ORIGINAL RESEARCH

Food Insecurity in Europe: A Gender Perspective

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Abstract
Food insecurity is the limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire foods in socially acceptable ways. The study presents a comparison of the principal determinants of individual food insecurity in Europe and other Continents, with particular regard to gender, since the literature clearly states the importance of women in the administration of food in the household. The study of gender related differences in food insecurity is particularly important in Europe, since women experience food insecurity at a larger extent than men, but with a variability related to the geographical distribution and with complex relationships with economic and social drivers. Using a large international sample of individual level data, that allows the analysis for developed Countries for the first time, and the first experiential measure of food insecurity comparable at the global level, the paper analyses the principal determinants of gender differences in food insecurity. In order to verify if women's vulnerability in food insecurity is moderated by specific factors, the modelling approach allows gender to vary by education, poverty, place of residence. The results suggest that the driver that could most mitigate women disadvantage is education: people with a university degree present a lower probability of experiencing food insecurity, both for men and for women. On the contrary, familial characteristics, such as the number of children in the household, present a higher impact on women's food insecurity than on men's.

Keywords Food insecurity · Gender · Ordered logistic regression · Europe

1 Introduction

Food insecurity can affect health and well-being in many ways, with potentially negative consequences for mental, social and physical well-being, even in the absence of measurable negative effects on nutritional status (Coates et al. 2006; Trenouth et al. 2018). The phenomenon is at the basis of any meaningful effort regarding sustainable development

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(Harris 2019; Hoddinott 1999), and it is a very important, stand-alone sustainable development goal (SDG), foreseen in the Agenda 2030 of the United Nations as Goal 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture (UN 2015). Among the SDGs, the United Nations define food insecurity as one of the most relevant development challenges with which low-income countries now have to cope (UN 2015).

Food insecurity affects more than 820 million people in the world (FAO 2019), and the number of people involved is estimated to have increased from 777 million in 2015, giving a further boost to the need for research and policy measures to tackle the issue of undernourishment (Fortin et al. 2016). In Europe, since 2010, the prevalence of food insecurity has been about 2.7% points (with the 95% confidence interval ranging from 0.56 to 4.85 percent); this is greater than would have been expected on the basis of previous trends and corresponds to an excess of about 13.5 million people (95% CI: 2.8 million–24.2 million) living with food insecurity (Loopstra et al. 2016).

What is driving food insecurity is, thus, a crucial question. Recent renewed level of interest in the measure of food insecurity on the part of policymakers and new developments in the methodology for measuring the phenomenon allow food insecurity to be directly measured at the individual level. In this way, it is possible to identify which population groups are more at risk for food insecurity, in order to develop more effective country-specific policies against food insecurity.

Food insecurity assumes diverse forms and gravity according to the characteristics of different groups of people observed and of the territory in which they live.

The study presents a comparison of the principal determinants of individual food insecurity in Europe and other Continents, with particular regard to gender, since the literature clearly states the importance of women in the administration of food in the household. Indeed, in the literature, the most important and frequently reported factor related to food security is gender. Broussand (2019) shows that women have a higher probability of being food insecure relative to men. 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 (Department of Agriculture of the Republic of South Africa 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). In New Zealand too, the prevalence of food insecurity was much greater in females than males (Carter et al. 2010). In Europe, similar studies were not available, because the lack of comparable data at European level. Similar studies were limited to single countries or populations, while a comprehensive study that allows geographical comparison like this one has—to our knowledge—not been conducted since nowadays (Borch and Kjaernes 2016; Bocquier et al. 2015; Pfeiffer et al. 2015; Alvares and Amaral 2014; Dowler and O'Connor 2012).

In this framework, our contribution wants to offer further issues concerning the territorial analysis of food insecurity in Europe, with particular regard to gender. The objective is, then, to investigate the drivers of individual experienced food insecurity, highlighting the

differences between men and women in experiencing food insecurity, and offering further insight into the specificities of the drivers of food insecurity for the two genders.

Governments, through their economic, social and food policies, create the general conditions for their population to be supplied with available foodstuffs and to gain the necessary incomes to procure them (availability and access). However, in recent years, awareness that food insecurity has become a problem for households and individuals has grown. In this respect, there are frequent situations when even in the richest countries, there are communities and persons subject to food insecurity or at high nutritional risk (Alexandri 2015). FIES allows the phenomenon to be captured in rich and also very rich countries.

This paper, then, allows to verify whether food insecurity is really a phenomenon that is still present in Europe, if there are any gender differences in how and how much people experience food insecurity, what are the most significant drivers of individual food insecurity for men and women in different areas of Europe, and whether the gender gap is mitigated by education and other specific factors.

The micro-econometric analysis of the Food Insecurity Experience Scale (FIES) module, developed by the Food and Agriculture Organisation of the United Nations (FAO), allowed for the identification of groups more at risk of food insecurity, going beyond the usual monitoring at macro level of food insecurity.

Compared to the existing literature, the paper presents some innovations, that could be interesting both to scholars and to policy makers. First of all, the geographical analysis is exploited: food insecurity in Europe is studied compared with other Continents, and also "from within", because different areas of Europe are analysed. The study of food insecurity in developed countries in a global framework is only possible since the FIES data are available. Moreover, the analysis of the drivers of gender differences in Europe in such a comprehensive way—at the authors' best knowledge—has not been carried out before.

2 Data and Methods

The paper draws on the Gallup World Pool (GWP) data, that included the FIES in 2014. The FIES module surveys an experience-based food insecurity individual scale, together with other social, economic and demographic characteristics of the respondents (Gallup 2017). The GWP conducts nationally representative surveys annually in 147 countries. The study adopted a three-stage sampling procedure to select the sample (ibidem). Country sample sizes of 1000 individuals, representative of the male and female resident population aged 15 and over (in very large countries such as India and China, sample sizes up to 5000), obtaining a sample of 150,000 individuals. The survey enables the collection of cross-culturally comparable information from individual respondents, and allows also an estimate of food insecurity in rich and developed countries.

2.1 The Food Insecurity Experience Scale

The importance of a measure of food insecurity centred on individuals rather than only on countries or regions was recognised starting with the work of Sen in the eighties (Sen 1981, 1983). At the World Food Summit in 1996, an innovative definition of food security was developed: "Food security, at the individual, household, national, regional and global levels [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an

active and healthy life" (FAO 1996). By explicitly acknowledging the four interdependent pillars of food availability, access, utilisation and stability, the World Food Summit (FAO 1996) marked a milestone contribution in the analysis of food security, which, until then, used to be identified only by food availability, that typically refers to Countries rather than on individuals.

The financial, economic and food crisis in 2008 fostered the need for data on food insecurity at individual and household levels, as many studies demonstrated that households that were more vulnerable before the financial crisis saw a worsened effect in terms of food insecurity with the crisis (Bloem 2010; Vilar-Compte et al. 2015). Disparities also increased among men and women, poor and not poor households, educated or uneducated people (d'Errico et al. 2018; FAO 2010), and smaller households performed much better than households with more members (Lokosang et al. 2016). These direct measures are intended to capture a household's or individual's reported experience of the problem through responses to validated survey items that are transformed into a scale (Coates et al. 2006). FIES data can be analysed at the individual level, allowing the analysis of inequalities in access to food by gender, taking into account several personal and household characteristics, and recognising that households do not necessarily distribute resources equitably and should not be conceived as a unique entity (Brunelli and Viviani 2014).

FIES measures the severity of food insecurity based on eight questions that ask people directly about having to compromise the quality and quantity of food, due to limited money or other resources to obtain food.

The FIES score—e.g. the number of positive answers to the FIES module—is a sufficient statistic to represent the severity of food insecurity of the respondents on an ordinal scale (Grimaccia and Naccarato 2019a; Nord 2014; Nord et al. 2016). This means that the FIES score is a quantitative, discrete and ordinal variable, with values ranging from zero (no events of food insecurity) to 8 (all events of insecurity), and it is a sufficient statistic for the latent trait that is being measured: experienced food insecurity.

2.2 Descriptive Analysis of FIES and Related Covariates

Together with the FIES module, other meaningful covariates have been surveyed. These variables are closely related to food insecurity, and they represent geographical, demographic, economic and social features. The variables considered are gender, education, household income, household composition (couples, lone parents, with or without children) and age of the respondents.

Other than the already mentioned factor "gender", another important demographic characteristic related to food security that has been analysed in previous researches is age (Nord 2003; Strickhouser et al. 2014).

Considering poverty (measured by international poverty lines), three quarters of the developing world's poor still live in rural areas. But, the share of the poor living in urban areas is rising, and more rapidly than for the population as a whole (Ravallion et al. 2007). As reported by the World Bank (2017), poverty rates are falling in both urban and rural areas, but they are lower in urban areas. Nevertheless, poverty is becoming "more urban" in more urbanised regions (Olinto et al. 2013).

As called for by eminent scholars (Champion and Graeme 2003), FIES data allow the classical distinction between rural and urban dwelling to be overcome. In the FIES data, it is possible to distinguish different kinds of settlements such as "a rural area or on a farm", "a small town or village", "a large city", or "a suburb of a large city".

The analysis takes into account other meaningful covariates. First of all, the level of education of the respondents has been acknowledged as an important driver against food insecurity (Bartfeld et al. 2006; d'Errico et al. 2018; Nord and Hopwood 2008): education is a good proxy of social status, and it is related to employment.

In the dataset, education is classified according to three levels: elementary, corresponding to having completed elementary education or less (up to 8 years of basic education); secondary, or having completed some education beyond secondary education (9 to 15 years of education); and tertiary, if the respondent has completed 4 years of education beyond "high school" and/or received a 4-year college degree (Gallup 2017).

In FIES dataset, globally the share of women who experience food insecurity is larger than men: 45% of the female population present at least one symptom of food insecurity compared with the 43.3% of men (Fig. 1).

The gender difference is widespread across every continent, including Europe. In order to evaluate the significance of these differences, we rely on the estimation of a micro-econometric model, that benefits from the large sample.

2.3 The Model

We analyse the individual FIES data on experienced food insecurity depending upon exogenous characteristics such as gender, age, level of education and household economic and social covariates. The analysis of results of the model offers a gain in knowledge on the gender differences in food insecurity in different territorial areas of Europe. In this way, we provide new evidence concerning the complex link between food insecurity and gender, controlling for other meaningful covariates.

An extensive analysis of the drivers of experience-based individual food insecurity show that the variables significantly impacting food insecurity are related to social, demographic and economic characteristics of the population, such as education, household income, household composition (couples, lone parents, with or without children) and age (Grimaccia and Naccarato 2018, 2019b).

In this work, first of all, we have analysed how FIES was related to the socio-economic status of the respondents across the globe, in order to highlight the different impact of each covariates to food insecurity in Europe, and—for comparison purposes—in other world continents. Furthermore, we evaluate more specifically the effects of such drivers
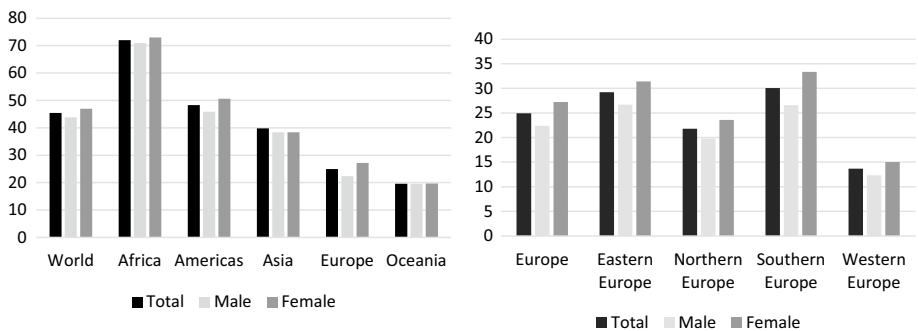
Fig. 1 Percentage of people who have reported one or more events of experienced food insecurity (FIES) in the last 12 months by gender, world regions and European areas—2014

separately for the female and male population in Europe. Finally, we extended our results analysing the differences in the determinants of food insecurity in different areas of Europe (Northern, Western, Southen, Eastern), that—according to the literature—present different socio-economic conditions.

To verify whether the observed differences (Sect. 2.2) are significant, we analysed—through an Ordered Logistic Model (OLM)—the relationships among FIES and the covariates described below. All the categorical variables, in order to be included in the model, have been transformed in dummy variables, thus allowing the estimation of a coefficient for each value of the variable. Among the observable individual characteristics, we take into account two dummies (male and female) for the dichotomous variable related to gender, age (both the linear and the quadratic relationships), three dummies for marital status (single, married or in a relationship, widows, divorced and separated), and level of education (primary, secondary and tertiary). The household economic and social covariates that we included in the model are two dummies for living in extreme poverty or not, the number of children in the household, and four dummies related to the kind of settlements where the respondents live (a farm or a rural location; small town; big city; or the suburb of a big city). A territorial specification of the model has been included, accordingly to the geographical extension of the model: a dummy for each region has been included to consider in the model a characterisation of the different territorial specificities (territorial fixed effects).

Then, the multivariate set-up we rely upon for our model is:

$$
\begin{aligned}
y = \text{ologit(y)} = {}& \alpha c + \beta_1 \text{ male} + \beta_2 \text{ female } + \beta_3 \text{ age } + \beta_4 \text{ age}^2 + \beta_5 \text{ single } + \beta_6 \text{ married} \\
& + \beta_7 \text{ widow separated divorced} + \beta_8 \text{ primary education} + \beta_9 \text{ secondary education} \\
& + \beta_{10} \text{ tertiary education} + \beta_{11} \text{ extreme poverty} + \beta_{12} \text{ no extreme poverty} \\
& + \beta_{13} \text{ rural area or farm} + \beta_{14} \text{ small town or village} + \beta_{15} \text{ large city} \\
& + \beta_{16} \text{ suburb of a large city} + \beta_{17} \text{ geographical fixed effects} + \varepsilon
\end{aligned}
$$

(1)

where the endogenous variable y is the sum of the affirmative answers to the FIES module.

Estimates were conducted using an OLM. As the variable measuring the experienced food insecurity is an ordinal variable (Sect. 2.1), a non-linear model has been preferred (Espinosa and Hennig 2019; Grimaccia and Naccarato 2019b; Agresti 2010). That is because we cannot state that the distances between categories are the same for all of them. For instance, we cannot affirm that the difference between two and zero is twice as important as the difference between five and four (Wooldridge 2012).

An OLM for an ordinal response Y_i with C categories is defined by a set of C-1 equations where the cumulative probabilities $g_{ci} = \Pr\left(Y_i \le y_c | x_i\right)$ are related to a linear predictor $\beta' x_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \cdots$ through the logit function.

$$
logit\left(g_{ci}\right) = \log\left(\frac{g_{ci}}{1 - g_{ci}}\right) = \alpha_c + \beta' x_i, \quad c = 1, 2, \ldots, C - 1
$$

(2)

The parameters αc, called thresholds or cut-points, are in increasing order ($c1 < c2 < \ldots$), and C = 1, 2,…,C − 1, where C is the number of categories of the ordinal variable. These cut-points reflect the predicted cumulative probabilities considering the covariates are all equal to zero. The last cumulative probability is necessarily equal to 1, so the model specifies only C-1 cumulative probabilities. When there are only two outcomes (zero and one),

we set the single cut-point to zero and estimate the intercept; this approach leads to the standard logit model (Wooldridge 2012).

First of all, we estimate model (1) for the whole sample in order to underline that food insecurity exists also in Europe. Moreover, compared with other continents, Europe presents a significant gender difference. Results of the estimation of the model are shown in Table 1, column (1).

As the significant gender coefficient in Europe (Table 2), in order to highlight whether the impact of exogenous variables varies by gender, we estimate model 1 separately for

Table 1 Coefficients and standard errors for the determinants of FIES score across the globe—2014

FIES score	World	Africa	Americas	Asia	Europe	Oceania
Gender						
Male	(base)	(base)	(base)	(base)	(base)	(base)
Female	.05605***	0.00783	.06568*	− 0.0044	.23407***	0.23932
Age	.03146***	.01993***	.05518***	.01226***	.06243***	.07199*
Age square	− .00039***	− .00024***	− .00063***	− .00022***	− .00068***	− .00108***
Education						
Primary	(base)	(base)	(base)	(base)	(base)	(base)
Secondary	− .50938***	− .32929***	− .79553***	− .43808***	− .87977***	− 0.29261
Tertiary	− 1.1724***	− .96729***	− 1.4741***	− .99448***	− 1.6601***	− 1.0591**
Poverty						
Extreme poverty	(base)	(base)	(base)	(base)	(base)	(base)
Not extreme poverty	− 1.0008***	− 1.0121***	− .93468***	− .94736***	− 1.1175***	− 0.20898
Number of children	.08756***	.03126***	.16641***	.13996***	.15637***	.23278***
Marital status						
Single	(base)	(base)	(base)	(base)	(base)	(base)
Married	− .17719***	− .23703***	− .34366***	.14235***	− .24323***	− .6859***
Widowed, divorced, separated	.3581***	.2428***	0.01577	.74386***	.3883***	0.31754
Other		.44471***	.13465**	.85076***	− 0.05505	− .62713*
Location of the household						
Farm, rural location	(base)	(base)	(base)	(base)	(base)	(base)
Small town	− .13821***	− .2181***	− .13696***	− 0.0368	− 0.03792	0.24221
Large city	− .2073***	− .50952***	− .29923***	− .10746***	.18031***	− 0.25124
Suburb of a large city	− .26527***	− .30009***	− .40343***	− .26223***	− 0.04989	− 0.05358
World regions						
Africa	(base)					
America	− .46048***					
Asia	− .9273***					
Europe	− 1.3622***					
Oceania	− 1.7284***					

Source: Authors' elaboration on FIES data

*p < .05; **p < .01; ***p < .001

Table 2 Coefficients and standard errors for the determinants of FIES score in Europe by gender—2014

FIES	Europe	Men	Women
Gender			
Male	(base)	–	–
Female	.23407***	–	–
Age	.06243***	.06207***	.06269***
Age^2	− .00068***	− .00066***	− .00068***
Extreme poverty	(base)	(base)	(base)
Not extremely poor	− 1.1175***	− 1.1405***	− 1.1047***
Education			
Primary	(base)	(base)	(base)
Secondary	− .87977***	− .80219***	− .93412***
Tertiary	− 1.6601***	− 1.758***	− 1.6115***
Number of children	.15637***	.11182***	.18504***
Marital status			
Single	(base)	(base)	(base)
Married	− .24323***	− .23263***	− .24026***
Separated/divorced	.3883***	.34163***	.42428***
Location			
Rural	(base)	(base)	(base)
Small town	− 0.03792	− .12208*	0.02149
Large city	.18031***	0.10746	.23331***
Suburb	− 0.04989	− 0.08695	− 0.01503

Source: Authors' elaboration on FIES data

*p < .05;**p < .01; ***p < .001

men and women (Table 2). This allows to obtain coefficients that indicate which driver is significant for each gender separately (Agresti 2010; Wooldridge 2010), and then to emphasise the difference of the impact of each covariate for men and women.

Subareas of Europe present very different characteristics of the population in relation with income per capita, distribution by age and level of education (Eurostat 2019). In order to give an account of these specific features, we include in the model dummies (areas' fixed effects) corresponding to more homogeneous areas with respect to the geopolitical usual distinction. In this way, the estimated coefficients evaluate the impact of living in each European area on the probability of experiencing food insecurity. The corresponding coefficients are significant. Therefore, we estimate the model for the five areas separately in order to verify if any differences exist in the main drivers (Table 3).

The obtained coefficients are comparable since the structure of the survey, the definition of the variables and their categories are the same in each and every territorial area, as in Chen et al. (2019), Espinosa and Hennig (2019), Williams (2016). The sample is, indeed, representative for each country and for both sexes (Gallup 2017). This allows to compare the results of the estimations and the significance and the sign of the coefficients in every subsample.

Table 3 Coefficients and standard errors for the determinants of FIES score in Europe by gender including European main regions effects—2014

Europe	Europe	Male	Female
Gender			
Male	(base)	–	–
Female	.21512***	–	–
Age	.06582***	.06502***	.06646***
Age^2	−.00069***	−.00068***	−.0007***
Poverty			
Extreme poverty	(base)	(base)	(base)
Not extremely poor	−1.04***	−1.043***	−1.0444***
Education			
Primary	(base)	(base)	(base)
Secondary	−.81974***	−.76436***	−.85807***
Tertiary	−1.5118***	−1.5962***	−1.4717***
Number of children	.17225***	.13407***	.19697***
Marital status			
Single	(base)	(base)	(base)
Married	−.30436***	−.29326***	−.30329***
Separated/divorced	.32714***	.30829***	.34869***
Location			
Rural	(base)	(base)	(base)
Small town	−0.0195	−0.09859	0.03658
Large city	.13906***	0.07689	.18596***
Suburb	0.0546	0.01652	0.088
Other location	−0.14214	−0.44811	0.07008
Europe areas			
East Europe	(base)	(base)	(base)
North	−.37276***	−.41219***	−.34225***
South	−.0905**	−.12956**	−0.063
West	−.90211***	−.85807***	−.9228***

Source: Authors' elaboration on FIES data

*$p < .05$;**$p < .01$; ***$p < .001$

3 Results

3.1 Gender Differences in Experienced Food Insecurity Across the Globe

First of all, model (1) has been estimated globally and for the five continents separately, in order to highlight the differences between Europe and other Continents. The estimations show that, at the global level, the ordered logit for women being in a higher FIES category is 0.056 more than males when the other variables in the model are held constant. This means that women have a higher probability of experiencing an event of food insecurity than men. Repeating the analysis separately for each region allows us to point out the peculiarities of individual food insecurity in different areas of the globe. In this way, it is possible to identify which relationships with food insecurity do not change in different geographical areas.

The ordered logit for females, keeping constant the other covariates, are positive in all the world regions except Asia. However, gender is not significant in Africa, Asia and Oceania, while it significant only in Europe and to a lesser extent in the Americas (Table 1), where women appear significantly more at risk of experiencing food insecurity than men. In the other world regions, both those with a higher prevalence of food insecurity like Africa and Asia and in Oceania, where the prevalence of food insecurity is minimal, the gap between men and women is not significant. These results suggest that in Africa and Asia, where the phenomenon is more common, gender is not a driver of policies. In Oceania, on the contrary, experienced food security is not widespread, and males and females are both food secure to the same probability. In synthesis, only in Europe (and to a lower extent in the Americas) the 'female' mode is statistically significant, while in the other regions gender seems not to be a determinant for FIES. Results suggest also that in Europe and the Americas, policies can be aimed particularly towards women.

Even if it is not the aim of the paper, it could be useful to briefly analyse those factors that have a significant impact on food insecurity, in order to better understand the complex phenomenon. In the global model, the probability of experiencing a greater number of events of food insecurity is higher for individuals who are less educated, living in extremely poor households or who have a higher number of children. In the model referring to the entire world, regions' fixed effects have been included considering African countries as a reference category, and it emerges that the risk of individual food insecurity in Africa is significantly higher than in other world regions.

Repeating the analysis separately in different continents allows us to identify which relationships with food insecurity do not change in different geographical areas. Across continents, individuals with a higher level of education are less likely to experience food insecurity in every region as well as in the global model. Moreover, extremely poor people have a higher probability of being food insecure (this relationship is not significant only in Oceania).

The number of children in the household is another risk factor for being food insecure in all the FAO regions, as well as in the global model: the higher the number of children, the higher the risk of food insecurity. The coefficients are highest in Europe and the Americas.

3.2 Gender Differences in Experienced Food Insecurity in Europe

In Europe, the results presented in Table 2 show that the ordered logit for women being in a higher FIES category is 0.234 more than for men when the other variables in the model are held constant. This means that women present a significantly higher number of events of food insecurity compared to men.

Estimating the model separately for men and women allows us to verify whether the drivers identified for the whole population are significant for both genders (Table 2).

For both men and women, the determinants of food insecurity are the same: individuals with a higher level of education are less likely to be food insecure, extremely poor individuals present a higher probability of being food insecure, the number of children in the household is another risk factor for being food insecure, and being married is related to a lower risk of food insecurity, both for men and women. In particular, for both genders, the number of events of food insecurity decreases with age, but its effect decreases with getting older. Moreover, the coefficients related to level of education and poverty are very similar for men and women. Furthermore, for men, one child more in the household increases the number of events of food insecurity by 0.11, while for women the effect is stronger and

equal to 0.18. Married respondents—both male and female—present a lower value for the logit estimates compared to singles, and thus they have a lower probability of experiencing events of food insecurity. On the contrary, widows and divorced people present higher estimations.

As we have seen in the descriptive analysis (Sect. 2.2), food insecurity presents a territorial distribution with significant differences. To take these differences into account, we have included in the model a fixed effect related to European areas. Analysing the dummies related to different areas of Europe, the results show that compared to Eastern Europe as a reference point, in the other areas the probability of experiencing one or more events of food insecurity is significantly higher, or in other words, that food insecurity is experienced more in Eastern Europe than in other areas of Europe (Table 3). Also included in the model is the territorial specification; according to the model [1], women appear to experience food insecurity to a significantly larger extent than men: in Europe, including the territorial dummies, the ordered logit for women being in a higher FIES category is 0.215 more than for men, with the other variables held constant.

Estimating the model (1) for the two genders separately, it is possible to analyse the drivers of food insecurity specifically for men and women in different areas of Europe. The results presented in Table 3 related to demographic factors—such age and marital status—are very similar for men and women. However, as in the model (1) estimated at the global level, the effect on the number of events of food insecurity of an additional child in the household is higher for women than for men (0.197 and 0.134, respectively).

The estimations confirm the role of education as extremely important against hunger for both genders.

Considering the territorial differences, for male respondents the probability of experiencing food insecurity is lower in Northern and Western Europe and to a lesser extent in the south of Europe compared to Eastern Europe. For women, the estimations suggest a lower risk of food insecurity in the north and west of Europe and a higher probability of experiencing food insecurity in south and east.

Estimating our model in different European areas makes it possible to identify the characteristics of the population experiencing a higher number of events of food insecurity and to verify whether the territorial dimension influences the impact on food insecurity of the covariates considered in the model (Table 4, Columns 2, 5, 8 and 11).

First of all, gender is a significant factor for food insecurity, with women experiencing a higher number of food insecurity events than men in all areas of Europe. Also, the age factor has a significant effect on food insecurity in all the areas considered with a decreasing impact. Extremely poor people should be made the target of specific policies as they are at higher risk of food insecurity across Europe, except in Western Europe, where presumably the available indicator is not able to give a proper measure of poverty. Respondents with a low level of education, families with a larger number of children and widows or divorced people present a higher coefficient across Europe.

As presented in Table 4, the results of the model, estimated by gender and European area, also show specificities and peculiarities of experienced food insecurity.

The analysis of the coefficients related to the drivers considered in the model show that there are not significant gender differences in the determinants of food insecurity in any of the European areas: the level of education (secondary and tertiary) is an extremely important driver for both genders; extreme poverty affects significantly both men and women (except in Western Europe, where probably the available indicator is not the best one to measure poverty); married people present a significantly lower number of events than singles, whether they are female or male; among widows or people who are divorced/

Table 4 Coefficients and standard errors for the determinants of FIES score in Europe by gender and European main areas—2014

FIES	Eastern			Northern			Southern			Western		
	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women
Gender												
Male	(base)	(base)		(base)	(base)		(base)	(base)		(base)	(base)	
Female	.168***			.264***			.230***			.208**		
Age	.066***	.083***	.056***	.065***	.0512***	.072***	.067***	.067***	.068***	.053***	.0483**	.059**
Age²	-.001***	-.001***	-.001***	-.001***	-.001***	-.001***	-.001***	-.001***	-.001***	-.001***	-.001***	-.001***
Poverty												
Extreme poverty	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)
Not extremely poor	-.537**	-.649*	-.453*	-1.242***	-1.186**	-1.377**	-1.269***	-1.142***	-1.350***	-0.390	-1.213*	0.269
Education												
Primary	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)
Secondary	-.850***	-.945***	-.801***	-.473***	-.413**	-.501***	-.907***	-.803***	-.987***	-.476***	-0.412	-.547**
Tertiary	-1.576***	-2.007***	-1.383***	-1.125***	-1.130***	-1.124***	-1.682***	-1.656***	-1.710***	-1.020***	-1.024***	-1.050***
Number of children	.207***	0.107	.265***	.128***	0.05705	.180***	.187***	.1814***	.188***	.111*	.165*	0.061
Marital status												
Single	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)
Married	-.179*	-0.228	-0.088	-.564***	-.347**	-.730***	-0.087	-0.167	-0.023	-.834***	-.856***	-.818****
Separated/divorced	.374***	.385*	.413***	.436***	.688***	.29139*	.315***	.09464	.455***	0.178	-0.034	0.316
Location												
Rural	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)	(base)
Small town	-.150**	-0.156	-.146*	.189*	0.078	.273**	-0.066	-.223*	0.055	0.150	0.166	0.129

Table 4 (continued)

FIES	Eastern			Northern			Southern			Western		
	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women
Large city	.186**	−0.091	−0.120	.405***	.348**	.456***	.136*	0.048	.214*	.400**	0.273	.504**
Suburb	−0.225	−0.014	−0.336	−0.084	−0.119	−0.045	.284***	0.089	.431***	0.178	0.307	0.083

Source: Authors' elaboration on FIES data

*p<.05;**p<.01;***p<.001

separated, there are no differences between the estimated coefficient, or they are not significant. Instead, the number of children in the household affects men and women in different ways: in Eastern and Northern Europe, the number of events of food insecurity for women increases respectively by 0.265 and 0.18 for each additional child in the household, while there is not a significant variation for men; in the south of Europe, any additional child in the household increases the probability of a food insecurity event in the same way for both genders (0.18); finally, in Western Europe, the coefficient is only significant for men.

Overall, the results of the estimations of the model for men and women in different areas of Europe suggest that determinants related to experienced food insecurity are very similar for men and for women, with the exception of household's characteristics that impact women's food insecurity to a large extent than men.

3.3 Extension: Is the Gender Gap Mitigated by Education and Other Specific Factors?

This section investigates gender-based disparities in individual food insecurity: is women's vulnerability in food insecurity moderated by education, location or age? So far, the appearance of a pro-men gap has been documented across the European sample. This section explores whether gender-based differentials in food insecurity would differ according to social and economic characteristics of people because the question of whether gender inequalities in experienced food insecurity are exacerbated or mitigated by specific factors, such as education or poverty status, has important policy implications.

To this end, the modelling approach allows for gender to vary by education, poverty, marital status and number of children in the household. Following Dercon and Singh (2013), this is achieved in practice by augmenting the basic cross-sectional model using an interaction variable between the gender dummy and each of those factors.

A significance for the interaction term and a change in the gender coefficient would suggest that that specific factor magnified or mitigated gender inequalities in food insecurity. The results of the estimation of the model offer important insights (Table 5). The coefficients related to the interactions between gender and the other food insecurity-related factors are (almost) always insignificant. These overall results suggest that gender determines the differences between men and women in spite of any other covariates in Europe, even taking into account specific territorial distribution.

Only in a few cases the coefficient of the interaction is significant and does it give indications concerning the drivers able to mitigate gender differences.

Considering Europe as a whole, the interaction between number of children and gender indicates that for women an additional child in the household determines an increase in the number of events of food insecurity significantly greater than that for men (Table 5, column 2).

More specifically, in Eastern Europe, tertiary education—with all the other variables constant—offers a significant advantage for women. In Northern Europe, the coefficients related to the interactions between gender and marital status are significant, suggesting a lower number of events of food insecurity for married and divorced women. In Southern and Western Europe, no interaction is significant.

Table 5 Coefficients and standard errors for the determinants of FIES score in Europe by gender and European main areas—2014

	Europe	East	North	South	West
Gender					
Male	(base)	(base)	(base)	(base)	(base)
Female	0.17074	−0.3345	0.57079	0.36203	−1.1946
Age	.06584***	.06521***	.0641***	.06717***	.05403***
Age^2	−.00069***	−.00062***	−.00076***	−.00068***	−.00076***
Extreme poverty					
Poor	(base)	(base)	(base)	(base)	(base)
Not extremely poor	−1.056***	−.65071*	−1.1947**	−1.1791***	−1.2195*
Gender#poverty					
Male poor	(base)	(base)	(base)	(base)	(base)
Male not poor	(base)	(base)	(base)	(base)	(base)
Female poor	(base)	(base)	(base)	(base)	(base)
Female not poor	0.03007	0.21943	−0.16099	−0.1504	1.513
Education					
Primary	(base)	(base)	(base)	(base)	(base)
Secondary	−.7757***	−.87209***	−.44508***	−.85317***	−0.39115
Tertiary	−1.6068***	−1.9246***	−1.1665***	−1.7148***	−1.0034***
Gender#education					
Male#Primary	(base)	(base)	(base)	(base)	(base)
Male#Secondary	(base)	(base)	(base)	(base)	(base)
Male#Tertiary	(base)	(base)	(base)	(base)	(base)
Female#Primary	(base)	(base)	(base)	(base)	(base)
Female#Secondary	−0.07389	0.02925	−0.0327	−0.08224	−0.13403
Female#Tertiary	0.14452	**.49161****	0.06964	0.06135	−0.01782
Number of children	.13443***	(omitted)	(omitted)	(omitted)	(omitted)
Gender#number children					
Male	(base)	(base)	(base)	(base)	(base)
Female	.06227*	0.1112	0.12098	0.0411	−0.06863
Marital status					
Single	(base)	(base)	(base)	(base)	(base)
Married	−.28786***	−.25815*	−.38504**	−0.09231	−.79849***
Separated/Widow	.32617*	.65903***	0.20636	0.0549	
Gender#marital status					
Male single	(base)	(base)	(base)	(base)	(base)
Male married	(base)	(base)	(base)	(base)	(base)
Male divorced/widow	(base)	(base)	(base)	(base)	(base)
Female single	(base)	(base)	(base)	(base)	(base)
Female married	−0.0204	0.17236	**−.31538***	0.01867	−0.05825
Female divorced/widow	0.01021	0.12387	**−.34578***	0.16049	0.18626
Location					
Rural	(base)	(base)	(base)	(base)	(base)
Small town	−0.01873	−.15057**	.19577*	−0.06597	0.14539

Table 5 (continued)

	Europe	East	North	South	West
Large city	.14082***	− 0.08867	.4133***	.13616*	.40028**
Suburb	0.05825	− 0.22204	− 0.07609	.28449***	0.18249

Source: Authors' elaboration on FIES data

*p < .05;**p < .01; ***p < .001

4 Conclusions

This study provides original evidence concerning the determinants of gender differences in individual food insecurity in Europe, using the FAO Food Insecurity Experience Scale. Until now, to our knowledge, it has not been possible to add further insight to the study of food insecurity in developed countries, due to the lack of suitable data. The lack of analyses concerning individual and familial risk factors for experienced food insecurity (Ballard et al. 2014; Brunelli and Viviani 2014) and for social and economic characteristics of food insecure people (Smith et al. 2017) have been overcome thanks to the analysis of FIES data. In particular, a measure of experienced food insecurity has been made available for European countries, together with other meaningful covariates.

In this study, we have been able to determine the personal and family factors of risk related to individual food insecurity in Europe. We have also acknowledged gender-based disparities and investigated the drivers that could mitigate food insecurity in Europe: level of education, composition and number of children in the household 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, very poor people and individuals with lower education.

The estimations have been carried out both for Europe as a whole and for different European areas, pointing out territorial similarities and differences of food insecurity analysed by gender. The study, first of all, finds out that women are more fragile toward food insecurity than men, and this is true in every European area. Furthermore, education plays the most important role in reducing the probability of experiencing food insecurity, while some household characteristics, like the number of children and the marital status for women, particularly impact on food insecurity, generally through Europe, pointing out specific drivers for policies.

The results estimated in the models add further insight to the study of food insecurity: gender disparities, the strong impact of education against hunger and the role of income are all determinants which we acknowledge in the paper for both men and women.

The analysis of food insecurity at an individual level offers important policy instruments to fight hunger also in Europe, and individual data gives us the opportunity to find out characteristics of population groups at greater risk of food insecurity. For instance, the COVID-19 pandemic could almost double the number of people suffering acute hunger, according to the first estimates of the World Food Program and FAO (WFP 2020; IFAD et al. 2020). More in detail, the COVID-19 pandemic is affecting food systems directly, through impacts on food supply and demand, and indirectly through decreases in purchasing power and in

the capacity to produce and distribute food. In particular, people working in the economic sectors most affected from job losses and income reduction could experience direct implications in access to food (Committee on World Food Security 2020). A timely and comparable scale as FIES could offer some knowledge to prevent and fight the spread of food insecurity also in Europe.

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