nord and Hopwood. 2008); education is a good proxy of social status, and it is related to employment. In our analysis, two-thirds of people with a lower level of education present at least one symptom of food insecurity, while the share halves among more educated people.

Income and food security have common determinants, but they are conceptually distinct. While income may determine a household's economic access to food, it by no means guarantees household food security, for the latter requires availability, utilization, and stability of food at all times. The indicator we used to measure extreme poverty (income lower than $1.25 per day) appears to be extremely relevant for vulnerability to food insecurity. Clearly, among households with very low income, the share of people with no symptoms of food insecurity is only 20%, against a percentage of 62.2% among other families (based on our elaboration from FIES data). This result demonstrates that the two phenomena are correlated but still distinct, because food insecurity can exist even in households that are not extremely poor, while, in some way, one out of five extremely poor households can afford to have enough food. This result extends similar research finding that lower household income is associated with significantly higher rates of food insecurity, as in the United States (Coleman-Jensen, Rabbitt, Gregory, and Singh, 2016).

Even if the relationship is significant everywhere, in some regions it is stronger than in others, due to urban/rural distribution of population, conflict, or extreme natural events such as droughts or floods that decrease the availability of food, regardless of household income (FAO, 2017). In Africa, where the FAO underlines a very fragile situation due to conflicts and natural disasters, the share of people without any symptom of food insecurity is much lower than everywhere else, regardless of poverty.

The rise of food prices in 2007 and 2008 caused an increase in hunger worldwide; this illustrates the fragility of a very large urban population, which have incomes so low that any increase in the price of food puts people at very high risk of food insecurity (Cohen and Garrett, 2010). From the analysis of FIES data, the results show that among urban populations the share of people with symptoms of food insecurity is

higher. Table 1 presents a summary of the main correlates of food insecurity. Results suggest that the factors identified are indeed strongly associated with individual food insecurity.

Table 1: FIES and related factors (Chi square and significance)

	World	Africa	America	Asia	Europe	Oceania
Gender	71.421	44.969	45.366	41.298	198.400	11.926
	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.155
Age class	1900.000	81.981	204.071	179.736	62.255	120.308
	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000
Marital status	1200.000	523.301	421.698	443.319	458.370	59.217
	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000
Number of children	12000.000	1200.000	908.711	1800.000	170.453	136.342
	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000
Education	16000.000	1900.000	1800.000	2300.000	1700.000	41.424
	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.123
Poverty	22000.000	4100.000	1200.000	2900.000	525.269	10.728
	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.218
Location	4500.000	1800.000	529.805	770.139	92.015	28.520
	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.000	Pr = 0.643

Source: Authors' elaboration on FIES data

The geographical differences affect the gravity of the vulnerability factors, but the relationships with food insecurity do not change. These relationships are cross-cutting across the continents; thus, they are significant regardless of geographical location, which is of great importance in the distribution of the phenomenon.

4. A CLASSIFICATION OF COUNTRIES BY LEVEL OF DEVELOPMENT

To maximize the effects of policies on food insecurity, policy makers also have to take into account similarities in the level of development of the population of the areas in question. Starting from this idea, we have grouped the world countries using three indicators composing the HDI, because this indicator summarizes economic and social aspects of the level of development (Anand and Sen, 1997).

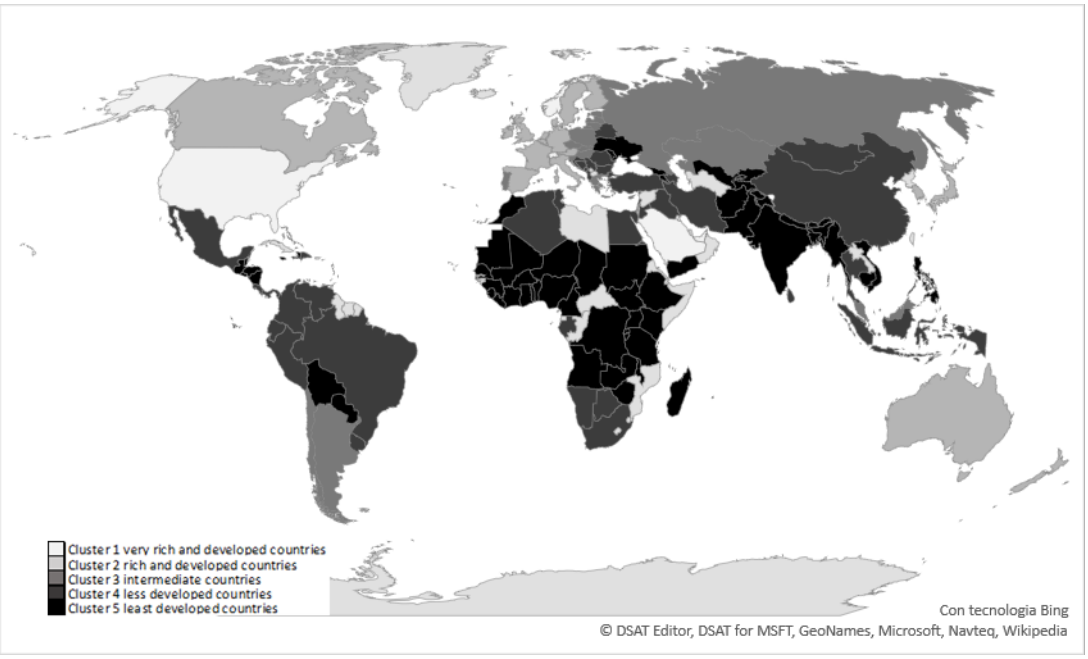
The distribution of a phenomenon does not depend exclusively on topographical elements such as spatial proximity and related metrics, but it depends also on characteristics of the population of the areas in question (Benassi and Naccarato, 2016; Benassi and Naccarato, 2017). As FAO regions are too uneven with respect to the level of development, inserting them into the model seemed too coarse. Clusters have therefore been identified that are homogeneous with respect to the level of development measured by the HDI indicators.

We preferred to take into account the effects of every dimension that the indicator considers: a long and healthy life, being knowledgeable, and having a decent standard of living (UNPD, 2015). Therefore, we used three indicators: life expectancy at birth, mean years of schooling, and gross national income per capita. Instead of using the threshold defined for the index, which presents some subjective choices in the aggregation process (e.g. a composite index using geometric mean), we preferred to group the countries with similar level of development using a hierarchical cluster analysis (Ward method), as in Marden (2015). This procedure allowed us to group countries according to their level of development, identifying similar groups to take into account in the model and to control the different characteristics of each country. The results are coherent with other methods of aggregation, such as hierarchical cluster with single linkage and k-means methods.

Five clusters have been obtained. They constitute countries with 1) very high income and high level of development (HDI ranging from 0.816 to 0.944, with an average of 0.888); 2) high income and development (West Europe, HDI from 0.824 to 0.935, with an average of 0.898); 3) medium-high development (eastern Europe and South America, HDI from 0.779 to 0.880, with an average of 0.835); 4) lower development (China, some of Asia, and North Africa, from 0.628 to 0.818, with an average of 0.741); and 5) low level of development (Africa, India, and south-east Asia, HDI ranging from 0.348 to 0.745), with an average of 0.55).

As shown in Figure 2, and as widely stated in the literature, less developed countries are present mostly in the southern half of the world.

Figure 2: Countries by cluster



Source: Authors' elaboration on UN HDI data

5. THE MODEL

As shown above (Section 3), personal and familial characteristics, such as gender, age, and education at the individual level and household income, household composition (couples, lone parents, with or without children), and location of dwellings are factors that influence food insecurity at the individual level.

The study analyses food insecurity measured by the FIES, in relationship with such variables. In this way, we improve the understanding of how household and individual factors affect food insecurity across countries. Moreover, comparisons of food insecurity in different economic and demographic subpopulations across the world indicate the groups of populations that may be best targeted by effective policies.

Given the nature of the variable, an ordered logistic regression has been applied on the dependent variable (Wooldridge, 2002). The insight is that the nine categories of the FIES score have a meaningful sequential order: a higher value shows a 'higher' level of food insecurity than the previous one.

To verify whether the observed differences are significant, we rely on a standard multivariate set-up:

$$g(y) = \text{logit(y)} = \alpha c + \beta_1 \text{gender} + \beta_2 \text{ age} + \beta_3 \text{ age}^2 + \beta_4 \text{ single} + \beta_5 \text{ married} + \beta_6 \text{ widow separated divorced} + \beta_7 \text{ other marital status} + \beta_8 \text{ education} + \beta_9 \text{ extreme poverty} + \beta_{10} \text{ rural area or farm} + \beta_{11} \text{ small town or village} + \beta_{12} \text{ large city} + \beta_{13} \text{ suburb} + \beta_{14} \text{ other location} + \beta_{15} \text{ cluster1} + \beta_{16} \text{ cluster2} + \beta_{17} \text{ cluster3} + \beta_{18} \text{ cluster4} + \beta_{19} \text{ cluster5} + \varepsilon$$

where the dependent variable FIES, measured by the FIES score (score of severity of food insecurity), has been analysed in relationship with:

- Observable individual characteristics: a dichotomous variable related to gender, age, age square, dummies for marital status, and level of education;

- Household economic and social covariates: urban/rural location (dummies), a dummy for extreme poverty, and number of children in the household;

- Country specification: a dummy for each cluster has been included, to consider in the model a characterization of the different territorial specificities;

The parameters α_c, called thresholds or cut-points, are in increasing order ($\alpha_1 < \alpha_2 < \ldots$), and c=1,2,…,C-1, where C is the number of categories of the ordinal variable.

Considering the FIES characteristics, the variable can be expressed as an ordinal variable, with values ranging from 0 (no symptoms of food insecurity) to 8 (all symptoms of food insecurity), representing the sum of affirmative answers to each of the eight questions comprising the FIES.

Given the nature of the variable, an ordered logistic regression has been applied on the dependent variable (Wooldridge, 2002). The insight is that the nine categories of the FIES score have a meaningful sequential order: a higher value shows a 'higher' level of food insecurity than the previous one. However, given the presence of numerous zeroes in the distribution of the variable, data also have been analysed through a Tobit regression, which provides evidence for the fact that the presence of the zero values was not generated by a distribution process different from the one that generated the other values of the distribution. The analysis allows us to conclude that an ordered regression model is a better choice for our data.

6. RESULTS

The model allows us to determine factors significantly related to food insecurity at the individual level, and also to link these results to a general level of development specified by the clusters identified in Section 4.

In our analysis, all the identified variables appear to have a significant relationship with the dependent variable: gender, age, number of children in the household, marital status, location of the dwelling, and poverty are all associated with the probability of experiencing food insecurity. For women and for individuals who are less educated, people living in extremely poor households, or with a higher number of children, the probability of higher food insecurity increases (Table 2).

In particular, considering individual characteristics, gender presents a significant association with food security, and women appear significantly more at risk of food insecurity.

The probability of experiencing food insecurity increases with age, but as people get older the effect is weaker. Not including the quadratic term 'age' instead seems not a significant factor.

Table 2: Coefficients and standard errors for the determinants of FIES score

FIES score	Coef.	Robust Standard Error	z	P > |z|	[95% CI]	
Gender (ref. male)						
Female	0.066364	0.013814	4.8	0.000	0.039289	0.093439
Age	0.042193	0.002307	18.29	0.000	0.037671	0.046715
Age2	-0.00046	2.42E-05	-19.02	0.000	-0.00051	-0.00041
Education	-0.48055	0.011757	-40.87	0.000	-0.5036	-0.45751
Poverty (ref. extreme poverty)						
Not extr poverty	-1.09239	0.019507	-56	0.000	-1.13062	-1.05416
Number of children	0.087022	0.004597	18.93	0.000	0.078012	0.096031
Marital status (ref single)						
Married	-0.2708	0.021123	-12.82	0.000	-0.3122	-0.2294
Widow Divorced Separ	0.24902	0.028645	8.69	0.000	0.192876	0.305164
Other	0.404658	0.029561	13.69	0.000	0.346719	0.462596
Location (ref. farm, rural location)						
Small_town	0.056921	0.014659	3.88	0.000	0.02819	0.085653
Suburb	0.235091	0.026751	8.79	0.000	0.182659	0.287522
Other_location	0.248219	0.098202	2.53	0.011	0.055747	0.440691
Cluster (ref. Cluster 1)						
Clus3	0.565436	0.030303	18.66	0.000	0.506044	0.624828
Clus4	0.893671	0.026349	33.92	0.000	0.842028	0.945313
Clus5	1.66783	0.026622	62.65	0.000	1.615653	1.720008
/cut1	0.398441	0.057068			0.28659	0.510292
/cut2	0.799815	0.057149			0.687805	0.911826
/cut3	1.124058	0.057213			1.011923	1.236192
/cut4	1.494254	0.057338			1.381873	1.606635
/cut5	1.821687	0.057434			1.70912	1.934255
/cut6	2.148434	0.057511			2.035714	2.261154
/cut7	2.478574	0.057602			2.365678	2.591471
/cut8	3.078648	0.05791			2.965146	3.19215

Source: Authors' elaboration on FIES and UNHDI data

As in the descriptive results and in the literature, education appears in the model as an important factor against food insecurity.

As underlined in Section 3, extreme poverty is a very important risk factor of food insecurity.

Referring to household characteristics, living alone implies significantly higher risk of food insecurity than living with a spouse. As found by Nord and Hopwood (2008), food insecurity increases together with the number of children in the household. Living in an urban area or in the outskirts of a big city is associated with a higher risk of food insecurity.

Considering as a reference category the cluster of the least developed country, it emerges that a higher level of country development implies less vulnerability of the population toward the risk of food insecurity.

Repeating the analysis in the different clusters allows us to point out the different peculiarities of food insecurity at different levels of development.

Table 3 shows the results from applying the model to the five clusters separately. We can appreciate several differences across different development levels in the determinant of food insecurity.

Table 3: Coefficients and standard errors[(a)] for the determinants of FIES in different clusters

FIES score	Cluster 1 Very rich and developed countries	Cluster 2 Rich and developed countries	Cluster 3 Intermediate countries	Cluster 4 Less developed countries	Cluster 5 Least developed countries
Gender (ref. male)					
Female	-.2630781*** (.08070)		. 1840099*** (.0437319)	.1302772*** (.0260245)	.0340459*** (.0191424)
Age		.051186*** (.0109697)	.0720847*** (.0076502)	.049331*** (.0042063)	.0313488*** (.0032474)
Age*2		-.0007217*** (.0001198)	-.0007411*** (.000076)	-.0004556*** (.0000444)	-.0003262*** (.0000355)
Education	-.2632614*** (.0571919)	-.3888676*** (.0563767)	-.7104291*** (.0373756)	-.3965883*** (.0227668)	-.5096868*** (.016714)
Number of children	.1060669*** (.02734)	.1825485*** (.0255984)	.1865746*** (.0230239)	.2595726*** (.0109328)	.0306053*** (.0050174)
Marital status (ref: single)					
Married		-.5516659*** (.0824241)	-.2317259*** (.0747907)	-.5170726*** (.0315302)	-.1648107*** .0280729
Widow Divorced Separated		.3775537*** (.1019021)	.3113946*** (.0850492)		.2594293*** .0408578
Other marital status	-.5136737** (.2393449)	-.2218415** (.1095312)	.2034996** (.1004484)	.5051842*** (.0513262)	.445612*** .0407386
Poverty (ref: extreme poverty					
Not extr poverty			-.7259992*** (.1688518)	-1.082648*** (.0495096)	-1.138635*** (.0223611)
Location (ref: farm or rural area)					
Small_town		.2017148** (.0850932)		.1367195*** (.03512)	.0365229** .0216599
Large_city		.2172271** (.0882432)	.1434978** (.0443477)	.0759397** (.0369639)	-.1178111*** .0266923
Suburb	.2504938** (.1043353)	.2172522** (.0967033)	.244545** (.0951873)	.1476885*** (.0502547)	.424118*** .0470277
Other_location	.9885799*** (.2156946)	.8602565** (.3933162)			
/cut1	1.044259 (.1397793)	1.438231 (.2130796)	.5928194 (.2291945)	.0722373 .1049796	-1.635432 .0657578
/cut2	1.45763 (.1441845)	1.826107 (.2125667)	1.027085 (.2289807)	.4733461 .1051081	-1.230061 .0655144
/cut3	1.790795 (.148402)	2.156177 (.2125475)	1.410558 (.2294036)	.7777389 .1052274	-.9014252 .0653999
/cut4	2.435549 (.1567957)	2.516353 (.2139002)	1.847139 (.2308292)	1.124477 .1053781	-.5199818 .0652874
/cut5	2.823537 (.1641628)	2.817355 (.2145619)	2.216641 (.2316942)	1.437695 .1057521	-.1859391 .0652331
/cut6	3.363314 (.1759583)	3.246638 (.2179022)	2.561608 (.2342384)	1.728047 .1061074	.1480627 .0652164
/cut7	4.307895 (.2056352)	3.69081 (.2217511)	2.969918 (.2362725)	2.022043 .1064779	.4788455 .0652969
/cut8	4.307895 (.2056352)	4.437743 (.2312771)	3.597198 (.2416928)	2.557899 .1076288	1.093061 .0656553
Pseudo R^2	0.0098	0.0265	0.0273	0.0412	0.0432

Source: Authors' elaboration on FIES and UNHDI data

(a) Robust standard errors in parentheses
*** p < 0.01, ** p < 0.05, * p < 0.1

First, gender is not significant in the second cluster (which includes many European countries), while in cluster 1 (very rich and developed countries, mainly outside Europe) men appear more at risk of food insecurity. In the other cluster, representing countries with a lower level of development, women are significantly more at risk of food insecurity. This result is consistent with many studies that have found a significant relationship between gender and food insecurity in developing countries (Section 3).

Age is not a significant factor of risk in cluster 1, even including a quadratic term, while in all the other clusters an increase in age corresponds to a significant increase in the risk of food insecurity.

The results show that individuals with a higher level of education are less likely to be food insecure at every level of development, as in the global model. As highlighted by Smith, Rabbitt, and Coleman-Jensen (2017), this result strengthens the importance of education as a determinant of food insecurity.

The number of children in the household is another factor of risk for being food insecure in all the clusters, as well as in the global model.

In the first cluster (richest and most developed countries), the marital status of the individual is not significant as a determinant of food insecurity. Nevertheless, in all other clusters, living without a partner (being single, widowed, or divorced) appears as a factor of fragility toward the risk of food insecurity.

As expected, extremely poor individuals present a higher probability of being food insecure. This relationship is not significant in the richer countries, where the measure is not associated with the phenomenon.

Results regarding the relationship between living location and food insecurity are more mixed. However, we can see that living in a small town increases the risk of food insecurity. Living in a large city is a factor related with a higher probability of being food insecure, except in least developed countries, where the opposite is true. Neither of these two factors is significant in most developed countries. The only factor that remains significant across the five clusters is living in the suburbs of a large city, and it is associated with a higher risk of being food insecure.

Even in the richest countries of the first cluster we have identified the population group affected by the risk of food insecurity: people with a low level of education, families with many children, or those living in the suburbs of large cities.

The values estimated for the parameters of the global model are more similar to those of intermediate and less developed countries. This result confirms the literature and previous analyses, which state that food insecurity is more widespread in developing and poorer countries.

7. CONCLUSIONS

This paper provides original evidence on the determinants of food insecurity using the FAO food insecurity experience scale. Thanks to the availability of this indicator at the individual level, we have obtained a more realistic measure of food insecurity even in very rich and developed countries.

The model allows us to identify the economic, social, and demographic characteristics related to food insecurity, offering further evidence to the existing literature, examining individual data on food insecurity comparable at the global level, and giving an account of the different levels of development of countries.

We have been able to determine the personal and family factors of risk related to food insecurity across the globe: level of education, composition and number of children in the household, and living

location all have a significant impact on the risk of food insecurity. We have also identified the population groups more at risk that could be subject to specific evidence-based policies with important impact: women, people living in households with children, and individuals with lower education.

The estimations have been carried out both at the global level and for each group of countries, pointing out the similarities and differences in the phenomenon by level of development.

In this way, the results go beyond the usual monitoring at the macro level of food insecurity, while the analysis of FIES allows us to identify the most vulnerable groups across countries, with those groups more at risk identified according to the different levels of country development.

Future research could be improved by focusing more closely on gender and educational level, as these were the factors most significantly associated with food insecurity in our analysis. Moreover, the lack of a temporal dimension in the data limited our analysis to the social and economic factors of food insecurity. With data available for a longer period, future studies could produce more definitive results.

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