The effect of fuel poverty on health care use: evidence from France

Rosy Fares[*‡]

[*] Univ. Grenoble Alpes, CNRS, INRAE, Grenoble INP, GAEL, 38000 Grenoble, France

[‡] Corresponding author. E-mail address: rosy.fares@univ-grenoble-alpes.fr

Abstract

Using the number of uses of different health services (such as visit to a general practitioner, visit to a specialist, pharmacy purchase, hospitalizations, laboratory analyses), this paper aims to study the relationship between fuel poverty and health status, while controlling for health care renunciation. A Zero-Inflated Negative Binomial is estimated after taking the endogeneity problem of fuel poverty into consideration in a two-stage model. The results suggest that in our data, the higher the probability of being fuel poor, the lower the probability of non-use of health services. In addition, the higher the probability of a household to be in fuel poverty, the higher the number of health care uses. This could mean that those who are in fuel poverty have a lower health status.

Keywords:

Fuel poverty; health services; health care renunciation; Zero-Inflated Negative Binomial

1- Introduction:

Fuel poverty have been a serious preoccupation in economic research since the 1970s, especially in the United Kingdom, and soon became more known in different regions of the world. Although no unique and clear definition was internationally used, fuel poverty was known as the inability to afford adequate warmth in a dwelling (Bradshaw and Hutton, 1983) (Markus, 2005).

France was one of the few countries to set a definition to fuel poverty. According to the Grenelle 2 French law (2010), a person is in fuel poverty if he "has particular difficulties in his accommodation having access to the energy supply necessary for the satisfaction of his basic needs due to the inadequacy of his resources or his living conditions". This definition has the advantage of emphasizing the discomfort that this situation generates and of specifying the causes. Low income, poor thermal performance of housing or increased energy costs are the main causes of the classification of households in fuel poverty. The combination of several of these factors makes the situation more extreme and makes the consequences more serious.

The literature mainly focused so far on measuring fuel poverty using different methods: from proposing new methods (Broadman, 1991) (Hills, 2011), to comparing the use of different measures (Owen, 2010) (Waddams Price et al., 2012) (Liddell et al., 2012), in order to be able to captivate its vague definition as much as possible.

Identifying households in fuel poverty was also an interest of the literature. (Boardman, 2013) described the social characteristics of English fuel poor households in 2006. They are vulnerable households with low income (lowest 30%). They are more likely to be household on means-tested benefit, disability living allowance or tax credit in addition to being a tenant. They are also more likely to be single parents, with kids under 16 years old, or with at least a person over 60.

Charlier et al. (2015) and Legendre and Ricci (2015) seek to identify the profile of French households in fuel poverty using different measurement methods of this phenomenon. The use of different indicators brings together the effects of fuel poverty on different axes of daily life, which makes it possible to identify its multidimensional aspect. Both studies prove that the households in fuel poverty are characterized by a very low income (total income three times lower than that of non-precarious people according to monetary indicators), a higher probability of being unemployed and being a tenant. The homes of energy insecure people are most often old and in poor thermal conditions. They also show, using different indicators, that the most vulnerable people have individual heating systems and they declare feeling cold during the winter and adapting self-deprivation behaviors to lower energy costs.

Being in fuel poverty can have negative effects in terms of social integration, thermal comfort, financial situation and many other aspects of the daily life (Hills, 2011). More serious than that, fuel poverty can affect the level of health of individuals; it may be a cause of physical or mental illness (Atanasiu et al., 2014). Although this subject of the effect of fuel poverty on health is well established in the literature, it is not broadly treated in France. The existing French

literature, that we know of, measures health using objective and subjective methods, but they rely solely on the feeling of cold to identify households in the event of fuel poverty. For this reason, it is interesting to study this link using a different type of method: monetary indicators of fuel poverty. This choice of a monetary point of view of fuel poverty is interesting to study due to the fact that the health consequences could cause the rise of health expenditures of the household which worsen the burden of the already high housing expenditures.

Part of the literature is not directly interested in the effect of fuel poverty on health, but it brings together studies making the link between the quality of housing and the health of residents. Martin and Platt (1987) and then Platt et al. (1989) study the effect of living in housing affected by humidity and mold. These studies are carried out respectively in Edinburgh and in Edinburgh, Glasgow and London. The authors explain that a selection bias could be present during the data collection, caused by the investigators and the interviewees. When asking about the state of housing and health in the same survey, the inhabitants of the housing may tend to exaggerate on the prevalence of health problems and the poor quality of housing. In addition, the collection of housing and health information by the same investigator influences how locals report the truth. To avoid having a selection bias, these studies suggest having data collections on health and the quality of housing, from the same households, independently of each other. The first study resulted in a sample of 101 households and shows that there is no significant difference between the health status of people living in poor quality housing and the other individuals in the sample; but the difference becomes significantly negative if we focus on the children. Platt et al. (1989) build a sample of 1,220 households to see if the reduced sample size explains the results obtained previously. Significant differences in health were found between residents of homes with humidity and mold and residents of dry homes, in terms of nervous disorders, joint pain, nausea and vomiting, back pain, blocked nose, fainting, constipation and shortness of breath. The lower the quality of the accommodation, the more serious the effects.

Robić and Ančić (2018) use ordinary least squares models at the household level to explain mental, physical and general health by the characteristics of housing in Croatia. The results show that housing insulation has a positive effect on the various measures of the level of health of individuals, while visible mold in the housing has a negative effect. Using the same type of models but at an aggregated level, Atsalis et al. (2016) find that the higher the percentage of households in fuel poverty is, the higher is the mortality as well as the number of people with respiratory and cardiovascular diseases. On the other hand Hernández and Siegel (2019) use logit models and find an association between fuel poverty and physical and mental illnesses including asthma, pneumonia, depression and sleep disorders.

Work linking fuel poverty to health has emerged in the United Kingdom (Liddell and Morris, 2010) and some papers have dealt with this subject in other countries (Atsalis et al., 2016 ; Llorca et al., 2020 ; Hernández and Siegel, 2019) including France (Lacroix and Chaton, 2015 ; Lacroix and Jusot, 2017). Very similar results were found in different studies; fuel poverty has negative effects on the health of individuals. Children's physical health is affected mainly in terms of respiratory illness, weight gain and the likelihood of illness, while mental health is most affected for adults (Liddell and Morris, 2010).

Atsalis et al. (2016), Llorca et al. (2020), and Hernández and Siegel, (2019), address this subject respectively in Greece, Spain, and the United States. Robić and Ančić (2018) and Llorca et al. (2020) use subjective measures of health; the feeling of the household on its state of health. Atsalis et al. (2016) approximate the state of public health by the number of deaths, cardiovascular and respiratory diseases, while Hernández and Siegel (2019) use another approach; they assess the health of each person by checking whether they are affected by physical and mental illnesses and accidents.

Different methods of measuring fuel poverty have been used; Hernández and Siegel (2019) is based on an objective measure (the reception of a power outage notice, use of the stove for heating, restriction of heating caused by costs and inability to pay for energy services) while Atsalis et al. (2016) and Llorca et al. (2020) use a combination of subjective and objective measures based on household declarations and energy expenditure.

Llorca et al. (2020) use an ordered probit with latent classes; this model made it possible to distinguish two classes of individuals. People in the first class tend to self-assess as being in fuel poverty and have, on average, a lower level of health than others. An increase in the (objective) level of fuel poverty of individuals in this class has a negligible effect on their health assessment. The same type of increase has a negative and significant effect on second-class individuals (who do not report having difficulty heating their accommodation during winter).

Recently, researchers have been interested in the link between fuel poverty and health in France. Lacroix and Chaton (2015) and Lacroix and Jusot (2017) use data from the 2010 “Survey on Health and Social Protection” to study the impact of fuel poverty on health status. These data provide a non-objective measure of fuel poverty based on the sensation of thermal discomfort (cold). Lacroix and Chaton (2015) use a subjective indicator of health status (level of health declared by each individual). They apply a Probit model to explain the probability of declaring poor health using energy poverty, socio-economic characteristics, physical health indicators (chronic diseases) and housing characteristics. The results of this article show that being in fuel poverty significantly increases the probability of reporting poor health by 2.36 percentage points. The absence of long-term and chronic illnesses reduces the probability of reporting poor health by 5.53 and 9.32 percentage points, respectively, all other things being equal. Lacroix and Jusot (2017) use three health indicators: a subjective indicator of general health and two objective indicators of physical (long-term illnesses) and mental health (score of the 5 questions on the mental state of "Short Form-36”). A Probit model for each health indicator is estimated, in the first step, without taking into account the correlation that there may be between health indicators and the measurement of fuel poverty. In these models, each health indicator is explained by fuel poverty and socio-economic characteristics. To correct the endogeneity problem, potentially caused by the individual sensation of unmeasurable cold, three recursive bivariate Probit models are implemented. The results of this study are consistent with what was found previously; fuel poverty has a negative and significant effect on health. After correcting the endogeneity problem, being in fuel poverty increases the probability of reporting poor health by 36.6 percentage points. Precarious people also have a 16 percentage point higher probability of having chronic illness and a 13 percentage point higher probability of having poor mental health compared to non-precarious people, all other things being equal.

In order to accomplish this study, the following section will be dedicated to present the data used, which is the 2011 French survey on family budget. We will be interested in finding households in fuel poverty and the number of times they seek health services. The second section will explain the econometric model used: the two-stage zero inflated negative binomial model. This model is appropriate for count data and it will allow to check for renunciation of health services behavior. After that, a section will be presenting the results of this study before concluding.

2- Data:

The aim of this study is to establish a link between health and fuel poverty using monetary indicator to identify household in fuel poverty. The INSEE's 2011 French survey on family budget (budget des familles) is the last survey available to the public and it is used in this study. This database is constituted from 15 797 French households, 307 of which are deleted for lack of information or negative revenues.

The survey used was conducted on six two-months waves, starting October 2010 and ending on November 2011. The households are equally divided on all these waves. Information on the household's income and the way it spends this money on different needs are available. Indeed, information on housing costs, equipment acquired, health expenditures, transportation fees and many other household spendings.

2.1- Fuel poverty indicators:

We use monetary indicators to identify households in a fuel poverty situation. This choice is supported by the fact that monetary based indicators are objective and they allow easier comparisons between the households and between this study and others. Although this type of indicators has its advantages and is easier to adapt to the data used in this study, it does not take into account the subjective side of fuel poverty. In other word, fuel poverty is primarily based on the thermal discomfort of the residents, which cannot be represented in a monetary indicator.

The first indicator used is the energy effort rate. This indicator, first used by the British in 1988, measures the share of a household's income dedicated to housing energy. Households are considered fuel poor if this share is greater than twice the median of the national heating cost, which sets the threshold at 10%.

The "Low Income, High Expenses" (BRDE) is also a monetary indicator of fuel poverty; It was developed by the National Observatory for Energy Precariousness (ONPE) from the work of Hills. To be considered in an energy poverty situation according to the BRDE, a household must satisfy two criteria. First, the household must have an energy expenditure (reported either on the surface of the housing, or the number of consumption units) greater than the national median. Second, the disposable income per consumption unit, after deduction of housing costs (excluding energy costs), must be less than 60% of the median of disposable income after deduction of housing costs and energy expenditure per consumption unit.

A binary variable is created for each type of measure of fuel poverty; they take the value 1 if the household checks the conditions set by each of the definitions of the measurement methods, otherwise these variables take the value 0.

2.2- Health indicators:

The data available does not allow to have precise and direct information about the health situation of each individual. It can however provide information on a household level about by

the number of times a health service was sought during the two months preceding the survey. The indicators used are: the number of visits to a general practitioner and a specialist, the number of purchases in a pharmacy, the number of hospitalizations and analyses in the laboratory in the two months preceding the survey.

As for the fuel poverty indicators, the health indicators also have the advantage of being objective measures. However, they are at the household level which gives an inaccurate indication of the effect of fuel poverty on each person's health. This disadvantage could become problematic because the higher the number of people in a single household, the higher the number of health services seeking without necessarily meaning that the individuals have a bad health.

2.3- Statistical analysis:

A set of variables are used in this study. They are represented and explained in table 1.

Variable	Definition
Household construction	
Portion of the household in each age range	Is equal to the number of individuals in each age range reported to the number of individuals of the household
Socio-Professional Category of the household's person of reference	Is equal to 1 if the Socio-Professional Category is the one of the household's person of reference, 0 otherwise
Single parent household	Is equal to 1 if it is a single parent household, 0 otherwise
Financial situation	
Revenue	Is equal to the revenue of the household in the last year
Financially weak	Is equal to 1 if the household evaluates itself as financially weak, 0 otherwise
Housing	
Year of construction	Is equal to the year range during which the dwelling was constructed
Individual house	Is equal to 1 if the dwelling is an individual house, 0 otherwise
Owner of the house	Is equal to 1 if the household is the owner of the dwelling, 0 otherwise
Isolation work (in the last year)	Is equal to 1 if the dwelling had isolation work in the last year, 0 otherwise
Would spend more on the dwelling	Is equal to 1 if, given more money, the household would spend it on the dwelling, 0 otherwise
Health related information	
CMU	Is equal to 1 if the household benefits from the CMU (Couverture Maladie Universelle), a medical insurance for the financially poor, 0 otherwise

Would spend more on health	Is equal to 1 if, given more money, the household would spend it on health, 0 otherwise
Respiratory device	Is equal to 1 if the household has rented or bought a respiratory device in the last year, 0 otherwise
Fuel Poverty using different indicators	
Energy Effort Rate (>10%)	Is equal to 1 if the household is fuel poor according to the 10% indicator, 0 otherwise
Low Income, High Costs	Is equal to 1 if the household is fuel poor according to the Low Income, High Costs indicator, 0 otherwise
Health	
Number of health services uses (2 months preceding the survey)	Is equal to the number of visits to each health service (set to max 20 by the survey)
Health expenditures	Is equal to the amount paid by the household for health services

Table 1: *Variables description.*

Table 2 presents descriptive statistics about the 15 490 households in the database. Most of the results of this table are close to the numbers given by the INSEE's 2011 census of the population. However, the data used in this study shows an under representation of the households whose person of reference is a worker and an over representation of the households whose person of reference is a retired.

The average household is constituted of almost 11% of kids under 14 years old, 17.34% of individuals aged between 15 and 29 years. 30 to 39 year-old adults represent 11.5% of the average household, those aged between 40 and 49 represent 12.38% and those who are between 50 and 59 years old constitute 15.09%. Individuals aged 60 years old or more represent the rest of the households (32.72%). Women constitute 53.29% of the average household. 8.31% of the households presented in this data are composed of a single parent with kids. The socio-economic category of the household's person of reference is also presented in table 1. Households with a retired person of reference are the most present in this sample (31.92%). Even though this category is the also the most present in the population, the percentage is over estimated (24.4% according to the numbers of INSEE). On average, a household makes almost 34 000 euros, and 61.16% of the household do not think of themselves as being at financial ease.

Information about the housing condition of each household is important because they have an effect on being in fuel poverty. A little over half of the households (56.13%) live in individual houses, and 54.56% own their homes. Very few households (1.76%) did isolation work to their dwelling during the year preceding the survey. 17.58% of the households, if given more money, would spend them on their homes. 24.68% live in very old homes (built before 1948), while 12.14% live in very recently built homes (after 2004).

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Household construction					
Portion of the household in each age range					
Under 14	15 490	0.1094	0.19	0	0.88
15 to 29	15 490	0.1734	0.31	0	1
30 to 39	15 490	0.1150	0.25	0	1
40 to 49	15 490	0.1238	0.26	0	1
50 to 59	15 490	0.1509	0.31	0	1
More than 60	15 490	0.3272	0.45	0	1
Portion of women	15 490	0.5329	0.32	0	1
Socio-Professional Category of the household's person of reference					
Farmers	15 490	0.0119	0.11	0	1
Craftsmen, traders and entrepreneurs	15 490	0.0446	0.20	0	1
Higher intellectual professions	15 490	0.1170	0.32	0	1
Intermediate professions	15 490	0.1560	0.36	0	1
Employees	15 490	0.1381	0.34	0	1
Workers	15 490	0.1507	0.36	0	1
Retired	15 490	0.3192	0.46	0	1
Unemployed	15 490	0.0622	0.24	0	1
Single parent household	15 490	0.0831	0.27	0	1
Financial situation					
Revenue	15 490	34 363.04	31 023.1	0	1 807 632
Financially weak	15 490	0.6116	0.49	0	1
Housing					
Year of construction					
Before 1948	15 490	0.2468	0.43	0	1
1949 – 1974	15 490	0.2717	0.44	0	1
1975 – 2003	15 490	0.3599	0.48	0	1
After 2004	15 490	0.1214	0.32	0	1
Individual house	15 490	0.5613	0.49	0	1
Owner of the house	15 490	0.5456	0.49	0	1
Isolation work (in the last year)	15 490	0.0176	0.13	0	1
Would spend more on the dwelling	15 490	0.1758	0.38	0	1
Health related information					
CMU	15 490	0.0349	0.18	0	1
Would spend more on health	15 490	0.0360	0.18	0	1
Respiratory device	15 490	0.0241	0.15	0	1
Fuel Poverty using different indicators					
Energy Effort Rate (>10%)	15 490	0.0654	0.24	0	1
Low Income, High Costs	15 490	0.0599	0.23	0	1
Health					
Number of health services uses (2 months preceding the survey)					
General practitioner	15 490	1.4244	1.76	0	20
Specialist	15 490	0.9304	2.06	0	20
Pharmacy purchases	15 490	1.9774	2.08	0	20
Hospitalizations	15 490	0.3396	1.08	0	20
Laboratory analyses	15 490	0.5502	1.13	0	20
Health expenditures	15 490	106.23	260.31	0	10 268

Table 2 : *Descriptive statistics of the sample.*
Source: Budget des Familles Survey, final sample, author calculation.

Knowing that the health in this study is measured with the number of health services used during the two months preceding the survey, it is important to check for variables that can influence these numbers. 3.49% of the sample are affiliated to the CMU and 3.6% would spend more on health if they were given more money. As shown by the literature (Liddell and Morris, 2010), fuel poverty increases the risk of being affected of respiratory diseases, which is why a variable showing if the household have bought or rented a respiratory device during the last year is presented. This variable shows that 2.41% of the households have acquired a respiratory device.

According to the energy effort rate indicator, 6.54% of the households are in a fuel poverty situation while the low income, high costs indicates 5.99% of the households are in fuel poverty. The ONPE indicates that, according to the French National Housing Survey of 2006, 14.4% of the household are identified as fuel poor by the energy effort rate indicator, while it is 10.3% if the low income, high costs indicator was used (Nolay, 2014).

Health indicators used in this study are count variables indicating the number of uses of health services. On average a household visited a general practitioner 1.42 times during the last two months and visited a specialist 0.93 times, the number of purchases in a pharmacy is 1.97 times, the number of hospitalizations is 0.33 and the number of analyses in the laboratory is 0.55 times. The amount payed for health services is on average 106 euros.

	Fuel Poor 10% indicator		**Non-Fuel Poor 10% indicator**	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Household construction				
Portion of the household in each age range				
Under 14	0.0503	0.14	0.1136	0.20
15 to 29	0.1170	0.28	0.1773	0.31
30 to 39	0.0631	0.21	0.1187	0.25
40 to 49	0.0714	0.21	0.1275	0.25
50 to 59	0.1484	0.32	0.1511	0.31
More than 60	0.5495	0.48	0.3116	0.44
Portion of women	0.6457	0.38	0.5251	0.32
Socio-Professional Category of the household's person of reference				
Farmers	0.0283	0.16	0.0107	0.10
Craftsmen, traders and entrepreneurs	0.0702	0.25	0.0428	0.20
Higher intellectual professions	0.0275	0.16	0.1232	0.32
Intermediate professions	0.0515	0.22	0.1634	0.36
Employees	0.0854	0.27	0.1418	0.34
Workers	0.0657	0.24	0.1566	0.36
Retired	0.5139	0.50	0.3055	0.46
Unemployed	0.1571	0.36	0.0556	0.23
Single parent household	0.0837	0.27	0.0830	0.32
Financial situation				
Revenue	13 635.06	8 240.21	35 815.33	31 510.42
Financially weak	0.7727	0.41	0.6003	0.49
Housing				

Year of construction				
Before 1948	0.3994	0.49	0.2361	0.42
1949 – 1974	0.3176	0.46	0.2685	0.44
1975 – 2003	0.2126	0.40	0.3703	0.48
After 2004	0.0701	0.25	0.1250	0.33
Individual house	0.7632	0.42	0.5472	0.49
Owner of the house	0.6109	0.48	0.5410	0.49
Isolation work (in the last year)	0.0142	0.11	0.0178	0.13
Would spend more on the dwelling	0.1759	0.38	0.1758	0.38
Health related information				
CMU	0.0655	0.24	0.0327	0.17
Would spend more on health	0.0668	0.24	0.0338	0.18
Respiratory device	0.0291	0.16	0.0238	0.15
Number of observations	897		14 593	

Table 3: *Descriptive statistics for fuel poor and non-fuel poor households.*
Source: Budget des Familles Survey, fuel poor and non-fuel poor samples, author calculation

For the rest of the study, the fuel poverty indicator taken into consideration is the energy effort rate. Dividing the sample into two separate samples, fuel poor and non-fuel poor households (table 3), can help create a profile for each type of households. It also allows comparison between the two categories and a comparison to the original sample.

The non-fuel poor households have characteristics similar to the results shown for the whole sample. This is not the case for the fuel poor households.

Every share of each age range is under-represented in fuel poor households, except for the part of the individuals aged more than 60 years; this share is 54.95% compared to the 32.72% represented in the original sample. In addition, the socio-economic category of the household's person of reference is more likely to be farmer, craftsman, trader or entrepreneur, retired or unemployed than the average of the population.

The average income of a household in fuel poverty is 13 635 euros per year. This amount is way under the whole sample average. This lower income is one of the main reasons a household is considered fuel poor. Having such a big difference in income with the rest of the households could also explain the higher self-evaluation of being financially weak and the higher average of being affiliated to the CMU.

The average of homes, of fuel poor households, constructed before 1974 is higher than the rest of the sample. These homes are very old and were constructed before the first thermal regulation in France. This could cause the dwelling to have poor thermal performance, which is another cause of fuel poverty. In addition, fuel poor household, on average, are more home-owners and live in individual houses.

A high of 6.68% of fuel poor households would want to spend more on their health if they were given more money, compared to the 3.38% of non-fuel poor households. This suggests that fuel poverty could be causing individuals to have a worst health situation. For this reason, it is

important to check the difference in health outcomes between households in fuel poverty and those who are not.

Variable	Mean Fuel Poor	Mean Non-Fuel Poor	ttest
Number of health services uses (2 months preceding the survey)			
General practitioner	1.1948	1.4405	***
Specialist	0.7127	0.9456	***
Pharmacy purchases	1.5921	2.0045	***
Hospitalizations	0.2781	0.3439	**
Laboratory analyses	0.5228	0.5522	
Health expenditures	69.60	108.80	***
Share of health expenditures	0.1634	0.0242	***

*** significative at 1% ** significative at 5% * significative at 10%

Table 4: *Difference in health variables due to fuel poverty*
Source: Budget des Familles Survey, final sample, author calculation

These significant differences between health care services used during the last two months and the share of the income dedicated to health expenditures of fuel poor and non-fuel poor households (table 4) suggest the presence of a behavior of renunciation of health services for financial reasons.

For further studying of the effect of fuel poverty on health, especially health services seeking or renunciation, it is necessary to conduct an econometric analysis that would take into consideration the count data and the possibility of having a privation behavior.

3- Econometric analysis:

The statistical analysis shows that households identified to be in fuel poverty are less likely to seek medical help. An econometric study is necessary to see to what extent fuel poverty (identified by the energy effort rate) has an impact on the number of visits to a general practitioner and a specialist, on the number of hospitalizations and analyzes in the laboratory and on the number of purchases in a pharmacy.

This model should be appropriate to count data (the dependent variables) and should take into consideration the possibility of having a renunciation effect.

3.1- Econometric issues:

Endogeneity problem:

We suspect that an endogeneity problem will be present, due to the fact that this model will be explaining the number of health care uses by being in fuel poverty.

Two sources of endogeneity are expected in these models. On the one hand, a problem of correlation between some explanatory variables and the error term might be present. Indeed, many variables are absent from the data, yet they can affect the level of health; for example, the presence of moisture or mold in the dwelling cannot be controlled in this study but it can have an effect on being fuel poor. On the other hand, an endogeneity problem could be caused by simultaneity. People in fuel poverty can see their health deteriorate, thus worsening household precariousness, either as a result of the greater weight of health expenditure in their budget or the consequences of degraded health on the labor market.

This endogeneity problem can be fixed by using an instrumental approach. This variable should be correlated to the endogenous variable while being uncorrelated to the dependent variable. Energy price can serve as a good instrument in this case; it has an effect on being in fuel poverty, but it should not affect the number of uses of treatment seeking. While information on energy prices cannot be found in the family budget database, this information can be approximated by the share of electricity in energy expenditures (amount of electricity bill / amount of bills payed to all energy sources). This variable can be used because it is correlated to fuel poverty while still uncorrelated to health.

Health services renunciation:

Health services renunciation as defined by the literature (Després et al., 2010 ; Warin, 2014) is the identification of a need to seek a health service that was not satisfied. In other words, a person does not receive a health service that his health situation requires. The statistical analysis showing that fuel poor households are less likely to seek a health service raise suspicion on the

possibility of having a renunciation behavior. Information about health needs are not available in the data used. For this reason, in order to study the health service renunciation, the characteristics of households who adopt a renunciation behavior, should be considered in order to see their effect on health services seeking.

Warin (2014) show that women are more likely to make renunciation, in addition to individuals aged between 40 and 59, individuals living alone or alone with children, farmers and unemployed individuals. Financially supporting a family member (most often parents or grandparents), or being financially supported by a family member (most often kids) and being precarious are often causes of health services renunciation.

Després et al. (2010) add to these information, that individuals covered by the CMU (couverture maladie universelle) are more likely to commit health service renunciation. This paper also indicates that the precarious situation of a household in the past, present and future, have an impact on the renunciation. they identify 9 dimensions of precariousness:
- experiences of difficulties during life: financial difficulties, periods of unemployment, periods of isolation and periods of absence of fixed accommodation.
- present situation (during the last 12 months): financial difficulties, suffered for part-time job, unemployment.
- perception of the future (upcoming year): fear of losing job and fear of being financially unsupported.

The characteristics, identified by the literature, of households who adopt renunciation to health services behavior should be added to check if this phenomenon is present in this study.

3.2- Econometric model:

Zero-Inflated Negative Binomial (ZINB) model:

To be able to take the excessive presence of zeros in the dependent variable into account as well as separating the causes of these zeroes between lack of need and renunciation, an adapted model should be applied. This model should be able to make a difference between the causes of declaring not seeking a health service during the two previous months. As seen by the section above, we have a doubt that fuel poor households are adapting renunciation behavior. Although this could be a possibility, we also cannot deny the fact that the source of zeros in this case could be explained by the lack of need. The “Zero-Inflated Negative Binomial” (ZINB) shows for an endogenous variable, the presence of an event or not (seeking a health service). If the event did not happen, a value of zero is given to the endogenous variable. This type of models was used, in the literature, to discuss problematics like adolescent marijuana use and school truancy (Roebuck et al., 2004) and public expenditures and number of Olympic medals won (Blais-Morisset et al., 2015). Applications in the field of insurance could be found, for instance car insurance and number of declared accidents (Vasechko et al., 2009). This study aims to explain the number of car accidents declared by a person to its insurer, with an extra attention given to those who declare not having any accidents over a certain period of time. Knowing

that clients could be lying about not having any accidents, a ZINB model is used in this study to differentiate between those who actually did not have any accidents and those who are hiding the fact that they have had.

The ZINB model is used for a counting dependent variable; the number of health services used. This variable takes a value of zero if the individual did not use a health service, or a positive value. The population of individuals with zero in their dependent variable is divided into two categories:

- Those who needed to seek a health service but did not, mainly for financial reasons.
- Those who did not seek a health service because they did not need to. This part of the population could be present because the dependent variable is measured in the two months preceding the data collection.

The distinction between these two types of individuals is interesting to our study, because it will help identify the population that prevents itself from seeking a health service, and then see the impact of fuel poverty on this behavior.

The ZINB model is a two-part model:

- The counting model: this part takes into consideration the number of uses of health services, for those who have declared seeking health services in the last two months.
- The zero-inflated model: a logit model that explains the probability of a non-declaration.

An additional step is required to solve the endogeneity problem, which makes it a two-stage model, with a ZINB model in the second stage.

The first stage of this model is dedicated to estimate the probability of being in fuel poverty. Being in fuel poverty in this case is explained, using a logit model, by variables describing the household's construction (portion of the household in different age ranges, portion of women in the household, the socio-professional category of the person of reference), and socioeconomic situation (household describing itself as financially weak), and by variables describing the dwelling (range of year of construction, individual house, the household is the owner and occupant of the dwelling), in addition to the instrumental variable: the share of electricity expenditures in the whole energy expenditures of the household. Using this model, the probability of being in fuel poverty is predicted and used in the second stage (the ZINB model).

The ZINB is separated into a negative binomial model that explains the number of uses of each health care service and an inflation model that explains the probability of non-use of these services. The negative binomial model contains variables describing the household's construction and socioeconomic situation (portion of the household in different age ranges, portion of women in the household, the socio-professional category of the person of reference, single parent household, household describing itself as financially weak) and variables related to access to health services (the household benefits from the CMU, the household would spend more on health if given more money, the household bought or rented a respiratory device during

the last year). In addition, variables describing the dwelling are represented because, according to the literature the poor dwelling quality is a cause to different diseases (range of year of construction, individual house, the household is the owner and occupant of the dwelling, isolation work done in the household during the last year). A variable controlling if the household was interviewed during winter (December to March) is present to control the seasonal effect on excess use of health services.

The inflation model contains variables indicating the profile of households that, according to the literature, adopt health services renunciation. according to the literature, individuals aged between 40 and 59 are more likely to adopt health services renunciation in addition to women, farmers or unemployed, single parents (Warin, 2014). Households who are financially weak, or risk to be financially weak in the near future are also more likely to deny health services when in need as well as those who are CMU adherents (Després et al., 2010). The literature also notes that those who are financially supporting a parent or being supported by a kid tend to adopt renunciation behavior (Warin, 2014), which explains the reason these variables are added. The prediction of the probability of being fuel poor is present, because we want to check if fuel poor households have this kind of behavior.

We suppose that the variable Y is a combination of a binary law B and a negative binomial law Y*.

$$\boldsymbol{Y = BY^*}$$

B takes a value b_i=0 if the household i did not seek a health service, and it takes a values b_i=1 in the opposite case.

Y* refers to the negative binomial model that allows the prediction of the number of times each household used a health service; it predicts the value of Y in case bi=1.

In a negative binomial model, the probability of Y taking a value y_i:

$$\mathbf{P(Y = y_i \,|X_i)} = \frac{\boldsymbol{\Gamma(y_i + v)}}{\boldsymbol{\Gamma(y_i + 1)\Gamma(v)}} . \left(\frac{\boldsymbol{v}}{\boldsymbol{v + \lambda_i}}\right)^{\boldsymbol{v}} . \left(\frac{\boldsymbol{\lambda_i}}{\boldsymbol{v + \lambda_i}}\right)^{\boldsymbol{y_i}}$$

Considering $v = \frac{1}{\alpha}$,

$$\boldsymbol{E(y_i \,|X_i) = \lambda_i = e^{X_i'\beta}} \qquad \text{et} \qquad \boldsymbol{Var(y_i|X_i) = \lambda_i(1 + \alpha \lambda_i)}$$

Where α is an over dispersion parameter (if this parameter is equal to zero, the negative binomial model is not adequate anymore and a Poisson model should be used). λ_i indicates the frequency of health services use.

In a ZINB model, the probability Y taking a value y_i:

$$\mathbf{P(Y = y_i \,|X_i)} = \boldsymbol{q_i(1 - min\{y_i\,, 1\})} + \boldsymbol{(1 - q_i)} . \frac{\boldsymbol{\Gamma(y_i + v)}}{\boldsymbol{\Gamma(y_i + 1)\Gamma(v)}} . \left(\frac{\boldsymbol{v}}{\boldsymbol{v + \lambda_i}}\right)^{\boldsymbol{v}} . \left(\frac{\boldsymbol{\lambda_i}}{\boldsymbol{v + \lambda_i}}\right)^{\boldsymbol{y_i}}$$

for i = 0, 1, 2…

Where q_i indicates the probability of non-use of health services ($b_i = 0$).

The X_i vector contains the explanatory variables and a prediction of fuel poverty made by the following logit model in a previous step:

$$\mathbf{P}(\mathbf{FP} = \mathbf{1} \,|\boldsymbol{Z_i}) = \boldsymbol{G}(\boldsymbol{\beta_0} + \boldsymbol{Z\beta})$$

Where G is a logistic function.

4- Results:

The results of the first stage of the model are presented in table 4. It shows that, compared to the share of individuals aged above 60 years old, the bigger the share of any other age range, the lower the probability of being in fuel poverty. The results are significant at a 5% level for the share of individuals under 14 years old and individuals between 40 and 49 years old. The level of significance is 10% for the share of those aged between 30 and 39 years old and it is not significant for the other age ranges. In addition, the higher the portion of women in the household, the more it is likely to be in fuel poverty. The socioeconomic category of the household's person of reference affects the probability of being in fuel poverty. Households with a person of reference who is in a higher intellectual profession, an intermediate profession, who is an employee, a worker or retired, are significantly less likely to be in fuel poverty. Households who live in dwellings built before 1974 are more likely to be fuel poor compared to those who live in new dwellings (built after 2004).

The instrumental variable used: the share of electricity in the energy expenditure, in addition to the share of gas significantly affect the probability of being in fuel poverty. The more each of these shares rises, the more likely it is for the household to be in fuel poverty.

Variable	Logit[1]	
Fuel Poverty		
Portion of the household in each age range		
More than 60	REF	
Under 14	-0.456	**
	(0.20)	
15 to 29	-0.261	
	(0.18)	
30 to 39	-0.399	*
	(0.23)	
40 to 49	-0.529	**
	(0.21)	
50 to 59	-0.042	
	(0.15)	
Portion of women	0.487	***
	(0.12)	
Socio-Professional Category		
Farmers	REF	
Craftsmen, traders and entrepreneurs	-0.128	
	(0.25)	
Higher intellectual professions	-1.989	***
	(0.31)	
Intermediate professions	-1.882	***
	(0.27)	
Employees	-1.254	***
	(0.24)	
Workers	-1.586	***
	(0.25)	
Retired	-0.682	***
	(0.24)	
Unemployed	0.261	
	(0.24)	
Financially weak	-0.778	***
	(0.09)	
Year of construction		
After 2004	REF	
Before 1948	1.022	***
	(0.13)	
1949 – 1974	0.596	***
	(0.13)	
1975 – 2003	-0.020	
	(0.12)	
Individual house	0.985	***
	(0.09)	
Owner of the house	-0.240	***
	(0.08)	
Share of electricity	0.612	***
	(0.09)	
Share of gas	0.708	***
	(0.14)	
Cons	-3.941	***
	(0.31)	

***significative at 1% ** significative at 5% * significative at 10%

[1] Standard Errors are in parenthesis.

Table 2: *Logit model for fuel poverty*
Source: Budget des Familles Survey, final sample, author calculation

The second stage is dedicated to the ZINB model. The results will be presented in two tables: the first one will present the results of the count model, which aims to explain the numbers of uses of each health service by the probability of being in fuel poverty, variables describing the composition of the household and its financial situation, in addition to variables describing the dwelling or those who could influence the health of the individuals are included.

Negative Binomial of the number of health services uses (2 months preceding the survey)[2]

Variable	(1) General practitioner		(2) Speciaist		(3) Pharmacy purchases		(4) Hospitalizations		(5) Laboratory analyses	
Fuel poverty	0.128	***	0.386	***	0.148	***	0.326	***	0.269	***
	(0.03)		(0.05)		(0.03)		(0.08)		(0.05)	
Portion of the household in each age range										
Under 14	REF		REF		REF		REF		REF	
15 to 29	-0.822	***	-0.408	***	-0.618	***	-0.709	***	0.253	***
	(0.06)		(0.09)		(0.05)		(0.14)		(0.09)	
30 to 39	-0.977	***	-0.206	*	-0.623	***	-0.448	**	0.419	***
	(0.07)		(0.11)		(0.06)		(0.18)		(0.12)	
40 to 49	-0.935	***	-0.195	*	-0.688	***	-0.709	***	0.298	***
	(0.06)		(0.10)		(0.06)		(0.16)		(0.11)	
50 to 59	-0.936	***	-0.596	***	-0.806	***	-0.606	***	0.294	***
	(0.05)		(0.09)		(0.05)		(0.13)		(0.09)	
More than 60	-0.951	***	-0.570	***	-0.749	***	-0.764	***	0.348	***
	(0.06)		(0.09)		(0.05)		(0.14)		(0.10)	
Portion of women	-0.209	***	-0.536	***	-0.080	**	-0.707	***	-0.614	***
	(0.04)		(0.07)		(0.04)		(0.10)		(0.07)	
Socio-Professional Category										
Farmers	REF		REF		REF		REF		REF	
Craftsmen, traders and entrepreneurs	0.140		0.169		0.058		-0.253		0.392	**
	(0.10)		(0.15)		(0.09)		(0.23)		(0.18)	
Higher intellectual professions	0.501	***	1.154	***	0.535	***	0.667	**	1.130	***
	(0.11)		(0.17)		(0.10)		(0.26)		(0.20)	
Intermediate professions	0.488	***	0.968	***	0.480	***	0.593	**	1.071	***
	(0.11)		(0.17)		(0.10)		(0.26)		(0.19)	
Employees	0.362	***	0.567	***	0.247	**	0.129		0.779	***
	(0.10)		(0.16)		(0.09)		(0.23)		(0.18)	
Workers	0.458	***	0.638	***	0.235	**	0.407		0.900	***
	(0.11)		(0.16)		(0.10)		(0.24)		(0.18)	
Retired	0.455	***	0.527	***	0.266	***	0.448	**	0.912	***
	(0.10)		(0.15)		(0.09)		(0.22)		(0.17)	
Unemployed	0.015		-0.131		-0.131		-0.391	*	0.137	
	(0.10)		(0.15)		(0.09)		(0.22)		(0.17)	
Single parent household	-0.077	**	-0.200	***	-0.096	***	-0.253	***	-0.018	
	(0.03)		(0.05)		(0.03)		(0.08)		(0.05)	
Financially weak	0.013		-0.251	***	-0.065	**	-0.141	*	-0.144	***
	(0.03)		(0.05)		(0.03)		(0.08)		(0.05)	
Year of construction										
After 2004	REF		REF		REF		REF		REF	
Before 1948	-0.093	*	-0.236	***	-0.098	**	-0.324	***	-0.221	***
	(0.05)		(0.07)		(0.04)		(0.11)		(0.07)	
1949 – 1974	-0.012		-0.187	***	-0.033		-0.121		-0.049	
	(0.03)		(0.06)		(0.03)		(0.09)		(0.06)	
1975 – 2003	0.081	***	0.091	**	0.079	***	0.008		0.084	*
	(0.03)		(0.04)		(0.02)		(0.07)		(0.04)	
Individual house	-0.122	***	-0.521	***	-0.216	***	-0.357	***	-0.331	***
	(0.04)		(0.06)		(0.03)		(0.09)		(0.06)	
Owner of the house	0.135	***	0.237	***	0.120	***	0.129	**	0.130	***
	(0.02)		(0.04)		(0.02)		(0.06)		(0.04)	
Isolation work (in the last year)	0.291	***	0.293	***	0.142	**	-0.033		0.268	**
	(0.06)		(0.11)		(0.06)		(0.17)		(0.11)	
CMU	0.083	**	-0.099		-0.124	***	-0.098		0.032	
	(0.03)		(0.06)		(0.03)		(0.09)		(0.06)	

Would spend more on health	0.120	***	0.144	**	0.041		0.058		0.156	**
	(0.04)		(0.07)		(0.04)		(0.11)		(0.07)	
Respiratory device	0.583	***	0.548	***	0.541	***	0.971	***	0.566	***
	(0.05)		(0.09)		(0.05)		(0.14)		(0.09)	
Survey in winter	0.097	***	0.045		0.078	***	-0.002		0.059	*
	(0.02)		(0.03)		(0.01)		(0.04)		(0.03)	
Cons	1.221		1.590	***	1.621	***	0.897	**	-0.316	
	(0.17)		(0.27)		(0.15)		(0.40)		(0.29)	

*** significative at 1% ** significative at 5% * significative at 10%

Table 3: *The count part of the ZINB model for each health service*
Source: Budget des Familles Survey, final sample, author calculation

Table 5 represents the part of the ZINB model representing the count data (negative binomial). This model only takes into consideration the positive values of the dependent variables. The results show the effect of each variable on the number of uses of a certain health service.

The shares of each age range have a significative and negative effect on the number of health services used during the last two months, compared to the share of individuals under 14 years old. This effect is exceptionally positive for the number of analysis in a laboratory. In addition, the share of women in a household has a negative effect on the number of health care used. We can also note that the socioeconomic category, and the dwelling characteristics are decisive in seeking a health service.

Those who chose to spend more on their health if they were given more money, go more often to the doctor (general practitioner and specialist) and do more analysis in the laboratory. This means that these people want to seek even more medical help. Households who have rented or bought a respiratory device during the last year use significantly more health services. Finally, households who were interviewed for this survey during winter (between December and March) have declared going more often to the doctor, buying more often from the pharmacy and doing more analysis. These results could be explained by the fact that the numbers given are for a two-months period and during flu season, these numbers could be higher to everyone.

Table 6 represents the part of the ZINB model representing the zero inflation (logit). These results show that the usual profile of households that adopt health care renunciation behavior is not very significative. It is important to note the probability of being in fuel poverty is negatively significative for every health care service. This means that, when the probability of being fuel poor increases, the probability of not using a health service declines. This allows to conclude that, according to the data we have, fuel poor households have a lower health status than the rest of the sample which pushes them to seek medical help and to do so more often than the others.

[2] Standard Errors are in parenthesis.

Logit for the number of non-use of health services (2 months preceding the survey)[3]

Variable	(1) General practitioner		(2) Speciaist		(3) Pharmacy purchases		(4) Hospitalizations		(5) Laboratory analyses	
Fuel poverty	-0.538	***	-0.180	**	-0.555	***	-0.339	**	-0.368	***
	(0.09)		(0.09)		(0.08)		(0.16)		(0.09)	
Portion of the household in each age range										
40 to 49	-0.129		0.063		-0.217		-1.191		-0.211	
	(0.24)		(0.27)		(0.30)		(0.89)		(0.29)	
50 to 59	-0.368		0.003		-0.364		0.725	*	-0.475	*
	(0.28)		(0.26)		(0.34)		(0.38)		(0.27)	
Portion of women	-8.896	***	-33.539		-2.399	***	-320.005		-12.048	***
	(1.69)		(57.09)		(0.32)		(0.20)		(2.62)	
Socio-Professional Category										
Farmers	1.211	*	0.123		1.443	**	0.663		-2.871	
	(0.70)		(0.84)		(0.60)		(1.20)		(8.28)	
Unemployed	1.308	***	-0.004		3.088	***	-1.022		1.328	***
	(0.35)		(0.38)		(0.23)		(1.19)		(0.40)	
Single parent household	0.333		-0.547		0.488	**	-0.787		-0.166	
	(0.37)		(0.51)		(0.22)		(0.94)		(0.46)	
Financially weak	0.426	**	0.12		0.659	***	0.182		0.232	
	(0.19)		(0.22)		(0.17)		(0.36)		(0.22)	
Financially weak future	-0.588	***	-0.038		-0.627	***	-0.283		-0.377	**
	(0.18)		(0.19)		(0.16)		(0.35)		(0.19)	
CMU	0.139		0.564	*	-1.184	**	-0.241		-0.035	
	(0.28)		(0.32)		(0.47)		(0.73)		(0.34)	
Would spend more on health	-0.206		-0.092		0.226		-0.697		-0.241	
	(0.42)		(0.42)		(0.33)		(1.11)		(0.42)	
Financially supporting parents	0.744		1.495		1.126	***	95.404		-0.644	
	(0.88)		(1.30)		(0.42)		(6605.41)		(1.46)	
Financially supported by kids	-0.030		0.081		-0.018		0.371		0.234	
	(0.25)		(0.27)		(0.23)		(0.44)		(0.28)	
Const	-2.877	***	-0.986	**	-4.086	***	-1.450	*	-1.105	**
	(0.46)		(0.45)		(0.47)		(0.76)		(0.45)	

*** significative at 1% ** significative at 5% * significative at 10%

Table 4: *The inflation part of the ZINB model for each health service*
Source: Budget des Familles Survey, final sample, author calculation

[3] Standard Errors are in parenthesis.

5- Conclusion:

Fuel poverty could be a dangerous position to be in, in terms of effects on the daily life of the individuals living in this situation, especially for health matters. The literature on this subject examines the effect of fuel poverty on the health situation. It shows that households in this situation suffer from a bad housing quality which could cause serious health issues. Using a monetary indicator of fuel poverty, the energy effort rate, this study aims to link it to the health situation, measured by the number of visits to a general practitioner and a specialist, the number of purchases in a pharmacy, the number of hospitalizations and analyses in the laboratory.

This type of health measure allows to look more into the health seeking behavior, especially for those in fuel poverty. Using the number of uses of health care services in this study pushes us to check for behaviors of health care renunciation especially due to financial reasons. Not seeking medical services could be explained simply by the lack of need, but it can also mean that the household chose not to seek help.

While the descriptive statistics suggested that fuel poor households are adopting health services renunciation behavior (the mean of number of uses for each type of health services is significantly less for fuel poor than non-fuel poor), the econometric study showed the opposite. The estimations of the Zero-Inflated Negative Binomial model show us that the variables describing the usual profile of households that make health care renunciation do not describe the probability of nun-use of health services. At the same time, fuel poverty explains, for almost all the health services studied, the probability of non-use. But the results are always positive, which means that being in fuel poverty increases the probability of seeking health services. This is due to the fact that they have a lower health status than those who are not fuel poor.

References:

Atanasiu, B., Kontonasiou, E., Mariottini, F., 2014. Allevating fuel poverty in the EU. Buildings Performance Institute Europe.

Atsalis, A., Mirasgedis, S., Tourkolias, C., Diakoulaki, D., 2016. Fuel poverty in Greece: Quantitative analysis and implications for policy. Energy and Buildings 131, 87–98. https://doi.org/10.1016/j.enbuild.2016.09.025

Blais-Morisset, P., Boucher, V., Fortin, B., 2015. L'impact des dépenses publiques en sport sur les médailles olympiques: une analyse économétrique 26.

Boardman, B., 2013. Fixing Fuel Poverty: Challenges and Solutions. Routledge.

Bradshaw, J., Hutton, S., 1983. Social policy options and fuel poverty. Journal of Economic Psychology 3, 249–266. https://doi.org/10.1016/0167-4870(83)90005-3

Charlier, D., Risch, A., Salmon, C., 2015. Les indicateurs de la précarité énergétique en France. Revue française d'économie XXX, 187. https://doi.org/10.3917/rfe.154.0187

Després, C., Dourgnon, P., Fantin, R., Jusot, F., 2010. Dépense de santé et accès financier aux services de santé: une étude du renoncement aux soins 11.

Hernández, D., Siegel, E., 2019. Energy insecurity and its ill health effects: A community perspective on the energy-health nexus in New York City. Energy Research & Social Science 47, 78–83. https://doi.org/10.1016/j.erss.2018.08.011

Hills, J., 2011. Fuel poverty: the problem and its measurement.

Lacroix, E., Chaton, C., 2015. Fuel poverty as a major determinant of perceived health: the case of France. Public Health 129, 517–524. https://doi.org/10.1016/j.puhe.2015.02.007

Lacroix, E., Jusot, F., 2017. Fuel Poverty is it harmful for health? Evidence from French health survey data 20.

Legendre, B., Ricci, O., 2015. Measuring fuel poverty in France: Which households are the most fuel vulnerable? Energy Economics 49, 620–628. https://doi.org/10.1016/j.eneco.2015.01.022

Liddell, C., Morris, C., 2010. Fuel poverty and human health: A review of recent evidence. Energy Policy 38, 2987–2997. https://doi.org/10.1016/j.enpol.2010.01.037

Liddell, C., Morris, C., McKenzie, S.J.P., Rae, G., 2012. Measuring and monitoring fuel poverty in the UK: National and regional perspectives. Energy Policy 49, 27–32. https://doi.org/10.1016/j.enpol.2012.02.029

Llorca, M., Rodriguez-Alvarez, A., Jamasb, T., 2020. Objective vs. subjective fuel poverty and self-assessed health. Energy Economics 87, 104736. https://doi.org/10.1016/j.eneco.2020.104736

Markus, T., 2005. Domestic Energy and Affordable Warmth. Routledge.

Martin, C.J., Platt, S.D., 1987. Housing conditions and ill health 3.

Nolay, P., 2014. ONPE - Premier rapport - Définitions indicateurs, premiers résultats et recommandations.

Owen, G., 2010. Review of the UK fuel poverty measure 47.

Platt, S.D., Martin, C.J., Hunt, S.M., Lewis, C.W., 1989. Damp housing, mould growth, and symptomatic health state. BMJ 298, 1673–1678. https://doi.org/10.1136/bmj.298.6689.1673

Robić, S., Ančić, B., 2018. Exploring health impacts of living in energy poverty: Case study Sisak-Moslavina County, Croatia. Energy and Buildings 169, 379–387. https://doi.org/10.1016/j.enbuild.2018.03.080

Roebuck, M.C., French, M.T., Dennis, M.L., 2004. Adolescent marijuana use and school attendance. Economics of Education Review 23, 133–141. https://doi.org/10.1016/S0272-7757(03)00079-7
Vasechko, O.A., Grun-Réhomme, M., Benlagha, N., 2009. Modelisation de la frequence des sinistres en assurance automobile 25.
Waddams Price, C., Brazier, K., Wang, W., 2012. Objective and subjective measures of fuel poverty. Energy Policy 49, 33–39. https://doi.org/10.1016/j.enpol.2011.11.095
Warin, P., 2014. Le Baromètre du renoncement aux soins dans le GARD.