Обзорная статья
Review article

DOI: 10.38025/ 2078–1962–2020–98–4–135–143
УДК 612.062

Health Impact of Fuel Poverty

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Abstract

This chapter reviews current knowledge about the health effects of several environmental conditions on home fuel poverty, including physiological and epidemiological aspects of cold and heat related illness, and epidemiological studies on excess morbidity and mortality. The inadequate home concept has been addressed with further contributions that have on mental health, asthma (dampness and mould), noise, CO poisoning and lung cancer for radon exposure. Measures for reducing cold and heat related mortality and morbidity related to poor energy housing include appropriate urban planning and housing design. This contributes confirm that poor housing quality is a significant public health issue. However, to realize a large health potential associated with adequate, safe and healthy homes, joint action on health and non-health sectors is required. The development of specific guidelines for general and healthcare practitioners to better manage information on patients living in bad situations of fuel poverty is desirable.

Keywords: fuel poverty; indoor environments; public health; risk factors, bioclimatology; vulnerability; preventive medicine; healthcare practitioners.

For citation: Condemi V., Gestro M., Solimene U. Health Impact of Fuel Poverty. Bulletin of rehabilitation medicine. 2020; 98(4): 135–143. https://doi.org/10.38025/ 2078–1962–2020–98–4–135–143
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Received: Jun 29, 2020 **Accepted:** Jul 13, 2020 **Published online:** Aug 30, 2020

Introduction

Hippocrates of Kos, in the 4th century BC with his treatise on the arias, waters and places to perceive, at the dawn of medicine, the extreme importance that the physical environment in general and the climate, in particular, could have on human health and on the recovery of the same during or after a disease. This attempt gave rise to climate-environmental research within a limited empirical and observational vision but did not have much luck. Only since the second half of the last century research in this area has begun to consolidate with increasing evidence in the various fields of application. The first attempt to summarize what was developing is due to Tromp [1] which provided a first relevant bibliographic framework, extending the applications not only to the human organism but to all living forms (animals, plants, microbiotas) and in different environmental conditions.

The interest in the climatic component and its impact on the different mechanisms of thermoregulation of living organisms has led to the development of a significant number of bioclimatic indices, well summarized in a recent scientific publication [2]. Pioneering research aimed at deepening the links between man, climate and architecture have been started since the sixties years of the last century [3]. At the same time, it became evident that the confined spaces had to be placed in a multidisciplinary context interacting with the living organisms and above all the man. The World Health Organization (WHO), especially in the last fifteen years, has developed a considerable amount of reports and synthesis work aimed at underlining the importance that environmental phenomena as a whole can assume in terms of public health [4].That being said, only 0.2% of the Earth's surface is covered by urban areas but 47% of the world population and 73% of the European population live in densely populated areas characterized by generally degraded environmental frameworks. Starting from this premise, the study of urban contexts justifies the current structure and the irreversible trend of the growing concentration of human activities in areas of high population density. The city is therefore an optimal epidemiological reference model to estimate the different effects deriving from precarious or inadequate housing conditions (urban fuel poverty).

This assumption was confirmed in a recent work carried out in England [5] where it was concluded that the most well-known indicators deployed in policy-making, the established 10% income indicator and the recent Low Income High Cost (LIHC) has disproportionately affected regions with lower housing costs, with higher prevalence of fuel poverty in urban areas and fewer fuel poverty 'hot-spots' and 'cold-spots'. In this contribution, it seems important to us to provide some definitions of WHO on health and housing: health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Housing is the conjunction of the dwelling, the home, the immediate environment and the community. In 2005 the WHO - Regional Office for Europe organized the first of a series of workshops bringing together housing and health experts to investigate how to quantify the negative health impact of certain housing conditions. This and two subsequent workshops developed an approach to the quantification of housing-related health impacts. This chapter provides a general review on the different aspects of human health that fuel dictates, directly or indirectly and with short or long-term effects (morbidity and mortality), on the general population and on specific risk categories. The epidemiological limits and uncertainties are also identified. Our contribution, in addition to the normal audience of policymakers, intends to reach the medical class to raise awareness of a risk factor inextricably linked to the various issues of fuel poverty.

Methodological note

In order to quantify the human health impact of buildings characterized by "fuel poverty" profiles, WHO has developed several epidemiological approaches by using the environmental burden of disease (EBD) methodology. According to WHO [6] report, for each particular housing risk factor, the related health impacts (if possible) are given in the number of deaths, the number of disability-adjusted life years (DALYs) and/or the number of persons suffering from an associated health outcome. Where possible, the assessment is also expressed as the EBD per 100 000 populations per year for the countries covered, in order to provide a more consistent prevalence estimate. Several EBD and DALYs estimates presented here are annual. At the international level there are no scientifically solid data on the different realities present in underdeveloped or developing countries, which has led us to examine the scientific evidence structured on the basis of researches almost exclusively in Canada, USA and especially in Europe; in particular, for Europe, the epidemiological WHO classification criterion EURO A, B and C (Epidemiological Sub-Regions) was used. Together with the scientific evidence directly attributable to the previous methodological criteria, the observational scientific literature that studied some climatic events (warm and cold) was considered as an indirect criterion (mortality in particular), providing incontrovertible results. Further epidemiological criteria that frequently occur in this contribution concern the assessment of relative risk (RR), cumulative relative risk (CRR), attributable risk (AR) and the population attributable risk fraction (PAF).

Indoor environments

While housing conditions are known to influence health, little has been done to examine the scale of that influence. estimating the magnitude of housing-related health impacts is the subject of the WHO report «Environmental burden of disease associated with inadequate housing» WHO [6] There is a consistent body of evidence on the several ways that inadequate housing adversely affects the health of occupiers. WHO recognizes that housing comprises four interrelated dimensions – the physical structure of the house (or dwelling), the home (psychosocial, economic and cultural construction created by the household), the neighbourhood infrastructure (physical conditions of the immediate housing environment) and the community (social environment, the population and the neighbourhoodservices). Each of these four dimensions has the potential to have a direct or indirect impact on physical, social and mental health, and two or more of them combined can have an even larger impact.

Cool waves epidemiology

The scientific literature of recent years includes numerous epidemiological studies that clearly show seasonal variations in morbidity and mortality with winter and summer peaks, depending on the type of climatology observed on average. The phenomenon involves several causes of death with prevalence of cardiovascular and respiratory events, such as exposure to air pollutants (cardiorespiratory events). Epidemiological criteria for measuring inadequate housing design and energy inefficiency is the housing exposure (Indoor winter temperature) while the health outcome refers to an excess winter mortality (EWM) primarily from cardiovascular and respiratory disease. On the side of morbidity there is also a consistent evidence of an association between different environmental parameters and significant statistical variations in the Emergency Rooms accesses (mention some recent ones) and different pathologies [7–9]. While the high temperatures produce immediate effects (as will be seen in the following chapter) with an exponential relationship, the low temperatures have a more prolonged effect that occurs up to several weeks after exposure and a dose-response relationship of almost linear. An epidemiological study concerning 15 European cities [10] reports that a decrease of 1 degree °C of temperature is associated with an increase in daily mortality of 1.72% for cardiovascular causes, 3.30% for respiratory causes and 1.25% for cerebrovascular causes, emphasizing higher increases for the elderly population. Further confirmations come from other multicentric research conducted in the USA [11] which validated the results of the research previously cited with an increased observed mortality due to cardiovascular causes, in particular in the cold climate contexts [12] Further and more recent studies [13] have calculated attributable deaths from heat and cold in a multicountry study; this research report that non-optimum ambient temperature is responsible in determining mortality excess rates, with important differences between countries. The mortality excess during the winter led to the formulation of some scientific questions about the real cause due to this epidemiological data for example cold stress or influenza? [14] The general picture briefly outlined leads us to deepen the relationship between the indoor cold and mortality (from months to years) for cardiovascular diseases. This topic is directly linked to exposure to excessively low indoor temperatures for long periods. Pioneer studies have already investigated the attributable risk to inadequate indoor environments [15] It appears that 50–70% of EWD are attributed to cardiovascular conditions, and some 15–33% to respiratory disease. While the EBD methodology could not be fully applied in this case owing to missing data, an estimate is given for the percentage of EWD related to cold bad housing conditions using data from several studies. The WHO estimates that, each year, 38.200 excess winter deaths in 11 European countries are related to low indoor temperatures, representing 12.8 excess deaths per 100.000 population due to indoor cold. Low indoor temperatures are a combined result of energy inefficiency of the dwelling (poor thermal insulation and/or inefficient or inappropriate provision for heating), the social or economic status of the household and the cost of energy [16]. New dwellings should be designed and constructed to meet energy efficiency standards while also providing for adequate heating and ventilation. For existing dwellings, there are two possible solutions – financial subsidies to those households struggling to meet the cost of energy required to maintain adequate temperatures, and energy efficiency measures (additional insulation and efficient provision for heating and ventilation). The first is a short-term solution, but necessary to protect health, while the second will provide a long-term solution that also contributes to measures to mitigate climate change. At present, mortality data, as opposed to morbidity, are the only consistent available national data. The annual burden of disease due to cold homes can be conservatively estimated as an EWD associated with inadequate housing proportion of 30% excess winter deaths, according to available evidence and expert opinion. This is related to a temperature threshold of 18 °C [17]. However, a different threshold for different parts of Europe may be advisable to account for differences between those with cold and those with mild winters. With a specific report [6] scientific evidence was summarized and specific guidelines for problem management were provided. The critical issues are not limited to private homes, but in school buildings, day-care centers, offices, and other buildings [18] In this context, we point out that specific information is lacking or studies on a possible interaction between living conditions in bad housing and contextual working conditions in indoor-outdoor environments (cold or warm working environments). One of the most significant childhood chronic conditions, especially in developed countries is asthma. A considerable proportion of childhood asthma cases are attributable to exposure to indoor dampness and mould. Based on data for 45 countries of the European Region (Euro A and B), the WHO estimate that 0.07 asthma related deaths and 50 asthma-related DALYs per 100 000 children per year are associated with exposure to dampness in dwellings, and that 0.06 deaths and 40 DALYs per 100 000 children per year are associated with exposure to mould. In total numbers, mould exposure is associated with 83 deaths per year. Statistical discrepancy existed in the link between temperature and childhood asthma, and also in the shape of this relationship (i.e. linear or non-linear) and whether temperature effects were lagged [19] Reducing exposure to damp and mould would be extremely beneficial to public health and prevent or reduce a large proportion of asthma among adolescents and adults. In addition, a number of studies investigated a potential relationship between respiratory infections and exposure to low temperatures. The number of general practitioner examinations (Athens) for respiratory infections was investigated [20] with cold temperature and absolute humidity as risk factors. Another study [21] supports the hypothesis that low temperature and humidity may be associated with an increased prevalence of respiratory tract infections. Preliminary research has highlighted a moderate association of otitis media with low temperatures with specific risk factors for this variable specially in children [22] These evidences probably have specific implications on human health in cold home environments.

Heat waves epidemiology

Very solid is the scientific literature on the effects, in terms of morbidity and mortality, that heat waves determine. Both in the outdoor environment and as a consequence of inadequate housings, heat wave stands out as a prolonged period of extreme weather conditions with very high temperatures and high hygrometric rates. In epidemiological terms, the heat waves that involved Western Europe in 2003 and European Russia in 2010 (Moscow area), were explored, as paradigmatic events [23]. These climatic phenomena have not been verified in the past, for duration and intensity, since they have sufficiently reliable meteorological measurements for these areas. Several epidemiological investigations have investigated mortality results (observed vs expected) in relation to situations of moderate and extreme heat. Preceded by a contribution extended to 11 US cities by Curriero [12] a research project (PHEWE) led by Michelozz [24] crossed First Aid data correlating them to extreme heat events in 12 European cities, focusing attention on the adverse effects of heat waves on various respiratory and cardiovascular diseases. In this paper, it has been observed that the scientifically known consequences of heat waves in determining mortality are combined with information still limited on the consequences of high temperatures on morbidity. In the contest of Paris Agreement, adopted in December 2015 (climate change) Vicedo-Cabrera [25] performed a multi-region analysis in 451 locations and in 23 countries with different climate zones, and evaluated changes in heat and cold-related mortality under scenarios consistent with the Paris Agreement targets. Other studies have shown strong differences in mortality among occupants of buildings with or without air conditioning. The basic question addressed was whether persons in households with air-conditioning experienced lower death rates during hot weather than persons in households without air-conditioning. Rogot [26] in a cohort study of 72.740 participants, the death rate for persons who had central air-conditioning was 42 percent lower than the rate for persons who did not have air-conditioning. Research carried out in hospital settings [27] have found strong evidence that, during the August 2003 heatwave in Europe, the presence of air conditioning in hospital wards, was associated with increased survival of patients admitted before the be-

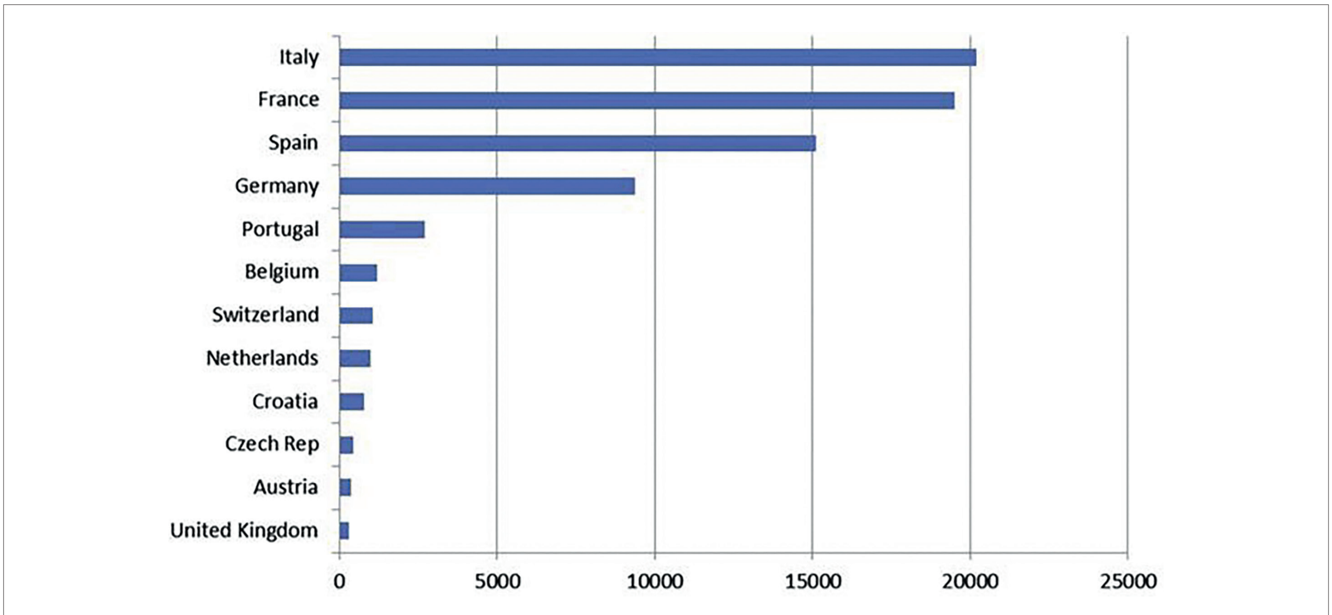

Fig.1. *The excess mortality in several European Nations*

ginning of the climate event. However, some situations that could cause pathology must be reported: the lack or insufficient maintenance of the conditioning equipment can lead to respiratory crises in people allergic to dust, pollen and dust mites. Furthermore, as demonstrated by various scientific works [28–29]; such plants (especially large ones like the cooling tower) can favor the onset of acute respiratory infections such as Legionella pneumophila, potentially lethal. The air conditioning use during the hot weather phases is therefore an important tool for mitigating the effects of high temperatures in homes. These devices, today widely penetrated in all environments (domestic, work environments, transport, etc.) are an undoubted help in achieving thermo-hygrometric comfort. Even taking into account its proper use it is always necessary to consider the problem of enormous temperature changes when moving from indoor and /or outdoor environments. However, as indicated by various works, the possession of air conditioning is an obvious protective factor. In conclusion, we provide a figure showing the epidemiological profile on mortality in Europe in the summer of 2003 (Fig.1).

The importance of the thermal factor (warm sensitive) in the etiopathogenesis of the urinary calculi as also been confirmed by studies performed in USA and Europe. With an innovative approach [30] investigated the relationship between climate changes from a scenario perspective, hypothesizing a risk of increased incidence of kidney stones in the United States using an epidemiological prediction model focusing on thermometric trends. The model estimated an increase in the trend of 10% in the first half of the 21st. Several researches in the recent past have gradually consolidated scientific evidence by effectively synthesizing the state of the art of the phenomenon studied and describing the different contributions, areas, mechanisms of action and the different weather-climatic modes that are potentially influential as risk factors in the etiology of urinary calculi [31–33]. The fuel poverty houses in the summer period (without air conditioning or in other critical warm housing situations) is a potential risk factor for this disease with an increase in the cumulative relative risk (CRR).

Fuel poverty and population at risk in cold and warm situations

In assessing the potential damage to the health of fuel-poor households, together with the classical determinants (low income, energy price and reduced access to energy inefficiency and supplies etc.), other factors (environmental and individual) in some cases not relevant to fuel poverty, that predisposes more to a health impact of this type of residence by adding illness risks in the short and long term [4, 34, 35].

This is a list of risk factors taken from the studies and web-sites previously reported:

Individual risk factors:

- the elderly (age> to 70 years);
- Infants and children, especially children <4 years old;
- pre-existing chronic diseases: diabetes, cardiovascular diseases and cerebrovascular diseases, neurodegenerative diseases, heart failure, kidney failure, liver failure, thyroid disease;
- Obesity and eating disorders;
- Pregnancy at risk;
- Subjects with memory disorders, behavioral disorders, difficulty in understanding and orientation, mental illnesses;
- Loss of autonomy (infirm or wheelchair users);
- Social isolation;
- Subjects who are alcohol or drug users;
- Subjects who use drugs that can interfere with adaptation to cold and heat;
- Subjects with febrile states associated with acute diseases.

Environmental risk factors:

- Greater risks during the first heat or cold waves of the season due to the minor adaptation of the human body at low or high temperatures;
- Who lives in a big city and/or in a very anthropized environments;
- Homes unsuitable for cold and heat (moderate and extreme) then converging towards situations of fuel poverty;
- Houses with excessively high temperatures during the summer (unprotected southern exposure, top floor of a building, attic apartment, flat-roofed building, large windows, bad insulation, etc.);
- Living in places with significant air pollution rates, in particular $PM_{2.5}$, O_3 and SO_2;
- Working conditions in hot or cold environments that require warm or waterproof clothes (foundries, bakeries, etc.);
- Absence or insufficient summer air conditioning and winter heating in indoor working environments;
- Lack of access to fresh areas during the day (for example supermarkets).

Indoor environment: mental health impact

In the last twenty years the evidence of the relationship between housing quality and mental health has increased. Inadequate housing is stressful in several respects, including concerns about hazards and safety, financial worries etc. The design of some types of housing (such as high-rise buildings) may encourage social isolation. Symptoms of stress, anxiety, irritability, depression and alteration of attention capacities at school in children may be related to bad housing conditions WHO, [16]. It is also accepted that stressful housing conditions can aggravate pre-existing psychiatric pathologies [11]. Several studies have tried to estimate the effects on health and mental well-being due to different fuel poverty conditions [36] with scientific results still to verify. This work deepens the living conditions of cold and dump homes and concludes that the problem must be evaluated in a multi-dimensional perspective. Besides, the impact of these bad home conditions on well-being are wide ranging, incorporating stress, positive mental health and mental disorders. The work previously mentioned concludes: "Despite this complex matrix, there is consistent evidence linking cold and dump homes with mental well-being, but with a number of studies (only nine) considered sufficiently rigorous and qualitatively important. In these studies, persists a level of empirical approach that does not allow to reach definitive conclusions on scientific evidence. A recent systematic review tries to understand what is the current evidence on sleep disturbance and sleep disruption, in relation to different categories of extreme climatic events [37], reaching similar conclusions to the previously mentioned work. Among the different subjects at risk mentioned above of particular interest (heat wave of 1999 in Cincinnati and Chicago) is what is shown by Kaiser [38], and Naughtonм [39] that identified an increased risk of morbidity and a higher risk of death in individuals suffering from different types of mental disorders. Half of the heat deaths occurred in subjects aged <65 years suffered from mental disorders, including depression. These results have been confirmed by the French Institute de veille sanitaire (InVS), in a report prepared in October 2003 (heat wave 2003 in France) where it confirms that 41% of people in mental or cognitive disorders, aged <60 years, died in August 2003.

Sleep time and quality are affected by age, psychological and physiological conditions, culture and environmental factors. There is strong evidence that extreme temperatures cause disturbances and frequent sleep disruptions, insomnia and frequent awakenings. Hot environments have been found to disrupt sleep significantly, with common impacts being increased wakefulness and reduced amounts of non-rapid eye movement (NREM) and rapid eye movement (REM) [40–41], Thermoregulation is greatly reduced during REM sleep, so extremes of temperature and humidity in the sleep environment and especially in next to skin microclimate, can significantly affect homeostasis and sleep quality [42].

Another aspect that must be considered examining the links between qualitatively poor buildings and mental health concerns a clinical form called Seasonal Affective Disorder (SAD), much studied in the Scandinavian countries [43, 44] In relation to this pathology, two forms have been documented: a bland, subclinical form, also called "winter blues" where the symptomatology never comes to complex frameworks. The second, SAD (very common in northern Europe and North America) is a seasonal affective or emotional disorder that is highlighted by a lasting pathological alteration of mood tone, characterized by alternating phases of depression and excitation, depression in autumn-winter and excitement in spring-summer (midnight Sun in summer and the opposite polar night in winter). The clinical context can result in depression, preferably in predisposed subjects. Such manifestations do not depend only on the external environment but also on specific conditions that are observed in insufficiently illuminated houses. The progressive use of light therapy in homes during the winter has allowed (especially in the Nordic countries) to achieve good results [43, 45].

Specific epidemiological profiles

In this chapter some situations are considered in which the population at risk is in a state of fuel poverty for the use, often linked to insufficient conditions of income, of heating systems obsolete or inadequate to the already known standards. Carbon monoxide (CO) poisoning is a major cause of immediate home poisoning related to the combustion of carbon-based fuels such as gas and solid fuels WHO [16] Searches conducted in England and Wales have underlined as the CO exposure in indoor settings can quickly reach lethal levels but reliable, measured data on domestic exposure are rare. Thus, the assessment provides only the potential range of health outcomes expected for countries of the Euro A sub-region for which relevant data are available [16] estimate that within this sub region there are between 114 and 1545 persons suffering from carbon-monoxide-related delayed or persistent neurological sequelae, corresponding to between 0.03 and 0.4 per 100.000 population. Based on the household energy sources in the Euro B and Euro C sub regions, it can be assumed that the EBD may even be higher there, but lack of data restricts the assessment to Euro A. Actions to prevent CO poisoning include the regular maintenance of appliances burning gas, oil and solid fuel, ensuring an add equate supply of air for combustion for such equipment, making occupiers aware of the dangers of using inappropriate forms of heating (such as fueless gas or oil heaters) and the installation of carbon monoxide detectors in homes with gas, oil or solid fuel appliances (which is already mandatory in some countries) WHO [16]

In conclusion, we briefly mention the effects on human health that noise brings, especially in the cardiovascular fields. It is important to underline that this theme, although secondary to the epidemiological picture described in other chapters, can also have relevance in terms of dwelling quality. The WHO in turn highlights the problem WHO [5] synthesizing the scientific evidence (housing, surroundings and outdoor-indoor noise sources) on some adverse effects caused by noise exposure. There is sufficient evidence of the relationship between noise in general, road traffic and various cardiovascular diseases [46–48]. The results of the research cited and others not mentioned in this work support the hypothesis that chronic exposure to high levels noise increases the risk for cardiovascular diseases.

A further risk factor present inside homes is the radon, a natural radioactive noble gas, a product of uranium decay. It is found in the ground, it is invisible, odorless and tasteless. Radon concentrations (measured in Bq/m^3) in the outdoor environment are not a health problem, while in home environments they can reach dangerous levels, especially for lung cancer. Radon penetrates the house through permeable areas, basement walls and floors and accumulates there. Another characteristic is that moving from lower floors to higher buildings the concentration decreases. Radon concentrations in buildings vary widely depending on the underlying geological formations, building structure, ventilation and other issues. Detailed estimates for the population attributable risk fraction (PAF), which is the proportion of disease that can be associated with radon exposure, have been published for several European countries [49–51]. Areas of uncertainty include the quality and extent of radon surveys in Europe, the impact of changing lives and housing conditions (multistory buildings, effects of improving insulation and energy efficiency), issues related to the radon-smoking interaction and between radon and other indoor air pollutants. The WHO concludes: "the available evidence suggests that radon clearly contributes to the risk of lung cancer, actions to minimize indoor radon exposure, including prevention in new homes and mitigation in existing homes are required. National radon programs should be implemented where feasible" [16]. In conclusion, we briefly mention the birth outcomes in hot or cold environments (low birth weight, preterm birth and stillbirth). Recent epidemiological evidence on seasonality of birth outcomes and the impact of prenatal exposure to ambient temperature indicates in winter, summer or both (extremes of temperature), an important determinant [52] This health issue can be favored in pregnancies conducted in homes with hot or cold conditions (indoor fuel poverty environments).

Conclusions – recommendations for Healthcare Practitioners

From an environmental point of view, the most evident aspects that emerge from our work (housing deficits and health outcome) essentially concern the two climatic categories that are at the antipodes, the cold and warm climatic conditions, moderate or extreme. In light of the substantial scientific literature especially on the side of mortality, it is evident that the fuel poverty with housing deficits is shown as a risk factor in different epidemiological profiles and matrices.

Table 1. *Summary of the observed or hypothesised effects on health in relation to different types of inadequate houses (single or multiple exposure).*

Fuel poverty	Effects	Population		More Vulnerable Clinical Groups	Other Confounder Factors
		1–4 years old **5–19 years old**	**>65 years old**		
Indoor Cold Environments					
Insufficient heating			Excess winter mortality (40% from cardiovascular diseases and 35% from respiratory diseases) Increased morbidity rate	Cardiovascular risk, organ dysfunction (>65 yr)	
	Cardiovascular effects		Rising blood pressure Ischaemic heart disease, stroke Ulcer exacerbations	Venous insufficiency, diabetes (>65 yr)	
	Imbalance of thermal regulation	Ipothermia			
	Respiratory effects	Upper respiratory tract infections Otitis media (<4 yr) Lower respiratory tract infections	Upper respiratory tract infections Lower respiratory tract infections , worsening COPD	Flu epidemia (>65 yr) Flu epidemia, respiratory insufficiency	Air pollution Active smoking, smoking in pregnancy, air pollution Air pollution
	Arthro-rheumatic effects		Exacerbation of pre-existing conditions such as arthritis and rheumatisms Consequence of arthritic inflammation: strength and dexterity reduction Increases risk of falls in the elderly	Arthro-rheumatic effects	
Indoor heat environments					
Lack of air conditioning			Excess summer mortality Increased morbidity rate	Cardiovascular risk, organ dysfunction (>65 yr)	
	Cardiovascular effects		Rising blood pressure Ischaemic heart disease, stroke Ulcer exacerbations	Venous insufficiency, diabetes (>65 yr)	
	Imbalance of thermal regulation	Ipothermia			
	Respiratory effects	Upper respiratory tract infections Otitis media (<4 yr) Lower respiratory tract infections	Upper respiratory tract infections Lower respiratory tract infections , worsening COPD	Flu epidemia (>65 yr) Flu epidemia, respiratory insufficiency	Air pollution Active smoking, smoking in pregnancy, air pollution Air pollution

Fuel poverty	Effects	Population		*M*ore Vulnerable Clinical Groups	Other Confounder Factors
	Arthro-rheumatic effects		Exacerbation of pre-existing conditions such as arthritis and rheumatisms Consequence of arthritic inflammation: strength and dexterity reduction Increases risk of falls in the elderly		
Indoor Heat Environments					
Lack of air conditioning			Excess summer mortality Increased morbidity rate	Cardiovascular risk, organ dysfunction(>65 yr)	
Dampness and Mould	***Hydro-salt imbalance***	Deydration	Hypotension, electrolyte imbalances, decrease in renal function, reduced renal clearance, calculi urinary Falls, fractures (hypotension), chronic intestinal diseases with diarrhea, heart failure	Pharmacological polytherapy, endocrine disorders with electrolyte alterations	
Insufficient ventilation and heating	***Allergology***	Asthma Allergy, dermatitis and eczema	Allergology Allergy		Active smoking,second-hand smoke, aerobiological pollution
Indoor corbon monoxide exposure					
Insufficient ventilation		Headache, nausea Severe intoxication:Coma, Death	Headache, nausea Severe intoxication:Coma, Death		
Toxic					
Radon exposure			Lung cancer		Active smoking, second-hand smoke air pollutants
Noise exposure					
		Sleep disturbances,insomnia	Sleep disturbances,insomnia Ischaemic heart disease		Noise in working environments (specific for the working population)
Mental health impact					
Global house quality impairment (poor-quality housing)		Decline in educational results (adolescents), behavioural problems Sleep disturbances Worsening of mental health problems Social isolation (adolescents)	Behavioural problems Sleep disturbances Mental health problems Social isolation SAD (depressive episodes during specific times of the year)	Neurological and mental illness Mental illness	

This work describes, in general, all the possible links between the fuel poverty and the implications on human health, comes to some specific conclusions, already highlighted by other authors, on the need to strengthen the knowledge of the problem, in addition to natural operators (engineers, architects, etc.). A recent study conducted by Mc Conalogue [53] highlights how the knowledge of fuel poverty concepts is poorly known by health professionals. The management of fuel poverty must, therefore, be framed in a perspective of preventive medicine. The Healthcare Practitioners (HCPs) are poorly aware of the health implications of poor buildings and there are no specific information and/or guidelines aimed at health professionals, especially primary care physicians, about the real living conditions of patients in homes with severe housing deficits. Healthcare professionals must be considered among the main actors in this sense and it would be desirable to provide training programs, guidelines and availability of administrative and assistance procedures to cope with the problem. The HCPs are at the forefront of the approach to the person who suffers or is likely to suffer from health problems related to fuel poverty. The studies tell us that the subjects involved are unwilling to report their hardship and suffering, often isolated and alone (like the elderly or rural populations), and this indicates the need for an active approach. An approach that is not necessarily limited to the study of the medical aspects, but oriented towards a careful global evaluation of the psychological-existential and social condition in order to arrive at a clinical-care decision as complete as possible. It is always a principle affirmed over a century ago by William Osler that "it was more important to know what kind of patient has a disease than what disease does a patient have", also with a specific view on fuel poverty. In conclusion, Table 1 provides a reasoned synthesis on the links between fuel poverty/bad housing and health outcomes, specific for the age groups <0–19 and >65 yr (population groups at greater risk).

Abbreviations

AR	Attributable Risk
CO	Carbon Monoxide
COPD	Chronic obstructive pulmonary disease
CR	Cumulative Relative Risk
DALYs	Disability-Adjusted Life Years
EBD	Environmental Burden of Disease
EWM	Excess winter mortality
HCPs	Healthcare Practitioners
LICH	Low Income High Cost
PAF	Population Attributable Risk Fraction
RR	Relative Risk
SAD	Seasonal Affective Dysorder
WHO	World Health Organization

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