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Food insecurity and social determinants of health among immigrants and natives in Portugal

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Abstract
Literature is scarce on food insecurity in the context of different illnesses and intersecting social hierarchies of gender and ethnicity. This study aims to describe and compare the prevalence of food insecurity between immigrants and natives in Portugal and explore social determinants of poor health outcomes associated with food insecurity. Data were derived from the National Food, Nutrition and Physical Activity Survey 2015–2016, which is a national and regionally representative survey of the Portuguese general population which collected nationwide data on dietary habits (including food insecurity measured by the Radimer/Cornell food security questionnaire) and physical activity, among other dimensions. Demographic, socioeconomic and health factors that could help explain ethnic disparities in food insecurity were explored through complex survey data analysis. The prevalence of food insecurity was 10.7% (95% CI: 6.5–15.0) among immigrants and 10.1% (95% CI: 8.3–11.9) among natives; no significant differences were found. Low family income and low level of education were the main factors associated with food insecurity in Portugal, in both native and immigrant groups. Self-reported diseases and poor self-rated health were also associated with food insecurity. Only among natives, women, older and unmarried subjects had higher food insecurity. Therefore, inter-sectoral policies addressing the social determinants of food insecurity are needed to reduce social inequalities and particular attention should be given for Portuguese women, elderly and unmarried people which are the most vulnerable groups. Promoting equality in household food and nutrition security in Portugal including among immigrant's populations is a public health priority.

Keywords Food insecurity · Social determinants of health · Immigrant health · Portugal

1 Introduction

The mass influx of migrants in recent decades has posed particular public health challenges (Carballo 2006; Ingleby 2012; Rechel et al. 2012). Disparities in health and disease have been shown for ethnic minority populations as compared to the general population, and also among the various immigrant groups (Glenday et al. 2006; Goulão et al. 2015; Kumar et al. 2006). Immigrants tend to quickly acquire the chronic disease patterns of the host country and present higher rates of mortality and morbidity linked to certain nutrition-related diseases than the indigenous population and those in their

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country of origin (Gilbert and Khokhar 2008; Ngo et al. 2009). Evidence indicates that there is a multiple range of factors influencing dietary behaviors among ethnic minority groups. However, studies have mainly focused on comparing ethnic minority groups to the native population mapping the 'differences' in terms of the socio-cultural environment and food beliefs (Osei-Kwasi et al. 2016). Comparing intersectional inequalities, that is how multiple social determinants of health intercept and impact dietary behavior, in the general population and in ethnic minority populations remains a research gap.

Food insecurity is a household-level socioeconomic situation of perceived "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways" (Bickel et al. 2000). Food insecurity has been recognized as a complex and multidimensional phenomenon (Schroeder and Smaldone 2015), being a relevant under-recognized cause of disparities in healthcare access and health outcomes in vulnerable populations (Vaccaro and Huffman 2017; Weiser et al. 2009; Whittle et al. 2015). There is a growing body of literature on the association between household food insecurity and diet, weight gain, increased cardiovascular disease risk and the development of chronic disease (Ford 2013; Franklin et al. 2012; Laraia 2012). Food insecurity has been significantly associated with higher rates of heart disease, diabetes, obesity, and depression (Heflin et al. 2005; Seligman et al. 2007; Siefert et al. 2004; Vozoris and Tarasuk 2003). Food insecurity has also been associated with increased hospitalizations and emergency department use, and postponing needed medical care and medications (Kersey et al. 1999; Kushel et al. 2006). Recent studies have contributed to addressing the epidemiological data gap in southern European countries, evaluating food insecurity and its impact on diet and health using representative samples of the Portuguese population (Alvares and Amaral 2014; Gregório, Rodrigues, Graça, de Sousa, Dias, Branco, et al. 2018). These investigations have provided relevant information about determinants and consequences of food insecurity, showing that food insecurity impacts increasingly seriously the most vulnerable population groups, such as the most underprivileged socioeconomic categories (unemployed people or those with precarious employment conditions, low education level or low household income) and the older adult population (Fernandes, Rodrigues, Nunes, Santos, Gregório, de Sousa, et al., 2018). Therefore, it is of utmost importance to study the magnitude and the multiple health impacts of food insecurity among subgroups of the population that may be particularly vulnerable to poor health outcomes, including migrant populations, using nationwide population-based surveys.

Thus, this study aims to fill the literature gap on food insecurity intersecting multiple social hierarchies, by describing and comparing the prevalence of food insecurity between immigrants and natives in Portugal and exploring social determinants of health impacting food insecurity and poor health outcomes. The following were the study questions: (1) Are there differences in the distribution of food insecurity between natives and immigrants? (2) Are there differences in the social determinants of health associated with food insecurity between natives and immigrants?

2 Methods

2.1 Participants and setting

The National Food, Nutrition and Physical Activity Survey 2015–2016 (Portuguese acronym: IAN-AF 2015–2016) is a national and regionally representative survey of the general population aged between three months and 84 years of age living in the community with the aims of collecting nationwide data on dietary habits and physical activity and of evaluating their relation with socioeconomic health determinants. Additional over sampling for high minority groups in Portugal was not implemented in IAN-AF 2015–2016. Survey design and data collection methodologies (which were adapted from the European Food Safety Agency Guidance in view of the European Menu methodology) have been previously detailed (Lopes et al. 2018).

The sampling method was a complex, multistage probability sampling design that used the National Health Registry to select a sample representative of the Portuguese non-institutionalized population from national territory, including the Autonomous Regions of Azores and Madeira. Individuals living in collective residences or institutions (e.g. elderly in retirement homes or individuals in hospitals, in prisons or military barracks), living in Portugal for less than one-year, non-Portuguese speakers, with diminished physical and/or cognitive abilities that hamper participation (e.g. blind, deaf, with diagnosed dementias) were not included.

Participants were contacted by telephone to check their willingness to participate. If an oral acceptance was provided by individuals, an invitation letter with participation details was sent by post mail. The examination location was selected according to participants' preference: participants' home or their Primary Health Care Unit.

A total of 5811 participants completed the two necessary interviews for dietary assessment, and 6553 completed only the first one. The nationwide cooperation and participation rate were 33.4% and 26.0%, respectively considering the first interview and 29.6% and 23.0%, respectively for the participants with both interviews completed.

For the present analysis, only adults aged 18 years and above were included. Final sample include 3860 participants with complete information on food security dimension, 3552 natives (91.8%) and 308 immigrants (8.2%).

2.2 Data collection

Data was collected from October 2015 to September 2016 by trained fieldworkers with nutrition background, by using computer-assisted personal interviewing. Demographic, socioeconomic and health-related data, such as self-reported morbidity and self-perceived health status, were obtained. Anthropometric measurements were performed according to standard procedures. Self-perception of general health status was retrieved by a single-item, five-point scale ranging from 1 'Poor' to 5 'Excellent' health. This question is a key predictor of severe morbidity and mortality (Baćak and Ólafsdóttir 2017; DeSalvo et al. 2005), and is extensively used, including in Portugal (Pais-Ribeiro 2005), namely in the National Health Survey.

Country of birth was used to determine immigrant condition and immigrants were grouped according to their country of origin (Europeans vs. non-Europeans).

Considering the principal outcome of interest, food insecurity assessment was obtained by applying a slightly modified questionnaire of the measure of household food security developed by Cornell/Radimer (Radimer et al. 1990), widely applied in the evaluation and monitoring of public food assistance programs in the USA and in other countries (Bickel et al. 2000), and adapted for Portugal by INSA and ERS/USDA. The three-stage design with screeners questionnaire provides estimates of food insecurity for households with and without children under the age of 18, by collecting information on four underlying dimensions and experiences of food insecurity during the past 12 months: availability, access, utilization, and stability / resilience. The food insecurity status of each household is classified by the number of food-insecure conditions and behaviors into three categories as: food security ("households had no problems, or anxiety about, consistently accessing adequate food"), moderate food insecurity ("households reduced the quality, variety, and desirability of their diets, but the quantity of food intake and normal eating patterns were not substantially disrupted") and severe food insecurity ("at times during the year, eating patterns of one or more household members were disrupted and food intake reduced because the household lacked money and other resources for food") (Franklin et al. 2012; Lopes et al. 2018).

The food security questionnaire was applied at the end of the second face-to-face interview.

2.3 Data analyses

Descriptive analyses for both socioeconomic and health characteristics were conducted for immigrants and natives. To compare determinants of food insecurity between Portuguese natives and immigrants, analyses were performed for each group separately. Firstly, associations of social factors and food insecurity were examined by the Chi-squared test and logistic regression models. Odds ratio (OR) and respective 95% confidence intervals (CI) were computed by comparing food insecurity (moderate plus severe) with food security in logistic regression models. Secondly, associations of reported common listed chronic diseases and food insecurity were assessed by the Chi-squared test. All estimates were weighted according to the complex sampling design, considering stratification by the seven Portuguese geographical regions (NUTS II) and cluster effect for the Primary Health Care Unit selected. A significance level of 5% was assumed. Analyses were performed using the library "survey" of R software (The R Project for Statistical Computing), version 3.4.1 for Windows.

3 Results

3.1 Sample characterization, demographic, socioeconomic and health characteristics

Characteristics of the study population, native and immigrants, are displayed in Table 1. Immigrants were younger (29.2% vs 47.6% aged 50 and over, $p < 0.001$) and more educated (88.6% vs 66.2% with secondary or higher education, $p < 0.001$) than natives. For immigrant population, analysis by region of birth also revealed age and educational differences among Europeans vs. non-Europeans immigrants, the latter younger (39.2% vs 5.0% aged 50 and over, $p < 0.001$) and more educated (84.8% vs 97.9% with secondary or higher education, $p = 0.001$).

Health status of the native and immigrant population is described in Table 2. The estimated prevalence of all self-reported diagnosed diseases was higher for natives than for immigrants. In particular, when compared to the Portuguese natives, immigrants presented significantly lower prevalence of diabetes (3.7% vs. 9.9%, $p = 0.032$), hypertension (17.5% vs. 28.0%, $p = 0.008$), dyslipidemia (18.6% vs. 27.6%, $p = 0.007$) and obesity (16.6% vs. 24.2%, $p = 0.014$). Finally, the prevalence of poor self-rated health (as less than good) was significantly lower among the immigrants: 40.1% (95% CI: 32.8–47.3) vs. 49.8% (95% CI: 47.2–52.3.

3.2 Food insecurity and associated factors

Table 3 shows the distribution of food insecurity across demographic and socioeconomic variables and the crude and adjusted odds ratios for their association. The prevalence of food insecurity was 10.7% (95% CI: 6.5–15.0) among immigrants and 10.1% (95% CI: 8.3–11.9) among natives; no statistically significant differences were found. Among Portuguese natives, gender was significantly associated with food security conditions, with odds of food insecurity being 75% higher for women, when compared to men. Yet, no association between

Table 1 Demographic and socioeconomic characteristics of native and immigrant population by region of origin, weighted for the distribution of the Portuguese population - the IAN-AF 2015–2016

	Portuguese Natives	Immigrants	*p* value	Immigrants by region		*p* value
				Europeans	Non-Europeans	
Sample size, n	3552	308	–	96	212	–
Estimated population, n (%)	7,621,783 (91.8)	684,883 (8.2)		200,940 (29.3)	483,943 (70.6)	
Gender, %						
Men	49.2	44.4		46.2	40.1	
Women	50.8	55.6	0.220	53.8	59.9	0.449
Age group (years), %						
18–49	52.4	70.8		60.8	95.0	
50–84	47.6	29.2	**<0.001**	39.2	5.0	**<0.001**
Marital status, %						
Married	61.2	60.5		35.0	50.4	
Not married	38.8	39.5	0.860	65.0	49.6	0.052
Education, %						
Until primary education	33.8	11.4		15.2	2.1	
Secondary or higher education	66.2	88.6	**<0.001**	84.8	97.9	**0.001**
Monthly household income (euros), %						
Under or equal 970	37.1	39.1		40.7	35.2	
Upper 970	62.9	60.9	0.613	59.3	64.8	0.463

these variables was observed among immigrants, and the overall interaction was not significant. Age was also significantly associated with food insecurity among Portuguese natives. Native older adults were more likely to be food insecure (OR = 1.55; 95% CI 1.20–1.98), when compared to the respective younger adults. No association between these variables was observed among immigrants, and the overall interaction was not significant. The association of food insecurity with marital status presents a significant interaction with being Portuguese native or immigrant. Among Portuguese natives, not being married significantly increased the odds of food insecurity by 56%, while among immigrants it acts as a protective factor, being associated to odds of food insecurity 72% lower. Among the immigrant population, the odds of being food insecure were highest for non-European immigrants (before adjustment for gender and marital status).

Income and level of education were main factors significantly associated with food insecurity, with higher levels of education and household income representing protective factors for both natives and immigrant populations, even after adjustment for gender and marital status.

Table 4 displays associations between health factors and household food security conditions among natives and immigrants. The prevalence of all self-reported chronic diseases was higher among the Portuguese natives who were food insecure. Heart disease (13.2% vs. 8.6%, $p = 0.034$), gastrointestinal disease (23.4% vs. 11.2%, $p < 0.001$), and depression (24.2% vs. 15.5%, $p = 0.008$) were significantly associated with poorer food conditions among the Portuguese natives.

Among the immigrants, only gastrointestinal disease was significantly associated with food insecurity: 23.4% (95%CI: 16.4—32.2) of the immigrants who were food insecure reported gastrointestinal disease, compared to 11.2% (95%CI: 9.4—13.4) who were food secure ($p = 0.001$).

Self-rated health was used as a key predictor of severe morbidity and significant associations were observed between poor self-rated health and food insecurity. The prevalence of those who self-rated their health as less than good was significantly higher among those who were food insecure compared to those who were food secure for both Portuguese natives and immigrants. Considering the native population, 70.8% (95% CI: 63.6–77.0) of those who were food insecure self-rated their health as less than good compared to 47.4% (95% CI: 44.8–50.0) among those who were food secure ($p < 0.001$). Among the immigrant population, 63.4% (95% CI: 37.8–83.2) of those who were food insecure and 37.3% (95% CI: 30.3–44.8) of those who were food secure self-rated their health as less than good ($p = 0.048$).

4 Discussion

This study used a national representative survey to describe and compare the prevalence of food insecurity

Table 2 Health status of native and immigrant population, weighted for the distribution of the Portuguese population - the IAN-AF 2015–2016

	Portuguese Natives % (95%CI)	Immigrants % (95%CI)	*p* value
Heart disease	9.1 (7.5–10.7)	7.0 (2.9–11.2)	0.403
Cancer	6.0 (4.8–7.2)	2.7 (0.5–5.0)	0.073
Diabetes	9.9 (8.4–11.3)	3.7 (0.2–7.2)	**0.032**
Hypertension	28.0 (25.5–30.4)	17.5 (11.4–23.6)	**0.008**
Dyslipidemia	27.6 (25.0–30.2)	18.6 (13.1–24.1)	**0.007**
Gastrointestinal disease	12.5 (10.4–14.5)	10.6 (5.4–15.9)	0.529
Depression	16.3 (14.2–18.5)	12.6 (8.0–17.2)	0.141
BMI, obesity*	24.2 (22.1–26.3)	16.6 (11.7–21.6)	**0.014**
Self-perceived health as "less than good"	49.8 (47.2–52.3)	40.1 (32.8–47.3)	**0.017**

*BMI, body mass index categories defined according to the World Health Organization criteria

95%CI: 95% confidence intervals.

between immigrants and natives in Portugal and found that the differences in the distribution of food insecurity between them (approximately 10–11%) was not statistically significant. This study also found that the major social determinants of food insecurity of both immigrant and native groups of the Portuguese community were low education level and low household income. It also identified disparities among social determinants of health associated with food insecurity between groups. Consistent with the literature, gender was significantly associated with food security conditions in Portugal. This finding is in line with other research conducted in Portugal, showing that dietary restrictions occurred more frequently in men among the immigrant group and in women among the native group (Alvares and Amaral 2014; Costa et al. 2018; Dias et al. 2008; Gregório et al. 2018). Likewise, age was also significantly associated with food insecurity, with native older adults reporting higher food insecurity levels compared to the respective younger adults. Studies focused on examining the older adult population in Portugal have also shown that food insecurity is more prevalent in the older population compared with the adult population (Fernandes et al. 2018). Being married was also a protective factor of food insecurity among the Portuguese natives but represented a significant risk factor among the immigrants. Income and level of education were positively linked to food security conditions, both among the natives and immigrant populations. Results confirm previous observations from the United States National Health and Nutrition Examination Survey (NHANES) from 2005 through 2010, which indicate that sociodemographic characteristics differed by food security versus insecurity. In the United States, adults who are food insecure are more likely to be younger, female, Hispanic, non-Hispanic black, unmarried, and less educated (Pruitt et al. 2016). Most importantly, this research indicates that the sociodemographic characteristics associated with food insecurity differ between immigrants and natives in Portugal, meaning that risk groups might differ among these populations.

Self-reported diseases and poor self-rated health were associated with food insecurity both among the native and the immigrant groups, which is in line with the existing literature demonstrating that food insecurity has serious negative health impacts among individuals suffering from chronic illnesses including infectious, noncommunicable, and mental illnesses (Alvares and Amaral 2014; Fernandes et al. 2018; Gregório et al. 2018; Pruitt et al. 2016; Whittle et al. 2015). Low food security is indicative of a reduction in diet quality (Alvares and Amaral 2014; Gregório et al. 2018), a marker of nutritional vulnerability (Kirkpatrick et al. 2015), and was related to all chronic diseases among Portuguese natives in this study.

In the current cross-sectional study among the adult population residing in Portugal, the prevalence of all self-reported diagnosed diseases was higher for natives than for immigrants, which could be explained by the well-known 'healthy immigrant effect', whereby immigrants are generally healthier than native-born population (Kennedy et al. 2015). These results appear to corroborate other research conducted in Portugal, showing this immigrant health advantage in terms of chronic conditions for some groups of immigrants (Dias et al. 2008; Goulão et al. 2015; Peralta da Costa et al. 2017). The lower levels of diseases can be partially explained by the fact that the immigrants were more educated and younger. Data and participants from the IAN-AF 2015–2016 did not consider the most vulnerable groups, namely refugees or irregular immigrants, with different socioeconomic characteristics and health outcomes.

The prevalence of heart disease, gastrointestinal disease, and depression were significantly higher among the Portuguese natives who were food insecure. Among the immigrant population in Portugal, gastrointestinal disease was significantly associated with food insecurity. These results indicate that promoting food security status of the households of

Table 3 Prevalence and association between food insecurity status and demographic and socioeconomic characteristics of Portuguese households, among Portuguese natives and immigrants, weighted for the distribution of the Portuguese population - the IAN-AF 2015–2016

	Portuguese Natives			Immigrants			
	Food Insecurity % (95%IC)	Crude OR* (95%CI)	Adjusted OR** (95%CI)	Food Insecurity % (95%IC)	Crude OR* (95%CI)	Adjusted OR** (95%CI)	*p*-interaction
Weighted n	767,853	–	–	73,341	–	–	–
Weighted %	10.1 (8.3–11.9)			10.7 (6.5–15.0)			
Gender							
Men	7.5 (5.5–9.4)	1.00	1.00	12.7 (4.5–20.8)	1.00	1.00	0.101
Women	12.6 (10.1–15.1)	**1.78** (1.29–2.47)	**1.75** (1.26–2.42)	9.1 (3.6–14.7)	0.69 (0.23–2.07)	0.68 (0.23–2.03)	
Age groups (years)							
18–49	8.6 (6.7–10.5)	1.00	1.00	9.1 (4.2–14.0)	1.00	1.00	0.744
50–84	11.7 (9.4–14.0)	**1.41** (1.11–1.80)	**1.55** (1.20–1.98)	14.5 (4.3–24.8)	1.69 (0.58–4.95)	1.32 (0.47–3.67)	
Region of birth							
Europe	–	–	–	14.0 (8.9–21.4)	1.00	1.00	
Non-European countries	–	–	–	2.6 (0.6–9.9)	**6.08** (1.26–29.24)	5.29 (0.07–26.15)	–
Marital status							
Married	8.5 (6.7–10.2)	1.00	1.00	14.7 (9.6–22.0)	1.00	1.00	**0.003**
Not married	12.6 (9.5–15.7)	**1.56** (1.14–2.13)	**1.52** (1.11–2.09)	4.6 (1.5–13.2)	**0.28** (0.08–0.99)	**0.27** (0.08–0.99)	
Education							
Until primary education	21.7 (18.1–5.4)	1.00	1.00	31.4 (15.5–53.4)	1.00	1.00	0.460
Secondary or higher education	3.3 (2.1–4.5)	**0.31** (0.22–0.44)	**0.29** (0.20–0.40)	8.0 (4.6–13.6)	**0.19** (0.06–0.62)	**0.19** (0.06–0.63)	
Monthly household income (euros)							
Under or equal 970	21.8 (10.1–15.1)	1.00	1.00	23.5 (14.9–35.2)	1.00	1.00	0.786
Upper 970	3.3 (5.5–9.4)	**0.12** (0.08–0.18)	**0.13** (0.09–0.19)	3.0 (1.1–8.3)	**0.10** (0.03–0.37)	**0.07** (0.02–0.28)	

*Odds ratio (ORs) and the respective 95% confidence intervals (95%CI) were computed by comparing food insecurity (moderate plus severe) with food security (1.00 category) in logistic regression models. Participants with missing values for any of the independent variables were excluded from the model. **Adjusted for gender and marital status

Table 4 Prevalence and association between food insecurity status and health factors of Portuguese households, among Portuguese natives and immigrants, weighted for the distribution of the Portuguese population - the IAN-AF 2015–2016

	Portuguese Natives			Immigrants		
	Food Security % (95%CI)	Food Insecurity % (95%CI)	*p* value	Food Security % (95%CI)	Food Insecurity % (95%CI)	*p* value
Heart disease, Yes	8.6 (7.1–10.4)	13.2 (9.2–18.6)	**0.034**	6.3 (3.1–12.2)	13.4 (3.4–40.5)	0.330
Cancer, Yes	5.9 (4.7–7.3)	6.9 (4.0–11.8)	0.578	2.3 (0.8–6.3)	6.8 (1.6–25.1)	0.228
Diabetes, Yes	9.6 (8.3–11.1)	12.4 (8.4–17.9)	0.189	3.7 (1.3–10.1)	3.7 (0.6–19.4)	0.983
Hypertension, Yes	27.4 (25.0–29.8)	33.3 (26.8–40.4)	0.080	16.7 (11.2–24.2)	24.0 (9.3–49.4)	0.470
Dyslipidemia, Yes	26.9 (24.4–29.7)	33.7 (26.6–41.6)	0.067	18.7 (13.4–25.5)	17.6 (6.2–40.9)	0.905
Gastrointestinal disease, Yes	11.2 (9.4–13.4)	23.4 (16.4–32.2)	**<0.001**	11.2 (9.4–13.4)	23.4 (16.4–32.2)	**0.001**
Depression, Yes	15.5 (13.6–17.5)	24.2 (17.5–32.5)	**0.008**	12.1 (7.9–18.1)	16.9 (6.1–38.9)	0.550
BMI, obesity, Yes*	23.5 (21.5–25.6)	30.8 (23.3–39.4)	0.070	14.8 (10.2–21)	31.3 (14.2–55.7)	0.103
Self-perceived health as `less than good', Yes	47.4 (44.8–50.0)	70.8 (63.6–77.0)	**<0.001**	37.3 (30.3–44.8)	63.4 (37.8–83.2)	**0.048**

*BMI, body mass index categories defined according to the World Health Organization criteria

95%CI: 95% confidence intervals.

Portuguese natives and immigrants may be one way to also improve their mental and physical health (Weigel et al. 2016).

Although our data did not support previous findings in Portugal showing a significant association between food insecurity and individuals with diabetes (Gregório et al. 2018), evidence linking food insecurity with diabetes has been well stablished by others (Laraia 2012). The relationship between food insecurity with cardiovascular risk markers and metabolic syndrome components in patients with diabetes has also been demonstrated, meaning that food security can play a significant role in the prevention and management of diabetes and also of cardiovascular disease among patients with diabetes (Mahmoodi et al. 2017). However, most of the studies do not compare food insecurity by race/ethnicity (Vaccaro and Huffman 2017). The present investigation highlights the need for further analysis exploring gender and race/ethnic differences in diabetes and cardiovascular events, given that health disparities have been shown to exist for food insecurity and several chronic diseases.

Similar to other investigations conducted in Portugal, our data did not show a significant association between food insecurity and obesity; however, there was a trend toward higher rates of obesity among natives and immigrants who were food insecure (Gregório et al. 2018). These findings corroborate the apparent paradoxical association between food insecurity and obesity, especially among women, found in previous research (Alvares and Amaral 2014; Dinour et al. 2007; Pan et al. 2012). However, as reported by an earlier review, there is missing evidence of a linear relationship between food insecurity and weight outcomes (Franklin et al. 2012). Continuing research is needed to further develop the understanding of disparities among population subgroups.

This study revealed that low education and low income were the main factors associated with food insecurity in Portugal, reinforcing the need of research intersecting social hierarchies of gender and ethnicity on food insecurity. Gender plays an important role in determining risk factors for food insecurity among high risk populations. Further research is needed to explain the well-known disparity in food insecurity in order to inform and guide corrective action (Pruitt et al. 2016).

Our study has some limitations and strengths that deserve discussion. Firstly, data were retrieved from the IAN-AF 2015–2016, which is a national and regionally representative survey of the general population living in Portugal, but without over sampling of the immigrant population. Secondly, individuals living in Portugal for less than one year and non-Portuguese speakers were excluded. Another limitation is that data were aggregated in just two regions (Europeans vs. non-Europeans). We are aware of the diversity among the non-Europeans immigrants in Portugal and expect that results from this study highlight the need for further investigation on food insecurity among immigrant populations in Portugal. However, nationwide data comparing dietary habits and food insecurity among natives and immigrants are presented for the first time, enabling comparison with future studies. Also, although literature has shown that the duration of stay and ethnicity are poor determinants of the dietary habits and health status of immigrants (Sanou et al. 2014), no questions were included in the IAN-AF 2015–2016 survey to address dietary acculturation. Further research with adequate acculturation measures should be performed to access the health and nutrition impact of immigration. Finally, while the experiences of food insecurity described here likely hold in other settings, they may also vary in different populations and contexts. Future studies of food insecurity and immigrants' health should consider factors such as health-related features of neighborhoods (e.g., walkability, recreational areas, and

accessibility of healthy foods), which can influence health-related behaviors, and also receipt of food assistance, which is a known factor associated with health of the poorest (Pruitt et al. 2016).

The data used in this study indicate that food security and health of immigrants are not significantly different from that of native Portuguese. However, considering the determinants of included and excluded immigrants in the data collection, a better assessment and understanding of migrant health differentials is needed, acknowledging that migrant populations are heterogeneous and move through different phases of the health transition during their life course. Further research of the association between food insecurity and social determinants of health in multi-ethnic societies should consider different approaches besides the 'ethnic inequality in health' dominant approach, which can constitute a considerable investment if considering the need to take into account all the intervene factors including early life factors, psychosocial, socio-economic, lifestyle, nutrition, genetics and contextual factors. Therefore, using different methods, i.e., comparing similar migrant populations living in different countries to explore the role of context or comparing migrants with the population in their home countries to analyze the role of migration, could contribute to a better understanding of the causes of migrants' health differences and commonalities (Agyemang 2019). Furthermore, research using a life course framework into account could offer new insights in the development of disease and the health situation of migrants (Spallek et al. 2011).

We analyzed nationally representative data and measured food security by using a validated, statistically reliable and meaningful measure of food insecurity. To the best of our knowledge, only a limited number of studies have been conducted to explore social and health determinants of food insecurity among ethnically diverse adult populations (Myers and Painter 2017) and this study is the first in Portugal.

5 Conclusions

The prevalence of food insecurity (10–11%) was not significantly different between native and immigrant groups of the Portuguese community. Educational level and family income were major factors associated with food insecurity in both. Particularly among natives, women, older and unmarried subjects seem to be the most vulnerable groups. The results of this study on the social determinants of food insecurity highlight the need for action against social inequalities for both immigrant and native groups of the Portuguese community and provide a starting point for further research. Knowledge on the magnitude of food insecurity intersecting multiple social hierarchies generated by this research may prompt more proactive policies at national and local levels, which will support the development of preventive strategies and health promotion initiatives addressing the social determinants of food security. Effective gender-based strategies to reduce nutritional and related health inequalities within the country should be considered, and particular attention should be given for Portuguese women, elderly and unmarried people.

Future research should focus on providing a better understanding of the role of social, cultural, and environmental factors and their interactions specially using longitudinal data analysis with a life course perspective; these data are necessary to inform potential interventions aiming to eliminate food and nutritional disparities in critical periods when food insecurity could be more impacting.

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Compliance with ethical standards

Ethical approval Ethical approval was obtained from the National Commission for Data Protection, the Ethical Committee of the Institute of Public Health of the University of Porto and from the Ethical Commissions of each one of the Regional Administrations of Health. All participants were asked to provide their written informed consent according to the Ethical Principles for Medical Research involving human subjects expressed in the Declaration of Helsinki and the national legislation.

Conflict of interest The authors declare that there are no conflicts of interest.

Abbreviations BMI, Body Mass Index; CI, Confidence interval; ERS/USDA, Economic Research Service of the United States Department of Agriculture; IAN-AF, National Food, Nutrition and Physical Activity Survey; INSA, National Health Institute Doutor Ricardo Jorge; NHANES, National Health and Nutrition Examination Survey; NUTS II, Nomenclature of territorial units for statistics; OR, Odds ratio.

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