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Food Insecurity among Europeans Aged 50+

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Abstract Using data from the fifth wave of the Survey of Health, Ageing and Retirement in Europe, this study investigates the association between food insecurity (FI) and several demographic and socioeconomic characteristics in a sample of individuals aged 50 and over in 15 European countries. On average, approximately 12% of individuals that eat meat/fish/poultry or fruit/vegetables less than 3 times per week cannot afford to eat these food items more often. Our Heckman probit analysis reveals that being employed, having higher levels of education and household income are associated with a lower probability of being unable to afford meat/fish/poultry or fruit/vegetables on a regular basis. Pronounced country-specific heterogeneity is also observed in food unaffordability: relative to Germany, the Eastern and Southern European countries, particularly the Czech Republic, Estonia, France, Italy, and Spain, are more vulnerable to food unaffordability. Nonlinear decompositional results show that household income and being employed are the two main contributors to the food unaffordability gap between high FI and low FI prevalence among European countries.

Keywords Food unaffordability · Heckman probit model · Decompositional analysis · Europeans

Introduction

Although the vast majority of undernourished people live in the developing world, over 20 million European Union (EU) households are also suffering from food insecurity (FI, Elanco 2015), defined as the inability to afford a high-quality meal (e.g. meat, fish,

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poultry, or a vegetarian equivalent) every other day. Not only did the proportion of individuals unable to afford meat or its equivalent rise from 8.7% in 2009 to 10.9% in 2012 (Loopstra et al. 2015), but in 2013, the share of the household budget spent on food across Europe ranged from around 10% in the UK, 20% in Italy, and 25% in Poland to 37% in Bulgaria (Elanco 2015). Food may be even less affordable in the wake of the recent recession, which has resulted in unemployment, debt, and housing arrears (Loopstra et al. 2015). At the same time, the European population is aging, with the proportion over 65 predicted to increase from 87.5 million in 2010 to 152.6 million in 2060 (Harper 2014), and anecdotal evidence suggests that this older population is particularly vulnerable to the economic crisis (AGE Platform Europe 2012). It has therefore become even more crucial to understand the drivers of FI in Europe, especially among older citizens for whom FI statistics are scant.

A small body of literature does examine the linkage between FI and demographic and socioeconomic determinants in Europe. For example, Elia and Stratton (2005), using data from the National Diet and Nutrition Survey of English residents 65 and over, demonstrate strong north-south inequalities (worse in the north) in the risk for protein-energy malnutrition and/or a deficiency in certain nutrients derived from fruits and vegetables. They further suggest that, although lower socioeconomic status (in terms of education, social class of household head, income, and old age pension) are important factors for nutritional status, a significant geographic gradient remains even after socioeconomic factors are accounted for. Likewise, Bocquier et al. (2015) find that, relative to French adults experiencing food security, their counterparts experiencing FI are significantly younger, more frequently female, especially single women with at least one child, and more likely to have lower socioeconomic status (as measured by occupation, education, income, perceived household financial situation, and living conditions). These findings echo Álvares and Amaral (2014) analysis of 2005/06 Portuguese National Health Survey data, which also shows that women and younger, unemployed, and less educated individuals are more vulnerable to FI. This observation is confirmed by Katsikas et al. (2014) for Greece and Tingay et al. (2003) for South East London. Pfeiffer et al. (2011) further observe that more Germans are being forced to rely on food banks for their regular nutritional supply and that the FI of those in poverty is heavily dependent on decisions by local entrepreneurs and volunteers. In a later study using longitudinal data from SILC/Eurostat, Pfeiffer et al. (2015) also identify delegation, denial, and stigmatization as the major societal strategies for coping with FI in Germany. In another study using Eurostat data, Loopstra et al. (2015) document an increasing FI trend between 2009 and 2012 and emphasize that the FI hardship could be heterogeneous among different European countries after the recent recession. Furthermore, drawing on Eurostat and OECD data, Loopstra et al. (2016) examine the association between country-level FI and unemployment, wage decline and different types of social protection in 21 EU countries from 2004 to 2012. They find that rising unemployment and falling wages are two important contributors for increasing FI, and social protection plays an important role in mitigating the risks of FI.

A set of different definitions for FI has evolved. One generally accepted definition is based on the Food and Agriculture Organization (FAO): "Food insecurity is a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient

purchasing power, inappropriate distribution or inadequate use of food at the household level. Food insecurity may be chronic, seasonal or transitory" (FAO, IFAD and WFP 2015, p.53). Another common definition is proposed by Anderson (1990): "Food insecurity exists whenever the availability of nutritionally adequate and safe foods or the ability to acquire acceptable foods in socially acceptable ways is limited or uncertain" (p.1576). Based on an official set of 18 FI questions, the United States Department of Agriculture (USDA) classifies households into different FI categories, ranging from food secure (households responding affirmatively to two or fewer of these 18 questions), low food secure (three to five questions) to very-low food secure (six or more questions) (Gunderson et al. 2011). Households are generally considered food insecure if they are classified as "low food secure" or "very-low food secure" (Gunderson et al. 2011). Especially in European countries, one common measure of household FI is defined as the prevalence of the household's inability to afford meat/fish/poultry (or a vegetarian equivalent) every second day (see Loopstra et al. 2015), which indicates a lack of financial resources for obtaining one essential component of a nutritionally adequate diet (Loopstra et al. 2016).

In our study, we extend the extant research (especially in Europe) by using data from the latest wave of the Survey of Health, Ageing and Retirement in Europe (SHARE) to conduct an international comparative analysis of FI determinants for Europe's 50+ generation. Our focus is on the *unaffordability* of meat/fish/poultry or fruit/vegetables, specifically the inability to consume these food items more than 3 times per week due to financial restrictions. This focus is in line with European definition of household FI, but only captures one aspect of the FAO's definition of FI, namely the insufficient purchasing power (FAO, IFAD and WFP 2015).

Given our research objective, it is important to highlight three important aspects of extant studies: First, virtually no comprehensive research exists on FI among Europeans aged 50+. To our knowledge, only one UK study by Elia and Stratton (2005) identifies a significant geographic divide in nutritional status among those 65+ even after adjustment for socioeconomic factors. This lack of prior research is surprising given the susceptibility of older individuals to poverty, functional impairment, and health problems, all of which may affect FI (Lee and Frongillo 2001; Wolfe et al. 1998). Second, although extant research does examine the association between FI and demographic and socioeconomic characteristics, no study applies a nonlinear decompositional approach to identify disaggregated contributions of individual determinants to FI differences between certain groups or geographic regions. Third, most past investigations focus only on one or two European countries, so despite substantial FI differences among European state – particularly with respect to national capacity to meet food demand (European Commission Directorate-General for Agriculture and Rural Development 2012) – there is a dearth of research assessing such cross-national differences. Comparing different European countries, therefore, should deepen our understanding of country-specific FI heterogeneity. These three points underscore the value of our paper's contribution: not only is it the first to investigate the association between FI and a range of individual characteristics (e.g. demographic and socioeconomic factors) among Europeans aged 50+, it also takes a detailed look at disaggregated contributions to the FI differences between groups of European states in order to identify country-specific FI heterogeneity.

Data and Methods

Data

The data for this analysis are taken from the Survey of Health Ageing and Retirement in Europe (SHARE), a unique European dataset on individuals aged 50 and older that includes information on health, socioeconomic status, and social and family networks (Börsch-Supan et al. 2013). This survey, which is harmonized with the U.S. Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA), has become a role model for several aging surveys worldwide (Börsch-Supan et al. 2013). Currently, the survey comprises four panel waves (2004, 2006, 2010, and 2013) covering current living conditions and retrospective life histories with several additional waves planned until 2024. One unique feature of the 2013 Wave 5 dataset is its inclusion of a specific work package of additional informative measures on respondents' material situations, including affordability (of specific expenses) and neighborhood quality. This Wave 5 dataset covers 15 countries: Austria, Germany, Sweden, Netherlands, Spain, Italy, France, Denmark, Switzerland, Belgium, Czech Republic, Luxembourg, Slovenia and Estonia, and Israel.

The SHARE data used in our analysis encompasses all persons born in 1962 or earlier, and persons who are a spouse/partner of a person born in 1962 or earlier, who speak (one of) the official language(s) of the country (regardless of nationality and citizenship) and who do not live either abroad or in institutions such as prisons and hospitals during the entire fieldwork period (Malter and Börsch-Supan 2015). The sampling frames and the associated sampling designs differ among countries, but the basic principles of probability sampling with minimal coverage errors guided the choice of the national sampling designs (Malter and Börsch-Supan 2015). Regarding the sample designs, a degree of standardization on stratification, clustering, variation in selection probabilities and sample size is assured among all participating countries by means of the "SHARE Sampling Guide" (Börsch-Supan and Jürges 2005). Our analytic sample is restricted to those aged 50 and over for whom detailed information is available on demographics, household socioeconomics, functional impairment, and health-related problems (proxied here by chronic disease).

Study Variables

Dependent Variable

In line with Loopstra et al. (2016), we adopt a single measure of household FI based on the unaffordability of meat/fish/poultry and fruit/vegetables. This measure is based on the following question: "Would you say that you do not eat meat/fish/poultry (or fruit/vegetables) more often because…". The possible answers to this question are 1 = we cannot afford it and 2 = [of] some other reason. We thus recode the responses into a dummy variable equal to 1 if the household respondent (on behalf of other household members) reports that they do not eat meat/fish/poultry (fruit/vegetables) more often because they cannot afford to, and 0 otherwise. It should be highlighted that this question is only asked of respondents who consume these food items less than 3 times per week, meaning that the dependent variables

identify households that consume these commodities less often because of unaffordability. As discussed above, such a measure is only a partial indicator of household FI and focuses primarily on the insufficient purchasing power aspect of FI (FAO, IFAD and WFP 2015). However, to our knowledge, it is the only available comparative measure of household FI across EU countries. Our final sample includes 10,157 observations for the former and 3379 observations for the latter. Note that the decrease of observations of fruit/vegetables affordability is mainly because a much smaller proportion consumes fruit/vegetables less than 3 times per week than meat/fish/poultry (a detailed description is shown in Table 6).

Explanatory Variables

We group the explanatory variables into three categories: (i) individual characteristics (ii) household characteristics, and (iii) other characteristics.

Individual characteristics: The individual characteristics are age, gender, employment status, marital status, and educational level. The gender dummy equals 1 if the respondent is a male; 0 otherwise. Employment status is a dummy if the respondent is employed or self-employed; 0 otherwise. Marital status is measured on a 5-point scale of 1 = unmarried, 2 = married/living together, 3 = separated, 4 = divorced, and 5 = widowed and then recoded as a dummy with unmarried as the reference category. Following Alavinia and Burdorf (2008), education is recoded according to the 1997 International Standard Classification of Education (ISCED-97) and then grouped into three categories: 1 = low (pre-primary, primary and lower secondary education), 2 = intermediate (upper secondary education) and 3 = high (post-secondary non-tertiary, first-stage and second-stage tertiary education), and finally converted to a dummy variable with low as the reference group. Given that extant studies (see, for instance Lee and Frongillo 2001; Quandt and Rao 1999) suggest that the concept of FI in the elderly might encompass altered food use because of functional impairment and health problems, inadequate availability, affordability, and accessibility of food, we introduce factors of functional impairment and chronic disease, which will be used in the first stage of the Heckman probit model (HPM, a detailed description of modelling is available in the method section). Specifically, following Lee and Frongillo (2001), we use limitations in (instrumental) activities of daily living (ADL, IADL) and chronic disease as proxies of functional impairment and health problems, respectively. ADL comprises 6 items: dressing, walking across a room, bathing or showering, eating, getting in and out of bed, and using the toilet (including getting up or down). IADL includes 7 items: using a map in a strange place, preparing a hot meal, shopping for groceries, making telephone calls, taking medications, doing work around the house or garden, and managing money. We then recode both ADL and IADL as dummies equal to 1 if the respondent has at least one ADL or IADL difficulty, respectively, and 0 otherwise. The chronic disease variable is based on the question: “Has a doctor ever told you that you had/Do you currently have any of the conditions of chronic disease? Please tell me the number or numbers of the conditions.” We then create a dummy equal to 1 if the respondent has at least two types of chronic disease; 0 otherwise.

Household and other (control) characteristics: In addition to using household income and size to measure household characteristics, we also include a country dummy to capture country-level policies that may influence FI in the 50+ population. Including a country dummy also facilitates intercountry comparisons, thereby capturing the country-specific heterogeneities that account for FI hardship adjusted by other contributing factors.

Estimation Procedure

Heckman Probit Model (HPM)

In the SHARE dataset, food unaffordability information is observed only for those households that consume meat/fish/poultry (fruit/vegetables) less than 3 times per week. Although these households are more likely to suffer from food unaffordability than those who consume these food items more often, the fact that we do not observe food unaffordability for individuals consuming these food items more than 3 times per week gives rise to censored data and thus to potential sample selection bias. To rule out this potential bias, we use a Heckman selection model (HSM). Because our food unaffordability measures are binary, we employ a probit estimation with Heckman selection adjustment (Heckman probit model, HPM). The specific procedure is divided into two steps: we firstly run a probit model with the binary dependent variable depicting food consumption (i.e., equal to 1 if a household consumes meat/fish/poultry (fruit/vegetables) less than 3 time per week, 0 otherwise) and calculate the inverse Mills ratio (IMR). The second step estimates a probit model in which the dependent variable is our food unaffordability measure and IMR generated from the first-stage estimation is also introduced as an independent variable in order to take account of the potential selection bias. To ensure that our models are well identified, we include ADL, IADL and chronic disease in the first-stage regression, thereby assuming that ADL, IADL and chronic disease are associated with food consumption among the elderly (yet not likely to directly influence the affordability). Specifically:

$$Latent\ equation: FIS_i^* = X_i\beta + \mu_{1i} \tag{1}$$

Note that we observe only the binary outcome below:

$$Response\ equatioin: FIS_i^{probit} = \left(FIS_i^* > 0\right) \tag{2}$$

However, food unaffordability is only observed for those households who consume meat/fish/poultry (fruit/vegetables) less than 3 times per week.

$$Selection\ equation: FC_i^{select} = (Z_i\delta + \mu_{2i} > 0) \tag{3}$$

where $\mu_{1i} \sim N(0, 1)$, $\mu_{2i} \sim N(0, 1)$, $corr(\mu_{1i}, \mu_{2i}) = \rho$, FIS_i^{probit} is a binary variable denoting meat/fish/poultry or fruit/vegetables unaffordability of individual *i*. FC_i^{select} is a binary variable representing meat/fish/poultry or fruit/vegetables consumption (less than 3 times/

week) of individual *i*. X_i is a vector of individual *i*'s characteristics, Z_i is a vector of exogenous variables, β_i denotes the coefficients of interest, and μ_{1i} and μ_{2i} are the error terms. It is worth mentioning that if $\rho \neq 0$, then standard probit estimation would give rise to biased results, meaning that the response and selection eqs. (2) and (3) are not independent and the error terms in the equations are correlated. To facilitate interpretation of the estimated coefficients, we report the corresponding marginal effects, which depict the probability that the household is experiencing food unaffordability.

Fairlie's (1999) Nonlinear Decomposition

As emphasized by Fairlie (2016), the adoption of the standard Blinder-Oaxaca (BO) and a linear probability decomposition provides misleading estimates in the case of binary dependent variables, particularly when group differences are relatively large for an influential independent variable. A relatively straightforward simulation technique for nonlinear decomposition is preferable. We therefore employ a nonlinear decompositional method to establish the contribution of demographic and socioeconomic characteristics on the differences in food unaffordability between two geographic groups of European countries. We first rank the countries according to the prevalence of food unaffordability and then create two approximately equally-sized groups for each item. Specifically, based on the country-specific prevalence of meat/fish/poultry unaffordability (see columns 3 and 7 of Table 1), we categorize the 15 survey countries into two groups: Group 1 (higher prevalence of meat/fish/poultry unaffordability): Spain, Italy, France, Israel, Czech Republic, and Estonia; Group 2 (lower prevalence of meat/fish/poultry unaffordability): Austria, Germany, Sweden, Netherlands, Denmark, Switzerland, Belgium, Luxembourg, and Slovenia. We adopt the same strategy for fruit/vegetables unaffordability: Group 3 (higher prevalence of fruit/vegetables unaffordability): Spain, Italy, France, Slovenia, Czech Republic, and Estonia; Group 4 (lower prevalence of fruit/vegetables unaffordability): Austria, Germany, Sweden, Netherlands, Denmark, Switzerland, Belgium, Luxembourg, and Israel.

For the analysis using meat/fish/poultry unaffordability as the binary dependent variable, the decomposition for nonlinear equation $Y = F(\mathrm{X}\beta)$ can be expressed as:

$$\overline{Y}^{G1} - \overline{Y}^{G2} = \left(\sum_{i=1}^{N^{G1}} \frac{F\left(X_i^{G1}\hat{\beta}^{G2}\right)}{N^{G1}} - \sum_{i=1}^{N^{G2}} \frac{F\left(X_i^{G2}\hat{\beta}^{G2}\right)}{N^{G2}} \right) + \left(\sum_{i=1}^{N^{G1}} \frac{F\left(X_i^{G1}\hat{\beta}^{G1}\right)}{N^{G1}} - \sum_{i=1}^{N^{G1}} \frac{F\left(X_i^{G1}\hat{\beta}^{G2}\right)}{N^{G1}} \right) \quad (4)$$

where N^j denotes the sample size of each group (j = Group 1 (G1), Group 2 (G2)). Two aspects are worth highlighting: First, in eq. (4), the first (explained) term on the right indicates the contribution attributable to a difference in the

distribution of the determinant of X, and the second (unexplained) term refers to the part resulting from a difference in the determinants' effects, meaning that it captures all the potential effects of differences in unobservables (Fairlie 2016). Second, in keeping with the majority of previous research using decompositional analysis, we focus on the explained part and the disaggregated contribution of the individual covariates. The contribution of a variable is given by the average change in function if that variable is changed while all other variables are kept the same. We use the same approach to analyze fruit/vegetables unaffordability (i.e., the differences between Groups 3 and 4).

One potential concern with Fairlie's (1999) sequential decomposition, however, is path dependence; that is, the possibility that altering the order of the variables in the decomposition may lead to different results (Schwiebert 2015). We therefore rule out the decompositional estimates' sensitivity to variable reordering by randomizing the variables during decomposition (Schwiebert 2015). Additionally, because a large number of replications are needed to retain the summing up property while approximating the average decomposition over all possible orderings, we use the recommended minimum of 1000 replications (see Fairlie 2016) and also perform a robustness check using 5000 replications. The analysis reported in the subsequent sections is performed using Stata/SE 13.1.

Results

Descriptive Statistics

As appendix Table 6 shows, the mean age in the sample is around 68, with the majority (approximately 63%) of respondents being female. Those suffering from at least one type of ADL and/or IADL difficulty make up 14.7% and 21.8%, respectively, and almost half (49.3%) are suffering from at least two types of chronic disease. Table 1 shows the prevalence of households who report consumption of meat (fish, poultry) or fruit (vegetables) less than 3 times per week and the corresponding unaffordability proportions in each country. Across all countries, the 2013 prevalence of meat/fish/poultry and fruit/vegetables unaffordability is 11.1% and 12.6% (columns 3 and 7), respectively. Large differences exist, with particularly high unaffordability rates in Southern and some Eastern European countries.

Before performing the nonlinear decomposition, we statistically compare meat/fish/poultry unaffordability in Group 1 versus Group 2 and fruit/vegetables unaffordability in Group 3 and Group 4. As Table 2 illustrates, a statistically significant divide exists between Groups 1 and 2 in meat/fish/poultry unaffordability, as well as in most demographics and socioeconomic factors. As shown in Tables 2 and 3, the prevalence of meat/fish/poultry unaffordability is 18.1% in Group 1 versus 4.4% in Group 2, and the prevalence of fruit/vegetables unaffordability is 21.2% in Group 3 versus 4.7% in Group 4. Those in Group 1 are also more likely to have lower socioeconomic status (in terms of employment, education, household income) than those in Group 2. This also applies to Group 3 and Group 4.

Table 1 Country-specific consumption (<3 times a week) and unaffordability of meat (fish, poultry) or fruit (vegetables)

	Meat/fish/poultry				Fruit/vegetables			
	<3 times a week		Unaffordability		<3 times a week		Unaffordability	
Country	Proportion (1)	Obs. (2)	Proportion (3)	Obs. (4)	Proportion (5)	Obs. (6)	Proportion (7)	Obs. (8)
All	0.1790 (0.3834)	63,398	0.1113 (0.3145)	10,157	0.0603 (0.2380)	63,382	0.1258 (0.3317)	3379
Austria	0.3322 (0.4711)	4121	0.0287 (0.1672)	1356	0.0696 (0.2546)	4121	0.0279 (0.1649)	287
Belgium	0.0768 (0.2663)	5405	0.0857 (0.2803)	385	0.0357 (0.1856)	5405	0.0722 (0.2596)	180
Czech Republic	0.2274 (0.4192)	5506	0.1760 (0.3810)	1068	0.1234 (0.3289)	5503	0.1842 (0.3880)	570
Denmark	0.0223 (0.1477)	3992	0.0370 (0.1900)	81	0.0849 (0.2788)	3991	0.0233 (0.1510)	301
Estonia	0.1885 (0.3912)	5638	0.3254 (0.4687)	1045	0.0951 (0.2934)	5637	0.2620 (0.4401)	523
France	0.0692 (0.2539)	4318	0.1365 (0.3439)	293	0.0250 (0.1562)	4318	0.1852 (0.3903)	108
Germany	0.3222 (0.4674)	5484	0.0515 (0.2210)	1360	0.0841 (0.2775)	5484	0.0833 (0.2768)	348
Italy	0.3501 (0.4770)	4596	0.1264 (0.3324)	1424	0.0472 (0.2121)	4596	0.2629 (0.4413)	194
Israel	0.2509 (0.4336)	2244	0.1068 (0.3092)	515	0.0684 (0.2503)	2234	0.0863 (0.2746)	135
Luxembourg	0.1434 (0.3506)	1548	0.0270 (0.1625)	222	0.0452 (0.2079)	1548	0.0143 (0.1195)	70
Netherlands	0.0713 (0.2574)	4011	0.0242 (0.1540)	248	0.0172 (0.1300)	4011	0.1034 (0.3072)	58
Sweden	0.0771 (0.2667)	4438	0.0325 (0.1776)	277	0.0856 (0.2799)	4437	0.0157 (0.1246)	318
Spain	0.1224 (0.3278)	6273	0.1578 (0.3649)	621	0.0306 (0.1723)	6273	0.1338 (0.3415)	151
Switzerland	0.1872 (0.3901)	2922	0.0333 (0.1697)	540	0.0215 (0.1453)	2922	0.0323 (0.1781)	62
Slovenia	0.2612 (0.4394)	2902	0.0623 (0.2419)	722	0.0265 (0.1607)	2902	0.1351 (0.3442)	74

Unaffordability is based on the following question that is posed to individuals eating the food items less than 3 times per week: "Would you say that you do not eat meat/fish/poultry (or fruit/vegetables) more often because…". The possible answers to this question are 1 = we cannot afford it and 0 = [of] some other reason

Standard deviations are reported in parentheses

Obs. observations

Determinants of Food Unaffordability

We report the results of the second stage of the HPM in Table 4 and the first stage in appendix Table 7. The results demonstrate that age, being employed/self-employed, and having higher levels of education and household income are linked to a lower probability of meat/fish/poultry unaffordability, and, except for high education, are similar to those of fruit/vegetables unaffordability (columns 1 and 2). It is particularly

Table 2 Descriptive statistics: meat/fish/poultry unaffordability

Variables	Group 1 (higher prevalence of meat/fish/poultry unaffordability)	Group 2 (lower prevalence of meat/fish/poultry unaffordability)	Mean difference
Meat/fish/poultry unaffordability	0.1812	0.0441	0.1371***
Age	68.8361	67.1576	1.6785***
Gender	0.3613	0.3599	0.0014
Employed/self-employed	0.1894	0.2583	-0.0689***
Marital status: Never married	0.0683	0.0867	-0.0184***
Marital status: Married/partnership	0.5820	0.5535	0.0285***
Marital status: Separated	0.0160	0.0216	-0.0056**
Marital status: Divorced	0.1036	0.1478	-0.0442***
Marital status: Widowed	0.2301	0.1905	0.0395***
Education: Low	0.5545	0.2737	0.2808***
Education: Intermediate	0.2527	0.4149	-0.1622***
Education: High	0.1928	0.3113	-0.1185***
Log(total household net income)	9.5782	10.3230	-0.7448***
Household size	2.0852	1.8915	0.1937***
N	4966	5191	

Group 1 includes Spain, Italy, France, Israel, Czech Republic, and Estonia; Group 2 includes Austria, Germany, Sweden, Netherlands, Denmark, Switzerland, Belgium, Luxembourg, and Slovenia

$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

important to highlight that the coefficients of the inverse Mills ratio are found to be significant and negative, irrespective of meat/fish/poultry or fruit/vegetables unaffordability, which indicates that sample selection bias is an issue in our analysis.

Table 3 Descriptive statistics: fruit/vegetables unaffordability

Variables	Group 3 (higher prevalence of fruit/vegetables unaffordability)	Group 4 (lower prevalence of fruit/vegetables unaffordability)	Mean difference
Fruit/vegetables unaffordability	0.2116	0.0471	0.1645***
Age	66.9508	65.7328	1.2180***
Gender	0.5326	0.6563	-0.1237***
Employed/self-employed	0.1943	0.2910	-0.0967***
Marital status: Never married	0.0929	0.1061	-0.0132
Marital status: Married/partnership	0.5830	0.5604	0.0226
Marital status: Separated	0.0197	0.0193	0.0004
Marital status: Divorced	0.1267	0.1668	-0.0401***
Marital status: Widowed	0.1777	0.1475	0.0302**
Education: Low	0.5443	0.3511	0.1932***
Education: Intermediate	0.2884	0.4022	-0.1138***
Education: High	0.1673	0.2467	-0.0794***
Log(total household net income)	9.3540	10.3339	-0.9799***
Household size	2.1082	1.8820	0.2262***
N	1620	1759	

Group 3 includes Spain, Italy, France, Slovenia, Czech Republic, and Estonia; Group 4 includes Austria, Germany, Sweden, Netherlands, Denmark, Switzerland, Belgium, Luxembourg, and Israel

$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4 Heckman Probit estimates for food unaffordability in 50+ individuals (second stage, marginal effects)

Variables	Meat/fish/poultry (1)	Fruit/vegetables (2)
Age	-0.0040***	-0.0025***
	(0.0005)	(0.0006)
Gender	0.0418***	-0.1015***
	(0.0117)	(0.0323)
Employed/self-employed	-0.0566***	-0.0711**
	(0.0112)	(0.0281)
Marital status: Married/partnership	-0.0037	0.0013
	(0.0147)	(0.0197)
Marital status: Separated	-0.0193	0.0181
	(0.0226)	(0.0475)
Marital status: Divorced	-0.0067	0.0007
	(0.0090)	(0.0245)
Marital status: Widowed	-0.0312*	-0.0158
	(0.0161)	(0.0115)
Education: Intermediate	-0.0479***	-0.0278***
	(0.0083)	(0.0103)
Education: High	-0.0676***	0.0099
	(0.0092)	(0.0237)
Log(total household net income)	-0.0233***	-0.0210**
	(0.0065)	(0.0131)
Household size	0.0038	-0.0102**
	(0.0051)	(0.0044)
Inverse Mills ratio	-0.2395***	-0.1505**
	(0.0610)	(0.0628)
N	10,157	3379
Pseudo R^2	0.171	0.178

The dependent variables are dummies indicating whether the household cannot afford to eat meat/fish/poultry or fruit/vegetables more often (1 = yes, 0 = [of] some other reason). Controls are age, gender (1 = male, 0 = female), employed status (1 = employed/self-employed, 0 = otherwise), marital status (measured on a five-point scale: 1 = never married, 2 = married/partnership, 3 = separated, 4 = divorced and 5 = widowed), education (1 = low, 2 = intermediate and 3 = high), translog total household net income, household size, country dummies (Germany as the reference) and inverse Mills ratio. Marginal effects are reported. Country-clustered standard errors are in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Country-Specific Heterogeneities in Food Unaffordability

As Fig.1 shows, the analysis reveals substantial country-specific heterogeneity, especially Estonia, France, the Czech Republic, Italy, and Spain, having larger proportions of 50+ individuals unable to afford meat/fish/poultry and fruit/vegetables on a regular basis. Even with a rich set of covariates controlled for, the marginal effects are large, ranging from about −0.084 to 0.142 for meat/fish/poultry and −0.146 to 0.121 for fruit/vegetables.

Explaining the Differences in Food Unaffordability

To better understand the disaggregated distributions of food unaffordability differences between our geographic groups, we perform a nonlinear decomposition (Fairlie 1999)

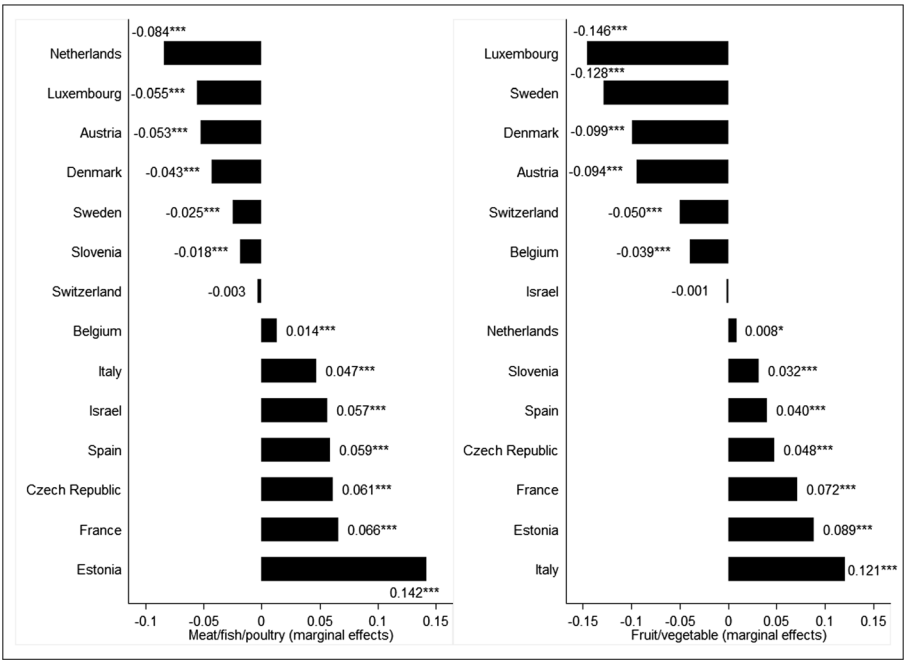

Fig. 1 Meat (fish, poultry) or fruit (or vegetables) unaffordability in Europe. Germany is the reference country. Marginal effects are reported. Country-level clustered standard errors are used to determine significance, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

with controls for demographics and socio-economic factors, and also take the sample selection bias into account. The results of the nonlinear decompostion are reported in Table 5, which shows the contributions of the explained part for meat/fish/poultry and fruit/vegetables unaffordability to be 44% and 40%, respectively.[1] For the individual contribution of demographic and socio-economic determinants in the explained part, household income consistently explains the largest share of the differences between Groups 1 and 2 in meat/fish/poultry and between Groups 3 and 4 in fruit/vegetables unffordability with proportions of 67% and 54%, respectively. Nevertheless, being employed/self-employed is also a relatively important contributor, accounting for approximately 15% of the explained part for both meat/fish/poultry and fruit/vegetables unaffordability. Regarding the explained part for meat/fish/poultry unaffordability, education accounts for about 29%, but it only explains 4% for fruit/vegetables unaffordability. It is also worth emphasizing that the inverse Mills ratios actually make a relatively larger contributions to the explained part, accounting for 37% and 29% for meat/fish/poultry and fruit/vegetables unaffordability, respectively.[2]

[1] The results with the replication of 5000 are quite similar to those in Table 5 and are available from the authors upon request.

[2] As any demarcation is quite arbitrary, we conducted a robustness test in which we also developed groups based on the five highest and five lowest ranking countries for meat/fish/poultry and fruit/vegetables. The results are qualitatively similar.

Table 5 Fairlie's (1999) nonlinear decomposition of demographic and socioeconomic differences in food unaffordability among 50+ individuals

	Meat/fish/poultry	Contribution %	Fruit/vegetables	Contribution %
Group 1 (higher prevalence of meat/fish/poultry unaffordability)	0.1812			
Group 2 (lower prevalence of meat/fish/poultry unaffordability)	0.0441			
Group 3 (higher prevalence of fruit/vegetables unaffordability)			0.2116	
Group 4 (lower prevalence of fruit/vegetables unaffordability)			0.0471	
Total difference	0.1371***		0.1645***	
Explained	0.0599	44	0.0657	40
Unexplained	0.0773	54	0.0992	60
Explained part				
Age	-0.0210***	-35	-0.0082**	-12
	(0.0023)		(0.0033)	
Male	-0.0026**	-4	0.0096***	15
	(0.0010)		(0.0017)	
Employed/self-employed	0.0090***	15	0.0097***	15
	(0.0019)		(0.0029)	
Marital status	-0.0053**	-9	-0.0004	-1
	(0.0021)		(0.0009)	
Education	0.0174***	29	0.0023	4
	(0.0026)		(0.0031)	
Log(total household net income)	0.0403***	67	0.0356***	54
	(0.0051)		(0.0119)	
Household size	0.0002	0	-0.0017	-3
	(0.0003)		(0.0012)	
Inverse Mills ratio 1	0.0219***	37		
	(0.0068)			
Inverse Mills ratio 2			0.0189***	29
			(0.0073)	
Number of replications	1000		1000	

The dependent variables are dummies indicating whether the household cannot afford to eat meat/fish/poultry or fruit/vegetables more often (1 = yes, 0 = [of] some other reason). Controls are age, gender (1 = male, 0 = female), employed status (1 = employed/self-employed, 0 = otherwise), marital status (measured on a five-point scale: 1 = never married, 2 = married/partnership, 3 = separated, 4 = divorced and 5 = widowed), education (1 = low, 2 = intermediate and 3 = high), inverse Mills ratios from the first-stage probit estimates for meat/fish/poultry or fruit/vegetables consumption, translog total household net income and household size. Standard errors are in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Conclusions and Discussion

Key Findings

This analysis of recent data from Wave 5 of the Survey of Health, Ageing and Retirement in Europe (SHARE) investigates the demographic and socioeconomic characteristics that account for food unaffordability among European individuals aged 50 and over. The focus is on the unaffordability of meat/fish/poultry and fruit/vegetables. Since food unaffordability is only reported by those households that consume food items less than 3 time per week instead of the whole

population, the estimated results might suffer from sample selection bias. To rule out this problem, we employ a Heckman probit model. Because an additional study objective is to identify the reasons for FI differences among European countries, we categorize SHARE's participating countries into two groups based on high versus low unaffordability prevalence. We then use Fairlie's (1999) nonlinear decomposition to determine which factors account for what share of the unaffordability differences between these two groups.

The study yields the following major findings: First, among individuals consuming meat/fish/poultry and fruit/vegetables less than 3 times per week, unaffordability among 50+ individuals in Europe is quite widespread (with approximately 11.1% of this population unable to afford meat/fish/poultry and 12.6% unable to afford fruit/vegetables more than 3 times per week). Clearly, as the Ready for Ageing Alliance (2015) points out, not all baby boomers are aging successfully. Second, being employed, having higher levels of education and household income are associated with a lower probability of inability to afford meat/fish/poultry or fruit/vegetables more often, suggesting that those 50 and over with lower socioeconomic status are more vulnerable to FI. These results are well in line with findings for Portugal (Álvares and Amaral 2014), France (Bocquier et al. 2015), the UK (Elia and Stratton 2005), the US (Alaimo et al. 1998; Borjas 2004; Gunderson and Oliveira 2001; Laraia et al. 2006) and Canada (Che and Chen 2001). Interestingly, consistent with Lee and Frongillo's (2001) findings for 60- to 90-year-olds in the U.S., the younger members of the older population are significantly associated with an elevated probability of both types of unaffordability. Third, relative to Germany, the Eastern and Southern European countries, particularly the Czech Republic, Estonia, France, Italy, and Spain, are more likely to suffer from food unaffordability, possibly because these countries are currently facing a combination of economic hardship and declining agricultural productivity (France), higher food prices relative to income than in most of the EU (Spain and Italy), or high unemployment (Spain, France, and Italy) (Elanco 2015). Nevertheless, significant country differences remain even after we control for particular demographic and socioeconomic variables, perhaps suggesting that not only food price differences but also institutional (e.g., availability of food, public transportation, and other amenities) and social support differences (e.g. family ties and networks) may matter. The nonlinear decomposition results show that household income and employment status (being employed/self-employed) are the two largest contributors to the explained part of the food unaffordability differences. The relatively important contribution of the inverse Mills ratio indicates that, besides those demographic and socioeconomic factors under consideration, some unobservables related to the inclination to eat these food items also account for the gap in food unaffordability differences between our geographic groups. Our decompositional analysis further reveals, however, that even our rich set of covariates cannot explain over 50% of the differences between countries with a low and high unaffordability prevalence, which implies that regional FI differences may be significantly affected by institutional and social support factors that differ among the countries in our analysis.

Strengths and Limitations

Our study extends the extant studies by investigating demographic and socioeconomic determinants of FI of Europeans aged 50+. We are not aware of comparative European analyses for this population group based on detailed microdata. Some limitations of our study should be mentioned: First, we use unaffordability of food items as a single measure of household FI and it focuses primarily on insufficient purchasing power, without covering the aspects of inappropriate distribution or inadequate use of food (FAO, IFAD and WFP 2015). In addition, our unaffordability measure (based on consumption less than 3 times per week), is somewhat narrower than the FI definition of Eurostat (which applies to consumption every other day). Our results will thus be comparatively lower. There is also no doubt that consuming these food items only twice a week or even less is well below nutrition recommendations in the European food-based dietary guidelines. All in all, our unidimensional measure is likely to lead to an *underestimation* of those experiencing FI. Finally, due to data availability, we are only able to use one recent wave of SHARE data set. Consequently, we cannot conduct a longitudinal analysis.

Future Research Directions

The limitations in this study point to several interesting avenues for future research. First, more detailed and comprehensive measures of household FI such as USDA module in the US (Gunderson et al. 2011) should be used to evaluate the prevalence, chronicity, and severity of FI across Europe (Loopstra et al. 2016). Additionally, even though one recent study by Loopstra et al. (2016) has examined the association of country-level FI with macro-level unemployment, wages and social protections in 21 EU countries from 2004 to 2012, having better longitudinal data at the micro-level is still vitally important particularly when assessing the long-term effects of demographic and socioeconomic factors on the temporal changes of household FI. Given that geographical FI differences may be attributable to country-level institutional and social protection factors, more research is also needed to clarify this aspect. Finally, as highlighted by Loopstra et al. (2016), detecting the effects of FI on health and nutrition in Europe is another important research direction.

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Compliance with Ethical Standards

Conflict of Interest The authors declare no conflicts of interest.

Appendix

Table 6 Descriptive statistics

Variable	Obs.	Mean/Proportion	Std. Dev.
Dependent variables			
Meat/fish/poultry consumption[a] (1 = if <3 times/week, 0 otherwise)	63,398	0.1790	0.3834
Fruit/vegetable consumption[a] (1 = if <3 times/week, 0 otherwise)	63,382	0.0603	0.2380
Meat/fish/poultry unaffordability[a] (1 = yes, 0 = [of] some other reason)	10,157	0.1113	0.3145
Fruit/vegetables unaffordability[a] (1 = yes, 0 = [of] some other reason)	3379	0.1258	0.3317
Independent variables			
Age (years)	10,157	67.9803	10.2874
Gender[a] (1 = male, 0 = female)	10,157	0.3606	0.4802
Employed/self-employed[a]	10,157	0.2245	0.4173
Marital status			
Never married[a]	10,157	0.0777	0.2677
Married/partnership[a]	10,157	0.5674	0.4955
Separated[a]	10,157	0.0189	0.1360
Divorced[a]	10,157	0.1261	0.3320
Widowed[a]	10,157	0.2099	0.4073
Education level			
Low[a]	10,157	0.4114	0.4921
Intermediate[a]	10,157	0.3354	0.4722
High[a]	10,157	0.2532	0.4349
ADL[a] (1 = if at least one type of ADL, 0 otherwise)	10,152	0.1473	0.3544
IADL[a] (1 = if at least one type of ADL, 0 otherwise)	10,152	0.2179	0.4128
Chronic diseases[a] (1 = if at least two types of chronic disease, 0 otherwise)	10,136	0.4929	0.5000
Log(total household net income)	10,157	9.9579	1.0113
Household size	10,157	1.9864	1.0053

Obs. observations, *Std. Dev.* standard deviation

[a] dummy variables

Table 7 Heckman probit estimates for food unaffordability in 50+ individuals (first stage, marginal effects)

Variables	Meat/fish/poultry	Fruit/vegetables
Age	-0.0013	-0.0174***
	(0.0008)	(0.0011)
Gender	-0.1651***	0.4074***
	(0.0124)	(0.0171)
Employed/self-employed	-0.1075***	-0.1216***
	(0.0169)	(0.0230)
Marital status: Married/partnership	-0.3004***	-0.2715***
	(0.0257)	(0.0331)
Marital status: Separated	0.0771	-0.0321
	(0.0545)	(0.0717)
Marital status: Divorced	0.0067	0.0375
	(0.0300)	(0.0381)
Marital status: Widowed	-0.0360	-0.0464
	(0.0291)	(0.0387)
Education: Intermediate	0.0579***	-0.0127
	(0.0143)	(0.0193)
Education: High	0.0200	-0.1537***
	(0.0156)	(0.0222)
ADL	0.0276***	0.0122
	(0.0093)	(0.0120)
IADL	0.0312***	0.0786***
	(0.0074)	(0.0095)
Chronic diseases	-0.0066	0.0323***
	(0.0040)	(0.0054)
Log(total household net income)	-0.0749***	-0.1234***
	(0.0067)	(0.0096)
Household size	0.0135*	-0.0303***
	(0.0072)	(0.0101)
N	63,274	63,284
Pseudo R^2	0.022	0.051

The dependent variables are dichotomous indicating whether the respondent eats meat/fish/poultry or fruit/vegetables less than 3 time per week or not (1 = yes, 0 = no). ADL = activities of daily living. IADL = instrumental activities of daily living. Controls are age, gender (1 = male, 0 = female), employed status (1 = employed/self-employed, 0 = otherwise), marital status (measured on a five-point scale: 1 = never married, 2 = married/partnership, 3 = separated, 4 = divorced and 5 = widowed), education (1 = low, 2 = intermediate and 3 = high), translog total household net income, household size, ADL, IADL and chronic diseases. Standard errors are in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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