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Freezing the poor—Indoor environmental quality in low and very low income households during the winter period in Athens

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ABSTRACT

Previous research has shown that the economic crisis has a very serious impact to the indoor environmental quality of the low income households. Indoor temperature as well as energy, environmental, social and health related data are collected during the winter 2012–2013 from 50 low and very low income dwellings in the major Athens area in Greece in order to assess the influence of the serious economic situation in the country on the energy and environmental quality of poor families. Results show that indoor temperatures are much below the accepted standards and in many cases place in risk the health and even the life of the residents. The energy consumption for heating is found to be minimum and much below the country's threshold while a high fraction of households is not using heating energy at all. Strong correlations are found between the minimum indoor temperatures and the level of thermal losses of the dwellings. In addition, a strong association of the income level to various environmental and energy parameters is found. Finally, a high fraction of the very low income population is diagnosed to suffer from mental problems and in particular depression.

1. Introduction

Reaching proper indoor temperatures in buildings is a necessary requirement to satisfy thermal comfort conditions, protect human health and improve the quality of life. Very low or very high indoor temperatures have a serious impact to indoor environmental quality, a severe influence on the social attainment of households and result in a very important seasonal increase of mortality and morbidity [1]. Although it is generally believed that improper indoor environmental quality is primarily a problem of developing countries, there are almost 80 million people in European Union, or 16.4% of the global population living below the poverty line, residing in dwellings of pure thermal quality due to inadequate indoor environmental conditions [2]. Official statistics in Europe show that the percentage of the population living in low income houses in the various European countries varies between 10% and 25% [3].

The construction, energy and environmental standards of the low income housing in Europe is of much lower quality than the average building stock [4,5]. In parallel, a high part of the low income population cannot cover the housing energy needs and lives in temperature conditions heavily outside the comfort limits [6]. According to Ref. [7], almost 20–55% of the low income households in Southern and Eastern Europe lives in housing with leaking windows. In addition, about 15–25% of the low income population in Southern Europe and Ireland cannot afford the expenses for heating while in Portugal the corresponding figure is close to 73% [7]. It is believed that the above figures may have dramatically increased because of the serious economic crisis in Southern Europe. Low construction and energy related standards in low income housing oblige households to spend a much higher share of their income to satisfy general housing needs. According to Ref. [8], the average running housing cost in the 27 EU countries is close to 11% of the actual household income, while for the low income population the figure increases to 40%.

To maintain adequate indoor temperatures during the winter period, heating is necessary in almost all areas of Europe. Several national and international standards define the threshold indoor temperatures to maintain comfortable conditions in buildings [9–11]. Proposed indoor temperatures are in the range of 18 to 21 °C, varying as a function of many parameters regulating thermal comfort. Almost similar thresholds are proposed as adequate temperatures for health reasons. The World Health Organisation [6] proposes 20 °C for vulnerable population while 18 °C is proposed in Ref. [12]. Various medical sources propose 21 °C as a minimum temperature for the more vulnerable population and 18 °C for sedentary activities and able health people [13], while the UK

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Department of Environment proposes as minimum temperatures for health reasons 16 °C in bedrooms and 18 °C in living rooms [14].

Cold homes are a serious problem in many European countries. Most of the existing data are available from UK, Ireland and other Northern countries where several studies have been carried out and many policies to improve the problem have been applied. Most of the experimental studies carried out in Northern Europe and UK found that indoor temperatures in low income houses were quite low and in most of the cases non adequate for humans, while problems of internal condensation, mold and damp were found in a high part of the buildings [15–26]. In some cases temperatures were found very low placing the health of humans in risk [7]. Recent medical research has associated low indoor temperatures to various illnesses like pneumonia, increased blood pressure, asthma, bronchitis, influenza arthritis, heart deceases, and migraine [7]. In parallel, medical problems associated to social pathologies like depression, anxiety, constraints of mobility and isolation are diagnosed at a high score in low income households [7,27].

Low indoor temperatures have a serious impact on mortality. According to Ref. [28], there are almost 30,000–60,000 excess winter deaths in UK and 1500–2000 in Ireland because of the low indoor temperatures in dwellings, while an important association between the housing quality and seasonal mortality is found [29]. As shown in Refs. [30,31] less insulated houses in UK, are associated with excess winter mortality. The continuous improvement of the energy quality of the building stock has permitted to improve indoor environmental conditions and decrease cold related mortality [32–35]. In fact, as mentioned in Ref. [36], during the last 40 years the average indoor temperature of houses in UK with central heating has increased by 3.6 K from 13.7 °C to 17.3 °C, while in non centrally heated buildings temperatures have increased from 11.2 °C to 14.8 °C.

Energy poverty in Greece is a serious problem. The specific percentage of energy poor varies as a function of the parameters and criteria used to calculate energy poverty. According to the estimations given in Ref. [37], fuel poverty in the country varies between 24.6% and 36% as a function of the weighting factor for each of the indicators used. Furthermore and based on the criteria proposed in Ref. [1], the percentage of energy poverty in Greece is close to 36%, while according to Ref. [27], is between 16% and 17%. According to Ref. [2], almost 20% of the population lives in low income housing while in Ref. [7] it is reported that almost 28% of the population lives in houses with leaking windows and 26% of the low income population in Greece cannot afford to cover the expenses for heating while the national average is close to 8%.

Specific information on the social and energy characteristics of the low income population in Greece is given in Ref. [38]. As reported, only 8% of the low income households live in insulated houses with double glazing while the corresponding figure for the high income group is close to 60%. In parallel, because of the housing inappropriate quality, low income people had to spend almost the double energy quantity for heating and cooling per square meter and inhabitant, to satisfy the basic energy needs of the houses. These specific data were collected much before the economic crisis hit the country. A recent study on the heating energy consumption in the country performed during the period of the crisis [39] reported that the energy consumption in the low income group has decreased significantly because of the increased prices of fuel and the serious decrease of the family income. The study found that most of the low income households have used for a minimum period or have not used at all their heating system.

The lack of resources to satisfy the heating and cooling demands has a serious impact on the indoor environmental quality of the low income houses in the country. Measurements of the indoor temperature performed during the summer period in 50 low income houses in Athens [40] showed that indoor environmental quality was very low and indoor conditions were completely out of the comfort zone. For almost 85% of the heat waves period indoor temperatures exceeded 30 °C, while spells of about 216 continuous hours above 30 °C were measured. In very low income houses, spells of six continuous days above 33 °C were also recorded.

Table 1
General characteristics of the households participating in the study.

No of households	43
Average persons per household	1.72
Average age	47
Percentage of employed people	38.30%
Percentage of unemployed or non-active people	28.70%
Percentage of retired people	22%
Percentage of students	11%
Average annual income (€)	8158.00
Average annual income per person (€)	4721.20
Average education score (0–3), 0 = compulsory education, 1 = low school, 2 = upper secondary school, 3 = tertiary	2.11
Percentage of population with tertiary education	33%
Percentage of population with upper secondary education	53.00%
Percentage of population with compulsory education	14%

The present paper aims to present specific measurements and analysis on the indoor temperature in low and very low income households in Athens, Greece. Fifty houses were selected and monitored continuously during the winter period of 2012–2013. Data on the energy consumption, housing and neighbourhood quality, social and economic status as well as the health level of the people were also collected and analysed.

2. Description of the study

In order to assess the environmental quality of low income households in Athens, Greece, fifty low and very low income households were selected for monitoring. The criteria applied for the selection were the declared household annual income that had to be lower or around 15,000 € and the willingness of the family to participate in the study. Almost all houses selected are located in dense areas of the city characterised by significant social economic and environmental problems [41]. In each house a miniature temperature sensor was placed measuring indoor temperature at 15 min intervals. Sensors were placed in a well-ventilated and heat protected part of each house, whereas all sensors were properly calibrated, with their accuracy being better than 0.5 K. Measurements were performed for the period between December 2012 and April 2013. All houses were regularly visited by trained surveyors to download the recorded data and get a report on the actual problems and the applied conditions in the households. All data were subjected to quality control and measurements not satisfying the requirements were rejected. During the initial period of monitoring, 12 of the initially selected houses were replaced by others as a result of observed problems. The final number of households used in the present paper was 43 and the total number of people participating in the survey was 74.

All information about the main characteristics defining the energy, environmental, economic, social and health indicators in the households was collected using a specific questionnaire similar to the one employed in the LARES study of WHO [7]. Specific information on the consumed energy was collected through inspection of the relevant fuel and electricity bills. All information collected through the surveys was doubled checked through specific phone calls to the participating families.

The main characteristics of the households which participated in the survey are given in Table 1. As shown, the average persons per household was close to 1.7 persons while the country's average is much higher [2.73]. In parallel, the mean age of the persons participating in the survey was 47 years while the country's average is