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The association of energy poverty with health, health care utilisation and medication use in southern Europe

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ABSTRACT

Energy poverty (EP) is defined as the inability of a household to secure a socially and materially required level of energy services in the home. The main objective of this study was to analyse the association between EP and distinct indicators of health status, health services utilisation and medication use in southern Europe, using the city of Barcelona as a case study.

We conducted a cross-sectional study using the data of the Barcelona Health Survey for 2016 (n = 3519, 53.3% women). We calculated EP percentages according to age, country of birth and social class. We analysed the association between EP and 26 health-related indicators through prevalence ratios (PR), and quantified the impact of EP on health at the population level by calculating the percentage of population attributable risk (PAR %).

In Barcelona, 13.3% of women and 11.3% of men experienced EP. The most frequently affected groups were people born in low- and middle-income countries, those from more disadvantaged social classes, and women aged 65 years and older. We found a strong association between EP and worse health status, as well as higher use of health services and medication. For example, compared with women without EP, those with EP reported poor mental health 1.9 (95% CI: 1.6–2.4) times more frequently. Compared with men without EP, those with EP reported poor mental health 2.1 (95% CI: 1.6–2.8) times more frequently. The combination of high EP prevalence and the strong association between EP and negative health outcomes resulted in high PAR%, indicating the striking impact of EP on health and health services at the population level.

EP is an important public health problem in southern European urban contexts that should be included in policy priorities in order to address its structural causes and minimise its unfair and avoidable health effects.

1. Introduction

Energy is essential for life and for safeguarding a broad range of basic human rights (Walker, 2015). Energy poverty (EP) is defined as the inability of a household to secure a socially and materially required level of energy services in the home (Bouzarovski, 2014). Because of the increasing number of households experiencing EP in Europe, this complex and multidimensional problem has become a topic in policy and science agendas. Although EP has mainly been studied in Anglo-Saxon countries, recent publications have shown that the countries most affected by EP are those in southern and eastern Europe (Bouzarovski & Tirado Herrero, 2017; Recalde et al., 2019). Moreover, these countries experienced a rapid increase in EP rates after the start of the economic crisis in 2008. In 2012, when the impact of the crisis and the policies implemented in response to it became more evident, 20.95% (interquartile range (IQR): 12.95%–25.9%) of the population of southern and eastern European countries experienced EP, whereas in northern and central European countries the median percentage of people living in EP

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was 2.1% (IQR: 2%–8.2%). Although these percentages dropped slightly in 2016 (12.6% (IRQ: 6.15%–18.15%) and 3.5% (IRQ:2.3%–5.9%) respectively), the economic crisis uncovered the structural vulnerability of the root causes of EP, mainly in southern and eastern European countries (Oliveras et al., 2020).

Insufficient energy for lighting, cooking, and washing and the inability to achieve a comfortable temperature at home (between 18 °C and 20 °C in winter and around 25 °C in summer (Ajuntament de Barcelona, 2018)), as well as the financial stress of being unable to pay energy bills, can obviously affect physical and mental health. Until now, most research on this topic has been carried out in Anglo-Saxon countries, where EP has been related principally to cold housing (Marmot Review Team, 2011). Those studies reported that EP and low indoor temperatures were associated with: i) greater cardiovascular and respiratory morbidity and mortality (Osman et al., 2008; Power et al., 2010; Rudge & Gilchrist, 2005); ii) a higher risk of infections and minor illnesses such as colds and flu (Howden-Chapman et al., 2007); iii) exacerbation of existing health conditions such as arthritis and rheumatism (Shortt & Rugkasa, 2007); iv) mental health problems such as anxiety, depression and stress (Gilbertson et al., 2012); v) a higher risk of accidents and injuries at home (Regional Public Health Group, 2009); and vi) fewer dietary opportunities and choices (Bhattacharya et al., 2003).

To contextualise this evidence, there are substantial differences between southern European and Anglo-Saxon countries. On the one hand, southern European countries have milder winters, but warmer summers. On the other hand, there are major differences in the economic, housing and energy models, which are recognised as the structural determinants of EP (Marí-Dell'Olmo et al., 2017). For example, southern European countries have higher unemployment and in-work poverty rates, less developed social protection systems, an insignificant social rental housing stock, dwellings that are poorly insulated and without adequate heating systems, and less active energy markets (Bouzarovski & Tirado Herrero, 2017; Csiba et al., 2016; Ferrera, 1996; Recalde et al., 2019). In addition, like the post-socialist countries of central and eastern Europe, they have experienced an increase in domestic energy prices above the EU average (Bouzarovski & Tirado Herrero, 2017). Although a few recent studies at the European level have shown that EP also negatively affects health in southern European countries, they have focused on a single or few health outcomes (Bosch et al., 2019; Oliveras et al., 2020; Recalde et al., 2019; Thomson et al., 2017, 2019). There is therefore a need for empirical evidence on the specific health consequences of EP and what it represents for health services in the southern European setting.

Questions on EP were included in the Barcelona Health Survey for the first time in 2016, providing a unique opportunity to explore this field using Barcelona as a case study. The city of Barcelona is a clear example of how EP is becoming increasingly important in the urban contexts of southern Europe. In 2016, 10.6% of the city's population experienced EP (Ajuntament de Barcelona, 2018). EP has also become an explicit priority of the current city council of Barcelona (Tirado Herrero, 2018).

Therefore, the main objective of this study was to analyse the association between EP and distinct indicators of the health status, health services utilisation, and the use of medication in the city of Barcelona in 2016. A secondary objective was to assess the impact of energy poverty on health, that is, the burden of poor health outcomes that can be attributed to energy poverty at the population level.

2. Methods

2.1. Design, study population and information source

We performed a cross-sectional study using data from the Barcelona Health Survey for 2016. The study population consisted of non-institutionalised individuals aged 15 years or older who resided and were included in the Barcelona city register of inhabitants in 2016. The survey was conducted by interview in the households of a representative sample of 3519 individuals (Bartoll et al., 2018).

2.2. Study variables

The **dependent variables** were 26 dichotomous health-related indicators that could be affected by EP. Indicators were selected according to the literature and by subsequent consensus in a meeting with experts. The indicators selected were as follows:

- Health status (13 variables):
  - Self-reported health, dichotomised into 2 categories: good health (excellent, very good or good) and poor health (fair or poor) (Manor et al., 2000). This variable is known to be a good indicator of current overall health and a predictor of morbidity and mortality (Idler & Benyamini, 1997; Quesnel-Vallée, 2007).
  - Mental health, measured using the General Health Questionnaire (GHQ-12) and classified as either good mental health (GHQ-12 $<$ 3) or poor mental health (GHQ-12 $\geq$ 3) (Rocha et al., 2011).
  - Quality of life, assessed through the Euroqol 5D-5L. We used a calculation adapted for the Spanish population by Ramos-Goni et al. that identifies people with and without problems (Ramos-Goñi et al., 2017).
  - Self-reported chronic morbidity: people completing the Barcelona Health Survey are asked if they suffer from any of the chronic disorders included on a list. Of this list we included the following 8: high blood pressure; myocardial infarction and/or stroke; asthma; chronic bronchitis; arthrosis, arthritis and/or rheumatism; allergies; migraine or frequent headaches; diabetes.
  - Overweight: defined as a body mass index (obtained through self-reported weight and height) equal to or greater than 25.
  - Domestic injuries: computed variable which included having experienced burns, cuts, blows and/or falls at home in the past 12 months.
- Health services use (8 variables):
  - Emergency services: 2 or more visits to an emergency service in the last 12 months.
  - Hospitalisations: one or more hospitalisation in the last 12 months.
  - Contact with other health services: people completing the Barcelona Health Survey are asked if they have visited any of the health and social health professionals included on a list in the past 12 months. Of these professionals, we included the following 5: primary care physician, nurse, psychiatrist, psychologist, social worker.
  - Unmet medical need: if respondents reported having had in the last 12 months a health problem that they believed required medical attention but did not ask for it.
- Medication use (5 variables):
  - People completing the Barcelona Health Survey are asked if that have used any of the medications included on a list in the last 2 days. Of this list, we included the following 5 medications or group of medications: painkillers, allergy medication, antibiotics, asthma medication, psychotropic drugs (which include tranquillisers, sedatives, antidepressants, and sleep medication).

The main **independent variable** was living in EP, defined as living in a household that could not afford to maintain the dwelling at an adequate temperature during the cold and/or warm months.

Other covariables used were sex, age (dichotomised into $<$65 and $\geq$ 65 years), country of birth (dichotomised into high income [HI] versus low- and middle-income [LMI] countries according to the 2018 World Bank classification) (The World Bank, 2018) and social class. Social class was based on the current or last occupation of the interviewee, or of the head of the household if the interviewee had never worked, and was dichotomised into non-manual (including management positions in the

public administration, large or small companies, professionals and administrative positions, security staff and manual worker supervisors) and manual class (skilled, semi-skilled and unskilled manual workers) (Domingo-Salvany et al., 2013).

2.3. Data analysis

First, we described EP percentages according to age, country of birth and social class and used chi-square tests to detect whether the distribution of EP changed depending on these axes of social inequalities. Then, we calculated the prevalence of the 26 dependent variables among people living with and without EP. To analyse the association between health outcomes and EP, we calculated prevalence ratios (PR) and their 95% confidence intervals (CI) using Poisson regression models with robust variance (Barros & Hirakata, 2003; Espelt et al., 2017). These models provide correct estimates and are a preferred alternative to logistic regression for analysing cross-sectional studies with binary outcomes. We adjusted these models for age and social class, as both can act as confounders because they are related to health and EP. The Poisson models are formulated as follows:

$$\ln(\lambda_i) = \beta_0 + \beta_1 EP_i + \beta_2 AGE_i + \beta_3 SC_i,$$

where λ_i is the Poisson mean for each individual i (this mean approximates the probability of presenting the studied health outcome), β_0 is the model intercept and β_1, β_2 and β_3 are the associated coefficient to the individual variables energy poverty (EP_i), age (AGE_i) and social class (SC_i) respectively.

Finally, to quantify the impact of EP on health at the population level, we calculated the population attributable risk percent (PAR%). PAR% can be interpreted as the proportion of negative health outcomes (e.g. poor self-reported health) in the population that is attributable to EP and that, theoretically, could be prevented by eliminating EP. We obtained PAR% adjusted by age and social class for each of the 26 health outcomes directly from the Poisson regression models with robust variance by subtracting the expected cases if EP were absent from the observed cases and dividing these by the observed cases (Gefeller, 1990; Rückinger et al., 2009). We used the bootstrap resampling method to calculate the respective 95%CI.

All analyses were conducted separately for women and men and we took into consideration the complex sample design by using sampling weights and strata. We used the R software (version 3.4.4, R Foundation for Statistical Computing).

2.4. Supplementary analyses

As a sensitive analysis, we repeated all the analyses selecting the individuals that could not afford to meet an unforeseen expenditure of €750 with their own resources. The results can be found in the supplementary information (S1 to S3).

2.5. Ethical considerations

This study was approved by the Clinical Research Ethics Committee of Hospital del Mar (2015/6155/I).

3. Results

Table 1 shows the sex-stratified distribution of EP by age, country of birth and social class. In Barcelona, 13.3% of the women and 11.3% of the men experienced EP. The most affected groups were those born in LMI countries (24.7% in women and 23.0% in men), people from more disadvantaged social classes (22.2% in women and 17.7% in men) and women aged 65 years and older (15.0%).

3.1. EP and health status

Table 2 shows the prevalence of each of the 13 health status indicators among people with and without EP, as well as the respective crude and adjusted PR and PAR%. EP was consistently associated with worse health outcomes in both women and men. In women, the strongest association was found with respiratory and cardiovascular diseases. Compared with women not experiencing EP, women living in EP reported chronic bronchitis 2.2 (95% CI: 1.3–3.6) times more frequently and myocardial infarction and/or stroke 2 (95% CI: 1.1–3.5) times more frequently. In men, the strongest association was observed in domestic injuries (aPR [95% CI]: 2.7 [1.5–4.7]) and poor mental health (aPR [95% CI]: 2.1 [1.6–2.8]). In both sexes, EP was strongly associated with more often having migraine or frequent headaches, which were 2 (95% CI: 1.6–2.4) times more frequent in women and 1.9 (95% CI: 1.3–2.8) times more frequent in men. Women and men living in EP also self-reported poor health around 2 times more frequently than women and men without EP (aPR [95% CI]: 1.8 [1.5–2.2] and 2.0 [1.6–2.6] respectively). As reflected by PAR% estimates, EP had a major impact on health and well-being at the population level. For example, regarding poor mental health, 12.3% (95% CI: 7.6–17.1) of the cases in women and 12.5% (95% CI: 7.1–18.2) in men could be attributable to EP.

Table 1
Energy poverty distribution by age, country of birth and social class, stratified by sex. Barcelona, 2016.

	Women (n = 1847)			Men (n = 1629)			p-value[a]
	cases	%	95%CI	cases	%	95%CI	
Total	244	13.3	(11.8–14.9)	186	11.3	(9.8–12.9)	0.076
Age (years)							
Less than 65	162	12.7	(10.9–14.5)	158	12.2	(10.4–14.0)	0.691
65 or more	82	15.0	(11.9–18.0)	28	8.1	(5.2–11.0)	0.003*
p-value[b]		0.201			0.035*		
Country of birth							
HI	159	10.7	(9.1–12.3)	116	8.7	(7.2–10.3)	0.086
LMI	85	24.7	(20.1–29.4)	70	23.0	(18.2–27.7)	0.598
p-value[b]		<0.001*			<0.001*		
Social class							
Non-manual	64	6.1	(4.7–7.6)	57	6.3	(4.7–7.9)	0.901
Manual	162	22.2	(19.2–25.3)	124	17.7	(14.9–20.6)	0.037*
p-value[b]		<0.001*			<0.001*		

n: sample size; cases: number of energy poverty cases; CI: Confidence interval; HI: High income: LMI: Low and middle-income; *: statistically significant p-value (<0.05).

[a] Chi-square test assessing sex differences within each category.

[b] Chi-square test assessing differences between categories within each sex; there were 43 missing values in the EP indicator; the final sample consisted of 3476 individuals.

Table 2
Prevalence of health status indicators among people with and without energy poverty, crude prevalence ratios (cPR), adjusted prevalence ratios (aPR) and adjusted population attributable risk percent (PAR%), stratified by sex. Barcelona, 2016.

Women	Energy poverty (n = 244)			No energy poverty (n = 1603)								
	c	%	95%CI	c	%	95%CI	cPR	95%CI	aPR	95%CI	PAR%	95%CI
Poor self-reported health	113	45.3	38.9–51.6	346	21.2	19.2–23.2	2.1	1.8–2.5	1.8	1.5–2.2	10.8	7.0–14.7
Poor mental health	86	38.0	31.5–44.4	267	17.5	15.6–19.5	2.2	1.8–2.7	1.9	1.6–2.4	12.3	7.6–17.1
Poor quality of life	178	72.5	66.8–78.2	827	51.2	48.7–53.7	1.4	1.3–1.6	1.3	1.2–1.4	4.0	2.4–5.7
High blood pressure	80	31.8	26.0–37.7	321	20.1	18.0–22.1	1.6	1.3–2.0	1.4	1.2–1.8	5.9	2.3–9.6
Myocardial infarction and/or stroke	17	6.6	3.5–9.7	42	2.6	1.8–3.4	2.6	1.5–4.5	2.0	1.1–3.5	13.1	0.4–27.1
Asthma	25	10.2	6.3–14.0	81	5.0	3.9–6.1	2.0	1.3–3.1	1.6	1.0–2.5	8.1	-1.4–18.2
Chronic bronchitis	24	9.6	5.8–13.3	60	3.6	2.7–4.5	2.7	1.7–4.2	2.2	1.3–3.6	15.5	4.2–27.4
Arthrosis, arthritis, rheumatism	83	32.7	26.8–38.6	389	24.0	21.9–26.2	1.4	1.1–1.7	1.3	1.0–1.5	3.4	0.3–6.6
Allergies	59	24.0	18.6–29.5	240	15.0	13.3–16.8	1.6	1.2–2.1	1.6	1.2–2.1	7.4	2.6–12.4
Migraine or frequent headaches	91	37.7	31.5–43.9	296	18.2	16.3–20.1	2.1	1.7–2.5	2.0	1.6–2.4	11.4	7.0–15.9
Overweight	124	50.1	43.7–56.5	605	37.8	35.4–40.2	1.3	1.2–1.5	1.2	1.0–1.3	2.1	-0.2–4.5
Diabetes	32	13.2	8.9–17.5	87	5.5	4.3–6.6	2.4	1.6–3.5	1.9	1.3–2.9	12.3	3.6–21.5
Domestic injuries	23	8.6	5.2–12.0	98	5.9	4.7–7.1	1.5	0.9–2.3	1.4	0.9–2.3	4.9	-2.7–13.1
Men												
	Energy poverty (n = 186)			No energy poverty (n = 1443)								
	c	%	95%CI	c	%	95%CI	cPR	95%CI	aPR	95%CI	PAR%	95%CI
Poor self-reported health	57	30.1	23.5–36.8	226	15.2	13.3–17.1	2.0	1.5–2.6	2.0	1.6–2.6	10.1	5.5–15.0
Poor mental health	57	33.9	26.7–41.1	195	14.0	12.2–15.8	2.4	1.9–3.1	2.1	1.6–2.8	12.5	7.1–18.2
Poor quality of life	115	61.8	54.8–68.9	581	39.5	36.9–42.0	1.6	1.4–1.8	1.6	1.4–1.8	5.9	3.8–8.2
High blood pressure	39	21.3	15.3–27.3	274	18.8	16.7–20.8	1.1	0.8–1.5	1.4	1.0–1.9	3.4	-0.2–7.2
Myocardial infarction and/or stroke	13	6.6	3.1–10.1	71	4.6	3.6–5.7	1.4	0.8–2.5	1.6	0.9–2.9	5.3	-2.5–13.9
Asthma	20	10.7	6.2–15.1	86	6.1	4.9–7.4	1.7	1.1–2.8	1.6	1.0–2.7	6.6	-0.9–14.7
Chronic bronchitis	12	6.3	2.8–9.8	57	3.9	2.9–4.9	1.6	0.9–3.0	1.7	0.9–3.2	7.6	-2.0–18.4
Arthrosis, arthritis, rheumatism	31	16.9	11.4–22.4	165	11.0	9.4–12.6	1.5	1.1–2.2	1.9	1.3–2.7	7.8	2.7–13.4
Allergies	43	24.0	17.7–30.3	200	14.2	12.4–16.1	1.7	1.3–2.3	1.7	1.2–2.2	6.9	2.0–12.0
Migraine or frequent headaches	36	19.3	13.6–25.0	126	9.0	7.5–10.5	2.2	1.5–3.0	1.9	1.3–2.8	10.5	3.6–17.6
Overweight	109	58.4	51.2–65.5	760	52.2	49.6–54.8	1.1	1.0–1.3	1.1	0.9–1.3	1.0	-0.7–2.7
Diabetes	13	6.5	3.1–10.0	102	6.9	5.6–8.2	1.0	0.5–1.7	0.9	0.5–1.7	-1.1	-7.3–5.7
Domestic injuries	15	8.3	4.2–12.3	45	3.0	2.1–3.9	2.7	1.5–4.8	2.7	1.5–4.7	16.8	4.6–30.0

N = sample size; c = number of cases with the health outcome; CI: Confidence interval.

3.2. EP and the use of health services and medication

Table 3 shows the prevalence of each of the 13 health services and medication use indicators among people with and without EP, as well as the respective crude and adjusted PR and PAR%. We observed a generalised increase in the use of general health services, such as visits to emergency services, primary care physicians, nurses and hospitalisation in both sexes. Specialised mental health services were those most strongly associated with EP, especially in women with EP, who, compared with women without EP, reported having seen a psychiatrist 2.5 (95% CI: 1.6–3.9) times more frequently and a psychologist 3 (95% CI: 2.0–4.6) times more frequently in the last 12 months. In men, the aPR (95% CI) were 2.3 (1.4–3.9) and 1.7 (0.9–3.3) respectively. Women and men living in EP also used social work services significantly more than women and men not experiencing EP: 2.7 (95% CI: 1.7–4.1) and 3.6 (95% CI: 2.2–6.0) times more, respectively. These results translated into a significant burden on health services. We observed high PAR% estimates for numerous indicators, such as social work visits, with 20.4% (95% CI: 9.7–31.6) of the visits in women and 24.4% (95% CI: 11.9–37.3) of those in men being attributable to EP. Of note, even with this higher use of health services, women with EP reported unmet needs 1.5 (95% CI: 1.2–1.9) times more frequently and men 1.2 (95% CI: 0.9–1.6) times more frequently than people without EP.

Medication use in the last 2 days was higher in women with EP than in those without. The strongest associations were found for allergy medication (aPR [95%CI]: 2.5 [1.5–4.3]) and antibiotics (aPR [95%CI]: 2.8 [1.5–5.0]). In men, EP was strongly associated with asthma medication (aPR [95%CI]: 2.2 [1.1–4.3]) and psychotropic drugs (aPR [95% CI]: 2.0 [1.4–2.8]).

4. Discussion

4.1. Main findings

This study shows that EP is a major public health problem in the urban contexts of southern Europe, such as the city of Barcelona. We found that Barcelona has above EU average rates of EP and with an unequal distribution, affecting above all people with a more disadvantaged social class, people born in LMI countries, and women aged 65 years and older. The results show a strong association in women and men between EP and worse health status, as well as with a higher use of health services and medication. Because of the combination of the high prevalence of EP and its strong association with poor health outcomes, EP has a substantial impact on health and health services at the population level.

4.2. Interpretation of results

We found a strong association between EP and poor self-reported health. This is consistent with 3 previous European studies that have also reported this association in southern European countries (Bosch et al., 2019; Oliveras et al., 2020; Thomson et al., 2017). So far, almost all the evidence of the negative effects of EP on health in southern European countries is based on European studies at the country level that have mainly used this indicator. The present study also shows a strong association between EP and poor mental health. In a previous European study, we found that the effects of EP were stronger on mental health than on self-reported health (Oliveras et al., 2020). Some Anglo-Saxon studies have discussed the multiple, and sometimes short-term, mechanisms and pathways through which EP affects mental health, which

Table 3
Prevalence of health services and medication use indicators among people with and without energy poverty, crude prevalence ratios (cPR), adjusted prevalence ratios (aPR) and adjusted population attributable risk percent (PAR%), stratified by sex. Barcelona, 2016.

Women

	Energy poverty (n=244)			No energy poverty (n=1603)								
	c	%	95%CI	c	%	95%CI	cPR	95%CI	aPR	95%CI	PAR%	95%CI
Use of health services in the last 12 months												
Emergency services*	68	27.4	21.7 - 33.0	234	14.7	13.0 - 16.5	1.9	1.5 - 2.4	1.6	1.3 - 2.1	8.1	3.2 - 13.2
Hospitalisations	36	14.7	10.2 - 19.2	204	12.6	10.9 - 14.2	1.2	0.8 - 1.6	1.1	0.8 - 1.5	1.0	-4.0 - 6.1
Primary health care	216	88.0	83.7 - 92.2	1252	77.9	75.8 - 79.9	1.1	1.1 - 1.2	1.1	1.0 - 1.2	1.2	0.4 - 2.0
Nursing	92	36.8	30.7 - 42.9	407	25.4	23.2 - 27.6	1.4	1.2 - 1.7	1.4	1.1 - 1.7	4.7	1.4 - 8.1
Psychiatry	30	12.3	8.1 - 16.4	76	4.9	3.8 - 5.9	2.5	1.7 - 3.8	2.5	1.6 - 3.9	15.9	6.4 - 25.9
Psychology	30	12.3	8.1 - 16.5	83	5.2	4.1 - 6.3	2.4	1.6 - 3.5	3.0	2.0 - 4.6	17.9	8.9 - 27.5
Social Work	32	13.5	9.1 - 17.9	71	4.4	3.4 - 5.4	3.1	2.0 - 4.6	2.7	1.7 - 4.1	20.4	9.7 - 31.6
Unmet medical need	62	26.9	21.2 - 32.7	253	15.8	14.0 - 17.5	1.7	1.3 - 2.2	1.5	1.2 - 1.9	6.9	2.2 - 11.7
Medication use in the last 2 days												
Painkillers	129	51.5	45.1 - 57.9	594	36.6	34.2 - 39.0	1.4	1.2 - 1.6	1.3	1.1 - 1.5	4.2	1.7 - 6.7
Allergy medication	21	8.1	4.7 - 11.4	54	3.2	2.4 - 4.1	2.5	1.5 - 4.1	2.5	1.5 - 4.3	16.6	4.9 - 29.0
Antibiotics	17	7.2	3.8 - 10.6	43	2.7	1.9 - 3.5	2.7	1.5 - 4.6	2.8	1.5 - 5.0	18.6	5.4 - 32.6
Asthma medication	15	5.9	3.0 - 8.9	42	2.6	1.8 - 3.4	2.3	1.3 - 4.1	1.9	1.0 - 3.5	12.4	-1.0 - 26.9
Psychotropic drugs	80	31.6	25.7 - 37.4	295	18.0	16.1 - 19.8	1.8	1.4 - 2.2	1.6	1.3 - 2.0	7.8	3.5 - 12.2

Men

	Energy poverty (n=186)			No energy poverty (n=1443)								
	c	%	95%CI	c	%	95%CI	cPR	95%CI	aPR	95%CI	PAR%	95%CI
Use of health services in the last 12 months												
Emergency services*	36	19.3	13.6 - 25.0	135	9.4	7.9 - 10.9	2.1	1.5 - 2.9	1.9	1.3 - 2.7	9.7	3.4 - 16.4
Hospitalisations	31	16.5	11.1 - 21.8	147	10.0	8.4 - 11.5	1.6	1.2 - 2.4	1.7	1.2 - 2.4	7.0	1.3 - 13.0
Primary health care	150	81.0	75.4 - 86.7	1032	71.3	68.9 - 73.6	1.1	1.1 - 1.2	1.1	1.0 - 1.2	1.4	0.4 - 2.4
Nursing	48	25.6	19.3 - 31.9	281	19.3	17.3 - 21.4	1.3	1.0 - 1.7	1.4	1.0 - 1.8	3.7	0.0 - 7.5
Psychiatry	21	10.7	6.3 - 15.1	67	4.7	3.6 - 5.8	2.3	1.4 - 3.6	2.3	1.4 - 3.9	13.1	3.2 - 23.5
Psychology	11	5.6	2.4 - 8.8	54	3.8	2.8 - 4.8	1.5	0.8 - 2.8	1.7	0.9 - 3.3	6.8	-3.1 - 17.9
Social work	25	13.7	8.7 - 18.8	49	3.3	2.4 - 4.2	4.1	2.6 - 6.6	3.6	2.2 - 6.0	24.4	11.9 - 37.3
Unmet medical need	43	23.4	17.3 - 29.6	240	16.8	14.9 - 18.8	1.4	1.0 - 1.9	1.2	0.9 - 1.6	2.6	-1.7 - 7.1
Medication use in the last 2 days												
Painkillers	85	45.7	38.4 - 52.9	388	26.9	24.5 - 29.2	1.7	1.4 - 2.0	1.6	1.3 - 1.9	6.9	3.8 - 10.1
Allergy medication	11	5.7	2.4 - 9.0	49	3.5	2.5 - 4.4	1.6	0.9 - 3.1	1.4	0.7 - 2.8	4.7	-5.2 - 15.8
Antibiotics	7	3.5	0.9 - 6.0	55	3.8	2.8 - 4.8	0.9	0.4 - 2.0	0.9	0.4 - 2.1	-0.9	-9.5 - 8.8
Asthma medication	10	5.3	2.1 - 8.6	40	2.6	1.8 - 3.4	2.0	1.0 - 4.0	2.2	1.1 - 4.3	11.4	-0.8 - 24.9
Psychotropic drugs	37	19.7	13.9 - 25.5	162	10.8	9.2 - 12.4	1.8	1.3 - 2.5	2.0	1.4 - 2.8	9.5	3.8 - 15.4

n= sample size; c=number of cases with the health outcome; CI: Confidence intervals; *Two or more visits to emergency services.

may also apply to the southern European context. Some examples are chronic thermal discomfort, worries about energy bills, the experience of falling into debt (or fear of it) and the absence of any solution or sense of control over the problem (Anderson et al., 2012; Gilbertson et al., 2012; Liddell & Guiney, 2015; Tod et al., 2012). In southern European countries, the increase in housing insecurity and household financial debt in the wake of the economic crisis, which are strongly related to EP and are also associated with poorer physical and mental health, could contribute to the association observed between EP and poor self-reported and mental health.

Due to their strong association with cold temperatures, cardiovascular and respiratory diseases have been the most studied EP health effects to date (Marmot Review Team, 2011). We also found a relevant association between EP and high blood pressure, myocardial infarction, stroke, asthma and chronic bronchitis. Although winters are milder in southern Europe, respiratory function appears to be impaired at temperatures below 16 °C, while the cardiovascular system becomes impaired at temperatures below 12 °C (Marmot Review Team, 2011). Furthermore, the housing stock in southern European countries is characterised by low energy efficiency and the lack of adequate heating systems (Bouzarovski & Tirado Herrero, 2017), which can result in cold housing in mild winters. In Barcelona, for example, the average monthly temperature during the winter of 2016 fluctuated between 9.7 and 13.1 °C (Meteorològic de Catalunya, 2016) and, according to the census, 48.2% of inhabitants had no central or individual heating systems (Ajuntament de Barcelona, 2001). Moreover, the risk of harm is greater

at lower temperatures, but also during longer periods of exposure to cold indoor temperatures. This could explain the stronger association between EP and cardiovascular and respiratory diseases that we found in women. Due to the sexual division of work, women still bear the brunt of the burden of care and housework, tasks that are energy intensive and involve spending more time at home, whereas men spend much more time in activities outside the home. This could play a particularly important role in southern European countries, which are characterised by traditional family models and low levels of support for female participation in the labour force (Artazcoz et al., 2016).

Furthermore, cardiovascular and respiratory problems have also been linked to warm temperatures (Oudin Åström et al., 2011). According to the data in this study, 12.1% of the women and 10.1% of the men living in Barcelona could not afford to maintain their dwelling at an adequate temperature during the warm months. In addition, 52.4% of the women and 50.4% of the men did not have air conditioning or did not use it when needed (data not shown). This finding is consistent with a European study showing that, although countries in southern Europe have the highest rates of air conditioning, they had higher percentages of the population living in a dwelling that was not comfortably cool during summertime (Thomson et al., 2019). We believe that the association between EP and cardiovascular and respiratory diseases in Barcelona is also influenced by the high vulnerability of households to heat. This can be especially critical in the context of extreme heat events, which are expected to become more common, more severe and longer-lasting due to climate change (Jessel et al., 2019).

Previous studies have shown that EP can exacerbate existing conditions (Marmot Review Team, 2011). In this study, we found a higher prevalence of arthrosis, arthritis or rheumatism, allergies, and migraine or frequent headaches in women and men living in EP. Although this is a cross-sectional study and we cannot assess changes over time, those are all conditions that can remain stable, but can be triggered by cold, heat, damp, mould or stress, common situations in energy poor households. In people living in EP, these conditions may become more common and therefore more frequently self-reported as chronic morbidity.

EP has also been linked to food insecurity, due to the constant dilemma of resource allocation and difficulties in conserving and cooking food (Hernández, 2016; Nord & Kantor, 2006). In the case of Barcelona, data from the 2016 health survey reveal that 35.9% of people with EP experienced food insecurity compared with 4.9% of people without EP (data not shown). Dietary impoverishment and higher consumption of cheap calorific food could explain the greater overweight found in women and men with EP, as well as the higher prevalence of diabetes in energy poor people. The cases of diabetes identified in the survey concerned mainly people with type 2 diabetes, which is usually acquired in adulthood and due to overweight and sedentariness.

As in previous studies, we found an association between EP and domestic injuries, although this finding was statistically significant only in men. It is known that strength and dexterity decrease as temperatures drop, increasing the risk of unintentional injuries (Marmot Review Team, 2011). As well as cold temperatures, both heat and lack of light increase the risk of falls in the elderly (Marmot Review Team, 2011). In addition, people with EP sometimes have to use less safe energy sources or to adapt some consumption behaviours that may also be less safe and increase the risk of domestic injuries. Some examples are cooking with a portable gas stove, heating water for the bath in the kitchen, restricting the use of lights or using candles to light the home, or even irregularly connect to the electricity grid. In Barcelona, firemen have been involved in detecting households experiencing energy poverty since 2017 and have introduced indicators in their regular reports to identify risk situations. In the last 2.5 years, there have been reports of 1100 cases (ara.cat, 2020).

There is little evidence of the effects of EP on the use of health services. Some studies have reported increased emergency respiratory hospital episodes among people with EP aged 65 years and older (Rudge & Gilchrist, 2007) and an increased likelihood of physician visits in people experiencing difficulties in paying fuel bills (Gilbertson et al., 2012). Our study adds new and relevant evidence. The results demonstrate that people with EP more frequently use general health services, such as emergency services, primary health care, nursing and hospitalisations, as well as specialised mental health services. This is consistent with the strong association found between EP and poor mental health. Our study also reveals a higher contact with social workers in people with EP. In the Catalan health system, social workers liaise between health and social services. One of the many tasks of social services is to issue residential exclusion risk reports. These reports prevent suppliers from cutting off water, electricity or gas due to non-payment due to lack of financial resources, as prescribed by the 24/2015 Catalan law of urgent measures to tackle housing and energy poverty emergencies, published on July 29, 2015.

This study also found significantly higher medication use in people living in EP. The importance of this result is that questions about medication use in the 2 days prior to the survey can sometimes be a proxy of acute medical processes. The observed increase in the use of antibiotics and other drugs such as painkillers and asthma medication supports the results of other studies demonstrating that people living in EP are more at risk of infections and minor illnesses such as colds, as well as of experiencing decompensations of their chronic diseases (Marmot Review Team, 2011). A notable finding of the present study was the high medication use in people living in EP. In the 2 days prior to the survey, 31.6% of the women and 19.7% of the men with EP had used psychotropic drugs, while for painkillers these percentages increased to 51.5% in women and 45.7% in men.

A final point is that EP can increase existing health inequalities. This study demonstrates that, as with other material resources, access to domestic energy services and adequate energy levels differ by several axes of inequality such as sex, social class, age and region of birth, reducing the opportunities for good health. According to the data in this study, women without EP generally have worse health outcomes than men without EP. This gender gap is further exacerbated among women and men experiencing EP. Furthermore, some social groups may be particularly vulnerable to EP, such as people with no alternative but to become squatters (an increasing problem in Barcelona) or children. This groups are not represented in this study and further research should try to include data from these invisibilized groups.

4.3. Methodological considerations, strengths and limitations

EP is a complex multidimensional phenomenon caused by multiple factors that interact with each other and configure different realities. EP can be considered as part of a set of widely heterogeneous emerging situations of inequality and precariousness that go beyond the traditional framework of poverty (Subirats et al., 2005). There is growing concern that income-based poverty indicators are ineffective at identifying population groups that are most at risk of being unable to meet their basic needs. A good alternative may be material hardship indicators, such as those of EP (Beverly, 2001). However, even though EP cannot be explained by income poverty alone, income remains one of its main causes and is also strongly related to health status; consequently, it can act as a confounder in the association between EP and health. In this study, we used social class as a proxy of socioeconomic position and adjusted the models by this single variable of socioeconomic position. We saw how EP is still associated with worse health and higher use of healthcare and medication, independently of social class. Even so, a single measure of socioeconomic position cannot capture the entirety of its effect on health (Galobardes et al., 2006) and there probably remains an unexplained aspect of the association found between EP and health and healthcare and medication use. To ensure that income is not the only EP driver that explains the association found between EP and negative health outcomes, we conducted a sensitivity analysis and repeated all analyses in a subgroup of people with greater financial difficulties, identified through their self-reported inability to meet an

unforeseen expenditure of €750 with their own resources. The analysis showed how EP disproportionately affects low-income households, increasing the percentage of people living in EP in this subgroup to almost 40% (S1). We observed that, in general the association between EP and the studied health indicators decreased slightly, in some cases losing its statistical significance, but the PAR% increased (S2–S3). By contrast, we did not adjust the final models by country of birth because, although people born in LMI experienced much more EP, this result did not modify the association with health status and the use of healthcare and medication.

Studying EP as a distinct condition of deprivation has clear advantages. On the one hand, it helps to identify the more structural and systemic factors that go beyond low-income, such as an inefficient and substandard housing stock and the unfair and abusive energy models (Middlemiss & Simcock, 2019). On the other hand, it can be used to allow better understanding of the circumstances and mechanisms through which it affects health. In this study, we aimed to study health effects separately in households that could not afford to maintain their dwellings at an adequate temperature during the cold months and in those that could not do so during the warm months. We finally analysed these groups together because we found an overlap in 68% of the cases. This indicates that, although It is true that cold and hot homes are 2 different manifestations of EP that can affect health through distinct mechanisms, they share many of the root causes such as low energy efficiency of dwellings or high energy prices. Therefore, the interventions needed to address the difficulty of keeping the home at an adequate temperature are the same.

This study analysed the effects of EP on health and healthcare and medication use in Barcelona, a southern European urban setting. Although Southern European countries share many similarities in the structural determinants of EP (Recalde et al., 2019), other factors may affect the extrapolation of EP health implications to similar settings. The results may also not apply to rural contexts, as there are substantial differences between urban and rural contexts. For example, in cities, the heat island effect and a physical context with less green space can aggravate the effects of EP in the warmer months, while in some rural areas, winters are colder, while larger and isolated houses can be more difficult to keep at an adequate temperature. There is a need to gain deeper insight into how EP and its effects on health are embedded in the rural contexts of southern Europe. However, urban spaces and global cities like Barcelona are privileged settings for studying complex realities and implementing and evaluating innovative and comprehensive interventions.

Finally, is should be notice that this is a cross-sectional study and therefore does not allow us to prove causality or rule out reverse causality. Nevertheless, one of the main strengths of this study is that the inclusion of questions about EP in a population-based health survey allowed us to study the association of EP with multiple indicators of health status and use of health services and medication. Although some of the indicators could be related to each other and this has not been studied in depth, the inclusion of all these indicators allows us to state more robustly that EP is associated with poorer health and to quantify the strength of this association. Moreover, the results obtained in this study are representative at the city level. Thus, we were able to estimate the burden of poor health and health services use made on the city by EP.

5. Conclusions

EP is also a major public health problem in Barcelona, a southern European urban context. This study observed a high prevalence of EP and a strong association between EP and worse health status and higher use of health services and medication. Underprivileged social groups, such as people from disadvantaged social classes, people born in LMI countries and older women, suffered disproportionately from EP, which can be one of the mechanisms explaining health inequalities. Southern European countries should therefore include EP in their political priorities to address the structural causes of this public health problem and minimise its unfair and avoidable health effects.

Declarations of interest

None.

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Ethical statement

The authors declare no conflict of interest.

This paper has not previously been published and no similar paper is in press or under review elsewhere.

All authors meet authorship criteria and have contributed as specified below.

CRediT authorship contribution statement

Laura Oliveras: Conceptualization, Methodology, Formal analysis, Writing - original draft. **Lucia Artazcoz:** Conceptualization, Methodology, Writing - review & editing. **Carme Borrell:** Conceptualization, Methodology, Writing - review & editing. **Laia Palència:** Conceptualization, Methodology, Writing - review & editing. **María José López:** Conceptualization, Methodology, Writing - review & editing. **Mercè Gotsens:** Conceptualization, Methodology, Writing - review & editing. **Andrés Peralta:** Conceptualization, Methodology, Writing - review & editing. **Marc Marí-Dell'Olmo:** Conceptualization, Methodology, Writing - review & editing, Supervision.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2020.100665.

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