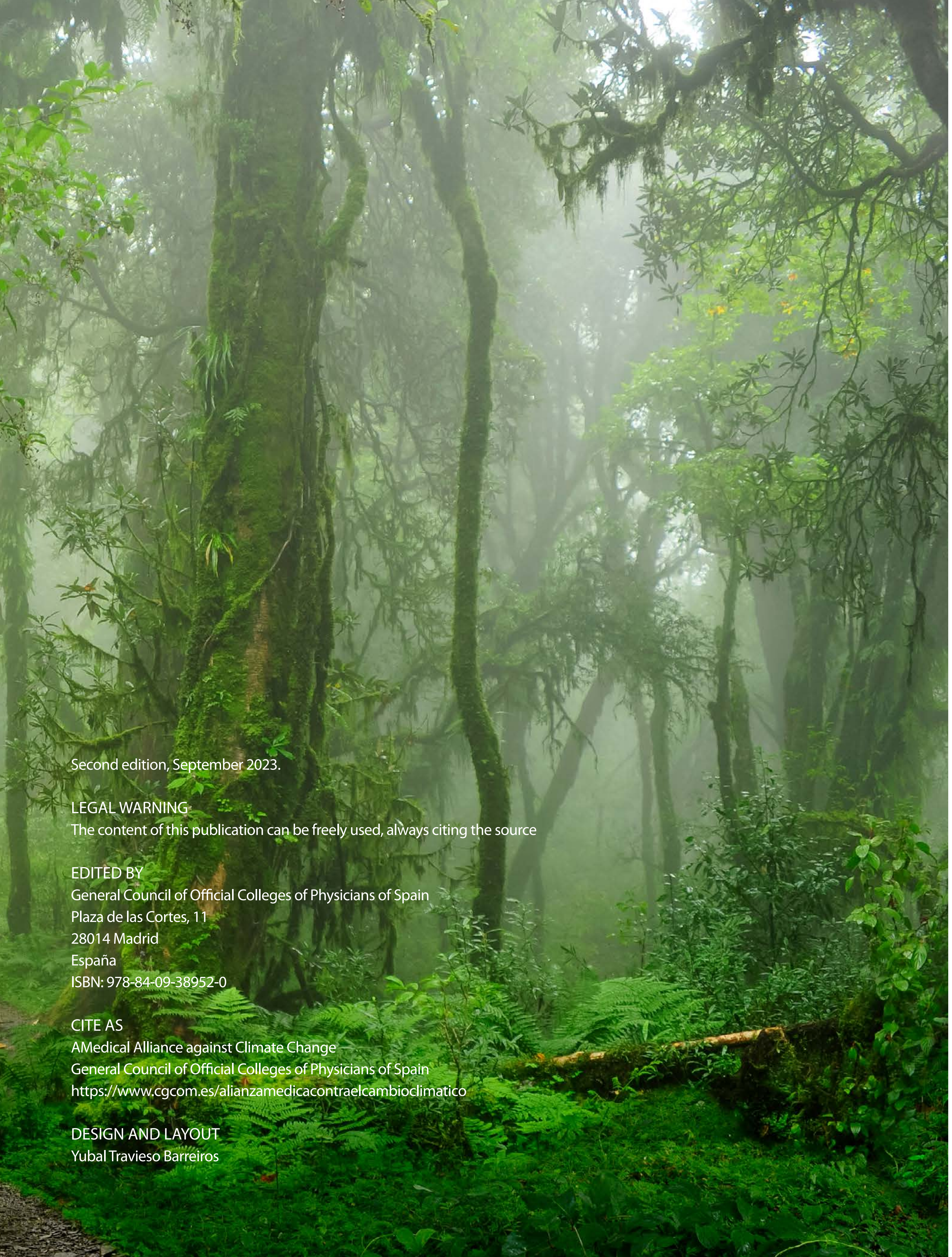
HEALTH AND CLIMATE

Medical Alliance against Climate Change (MACC)

OMC ORGANIZACIÓN MÉDICA COLEGIAL DE ESPAÑA | CONSEJO GENERAL DE COLEGIOS OFICIALES DE MÉDICOS

MEDICAL ALLIANCE AGAINST CLIMATE CHANGE



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MEDICAL SCIENTIFIC SOCIETIES ADHERED TO THE MACC

- Sociedad Española de Cardiología | Fundación Española del Corazón
- SEDAR Sociedad Española de Anestesiología, Reanimación y Terapéutica del Dolor
- semFYC Sociedad Española de Medicina de Familia y Comunitaria
- Sociedad Española de Medicina Preventiva Salud Pública e Higiene
- sedisa sociedad española de directivos de la salud
- Sociedad Española de Neumología y Cirugía Torácica SEPAR
- SEOM Sociedad Española de Oncología Médica
- SEMI Sociedad Española de Medicina Interna — La visión global de la persona enferma
- SEPSM sociedad española de psiquiatría y salud mental
- AEC
- SEOR Sociedad Española de Oncología Radioterápica
- Sociedad Española de Nefrología
- Sociedad Española de Reumatología
- SEMG Sociedad Española de Médicos Generales y de Familia
- seram Sociedad Española de Radiología Médica
- SEMERGEN AP Sociedad Española de Médicos de Atención Primaria
- Sociedad Española de Oftalmología
- Sociedad Española de Cirugía Pediátrica 1962

ABBREVIATIONS

APA	American Psychiatric Association
BAI	Breath Actuated Inhaler
CGCOM	Consejo General de Colegios de Médicos (Spain)
COM	Colegio Oficial de Médicos (Spain)
COPD	Chronic Obstructive Lung Disease
CVD	Cardiovascular Diseases
DPI	Dry Powder Inhaler
EU	European Union
GDP	Gross domestic product
GHG	Greenhouse Gas
GHGP	Greenhouse Gas Protocol
GIRFT	Getting It Right First Time
GWP	Global Warming Potencial
HFA	Hydrofluoroalkanes
HFC	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
MACC	Medical Alliance against Climate Change
MSS	Medical Scientific Societies
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
PHC	Primary Health Center
PM	Particulate Material
pMDI	Pressured Metered Dose Inhaler
SDG	Sustainable Development Goals
SMI	Soft Mist Inhaler
SNS	Servicio Nacional de Salud (Spain)
WHO	World Health Organization

FOREWORD

The Medical Alliance against Climate Change (MACC) was established, in December 2021, as a common space for Spanish doctors that brings together all the Official Colleges of Physicians of Spain represented by their General Council and a large group of medical scientific societies, with the intention of facing the climate crisis and the sustainability of the planet from a common position.

The MACC understands the fight against climate change as a preventive medicine action and, recently, the Central Commission of Ethics and Medical Deontology of the General Council of Medical Colleges of Spain has established as an ethical duty of Spanish doctors their involvement in the sustainability of the planet.

The health sector forms a socially credible and influential community, although often marginalized in many forums to combat the climate crisis.

The COP 26 Presidency established a Health Program that, among other issues, called on countries to establish their development projects for climate resilience, decarbonization and development of sustainable health systems [1]. Likewise, governments must rely on their professionals and rely on their political, economic and moral influence to strengthen the climate and health relationship, show solidarity with the most vulnerable and ensure a healthy future for today's children and young people [2].

Within this strategy, four major actions have been established to make the healthcare world visible as a main actor in the decarbonization of the planet and in climate change mitigation and resilience plans.

1. Train health professionals to face climate change

In order for workers in the health sector to be trained to face the challenges of climate change, they need additional training, allocate resources, promote research and have support programs [3]. Beginning by updating the training of process leaders. With all this, professionals must be able to anticipate and treat secondary vulnerabilities to climate change. In addition, this training must be aimed at reducing the carbon footprint of the health sector itself, making it more resilient.

2. Act in the health sector towards a low-emission, resilient and sustainable health sector

The health sector is one of the sectors that generates the most employment with an economic impact close to 10% of GDP. Therefore, leaders in the healthcare world have an ethical duty to reduce their own carbon footprint to protect the vulnerable population they care for. The proposal must be to reach 2050 free of emissions for which a roadmap must already be in place.

3. Advocate for health professionals who are aware of the relationship between health and climate change

Health professionals are highly credible communicators with the general population. And their social capillarity invests them in the ideal transmitters to raise awareness in society and promote policies that face the climate crisis. Governments and health authorities must give all possible support to sensitize their health professionals and collaborate with them to face the challenges of climate change.

4. The health sector must position itself as a defender of the next generations

Children are a vulnerable population in the face of climate change. In addition, social inequities are magnified in the environmental aggression to the world of children. Every year, environmental factors claim the lives of 1.7 million children under the age of five. For all these reasons, the authorities and the health world must make an effort to mitigate and resilient future generations.

On the other hand, international agreements, such as the 2030 Agenda and the Sustainable Development Goals (SDGs) make special reference to the world of health, prioritizing them in third place. For its part, the EU has published a wide range of regulations in this regard.

The World Health Organization (WHO) have generated multiple documents on climate change as an inducer of different diseases and health risks. Without neglecting this effect, this document also addresses this relationship in the opposite direction, analyzes the aggression that the health sector poses to the environment and its role in climate change; with special attention to the production of greenhouse gases and the generation of waste. Likewise, it addresses the possibilities of the health sector to contribute to the decarbonization of the planet, promoting biodegradable products, the circular economy and, above all, the commitment of doctors to minimize climate aggression both in their daily work and in the orientation of the medical council to the population.

The benefactor role that society recognizes in the health sector is masking its role as an environmental aggressor. Two examples are enough to make an approximation to this threat: 1) Considered as a whole, the health sector would be the fifth country with the greatest climate aggression and 2) Within the sector, only the pharmaceutical industry releases more greenhouse gases (GHG) into the environment than the automotive industry [4].

In short, in the face of the climate crisis, doctors must be heard and empowered by the public authorities and must make a self-reflection that, together with their patients, turns them into agents of the sustainability of the planet.

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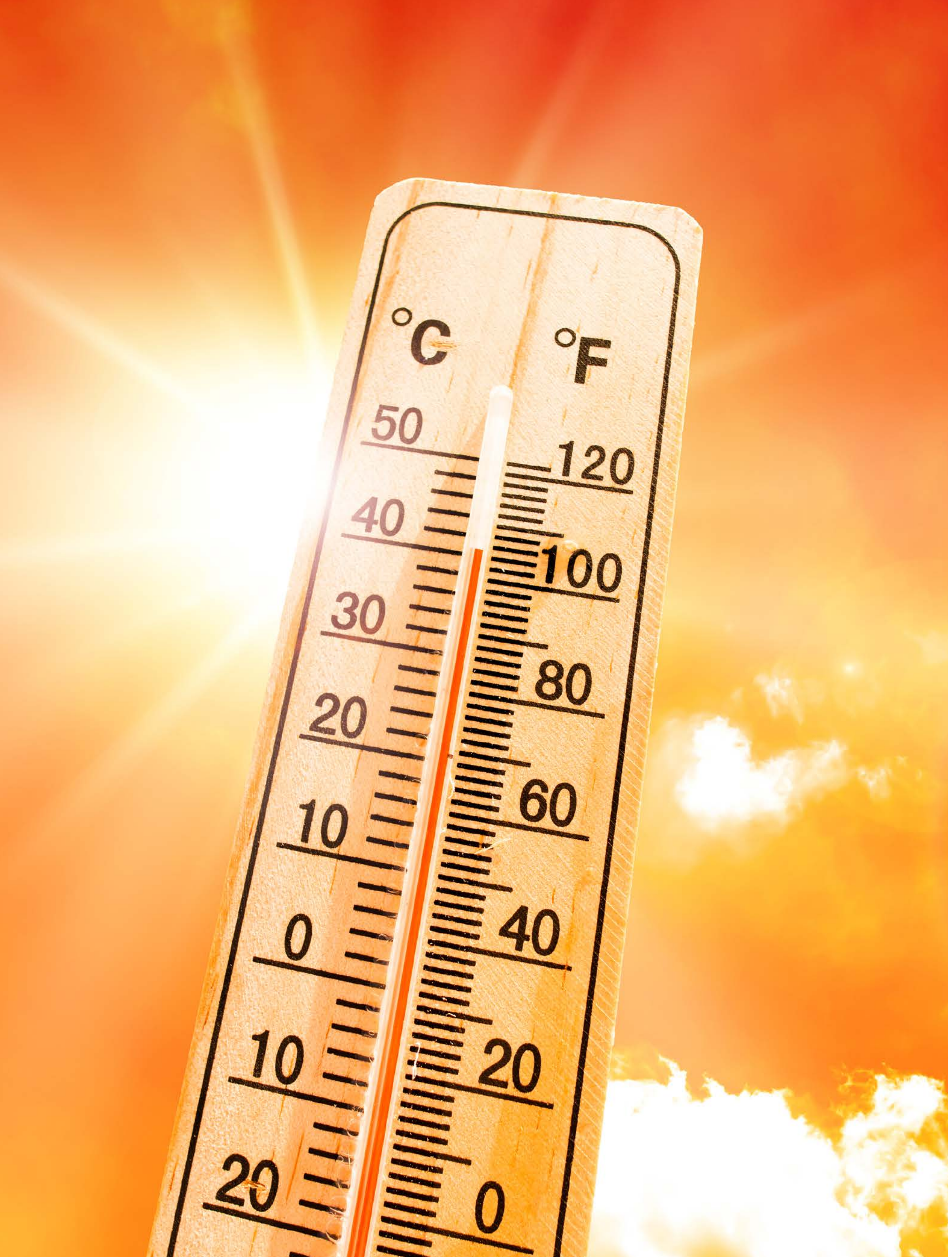


CHAPTER I
THE IMPACT OF CLIMATE CHANGE IN HUMAN HEALTH

Climate change poses a threat to population health through multiple pathways. The anthropogenic creation of greenhouse gases has led to a progressive warming of the planet, altering ecosystems and facilitating record-breaking heat events that occur each year [1]. The consequences of global warming are diverse, and how they affect health will depend on the geographic location and the adaptive capacity of the affected population. The impact of climate change is far from uniform, generally affecting the most vulnerable populations, including the elderly, children, and particularly countries with limited economic resources. This phenomenon has been referred to as climate racism [2].

As the planet's temperature increases, deaths related to cold weather decrease. However, this reduction is overshadowed by the increase in deaths related to extreme heat events. The World Health Organization estimates that starting from 2030, there will be an additional 250,000 direct deaths attributable to climate change[3]. Nevertheless, mortality due to indirect causes is much higher. The medical journal The Lancet has defined climate change as the greatest health challenge of the 21st century[4].

The effects of climate change include vector-borne infections, damage caused by water pollution after extreme rainfall events, increased respiratory infections due to temperature variations, higher incidence of allergic and asthmatic diseases due to pollen, destabilization and mortality from extreme heat events, lung and cardiovascular damage due to urban pollution, psychiatric disorders, and malnutrition in countries with limited economic resources [5].

I. Climate change and health

This review of the damage caused by global warming to health does not aim to be exhaustive but rather to provide a general understanding of its impact on health. It highlights the need for decarbonization as a preventive measure to reduce the number of diseases in the general population and to avoid destabilizing individuals with established respiratory and cardiovascular diseases.

I.1. Climate change and respiratory diseases

Climate change poses a clear threat to respiratory health, promoting the emergence of respiratory pathologies or exacerbating existing ones. The most affected diseases include asthma, rhinosinusitis, chronic obstructive pulmonary disease (COPD), and respiratory infections. The impact of global warming on the respiratory system is such that there has been a reversal in the seasonal pattern of deaths due to respiratory causes, with more deaths occurring in the summer months

than in winter [6]. It has been demonstrated that during the summer, for every one-degree Celsius increase above 29°C, mortality and hospitalizations due to respiratory causes increase by 7% and 4%, respectively. These figures are of greater magnitude than those caused by low temperatures [6].

The relationship between climate change and environmental pollution has been extensively studied. Tropospheric ozone (O_3) has a formation rate that depends on temperature, making it directly related to global warming [7]. Ozone is associated with decreased lung function and increased mortality, particularly in children and adults. Moreover, it triggers exacerbations of COPD and asthma [8, 9].

Pollution, which is a contributor to climate change, also has deleterious effects on respiratory health. Fine particulate matter with a diameter of less than 2.5 µm ($PM_{2.5}$) is responsible for mortality due to COPD as well as lung cancer [10]. The risk of lung cancer in individuals who have never smoked increases by 15% to 27% for every 10 µg/m³ increase in $PM_{2.5}$ [11].

Another effect of climate change on respiratory pathologies is related to alterations in pollen patterns. It has been demonstrated that climate change affects the distribution of pollen on a global scale [12]. The effects of warmer temperatures and increased CO_2 levels on pollination lead to increased plant growth, greater pollen production per plant, higher levels of allergenic proteins in pollen, and an early and prolonged pollen season [13]. It has been theorized that the increase in allergic respiratory diseases related to pollen may be due to the effect of global warming. The association between storms and asthma morbidity is well-established, with a clear relationship between the onset of the storm and the peak concentration of pollen in the air [14]. The impact of pollution (especially diesel particles) and pollen has also been studied. Diesel particles increase the concentration and biological activity of allergens, contributing to asthma exacerbations [15].

I.2. Climate change and cardiovascular diseases

Climate change directly affects cardiovascular diseases (CVD). The effects of heat are reflected in the number of hospitalizations due to CVD. It has been shown that during extreme heat days, there is a 7% increase in the risk of myocardial infarction[16]. This risk persists in the following days, with a 4% increase in hypertensive crises and a 6% increase in cardiac arrhythmias. Comprehensive studies have demonstrated that for every 1°C increase in temperature, the risk of hospitalization for myocardial infarction increases by 1.6%. The relationship between heatwaves and myocardial infarction is even stronger [17, 18]. This relationship is also present during episodes of extreme cold temperatures and is more frequent among elderly individuals [19]. As temperatures continue to rise, an increase in cardiovascular mortality is expected, reaching up to 10.2% depending on the different scenarios studied [20].

Pollution also affects mortality in cardiovascular diseases. Chronic exposure to $PM_{2.5}$ affects vascular function, which can lead to myocardial infarction, hypertension, stroke, and heart failure [21]. Recent studies have shown that excess mortality due to air pollution in Europe is around 790,000, of which 40% to 80% are due to cardiovascular causes, reducing life expectancy in Europe by approximately 2.2 years [22]. Nitrogen dioxide (NO_2), a common chemical compound in urban pollution, independently affects excess mortality due to CVD (1.23% of excess cardiovascular deaths), regardless of $PM_{2.5}$ and PM_{10} [23].

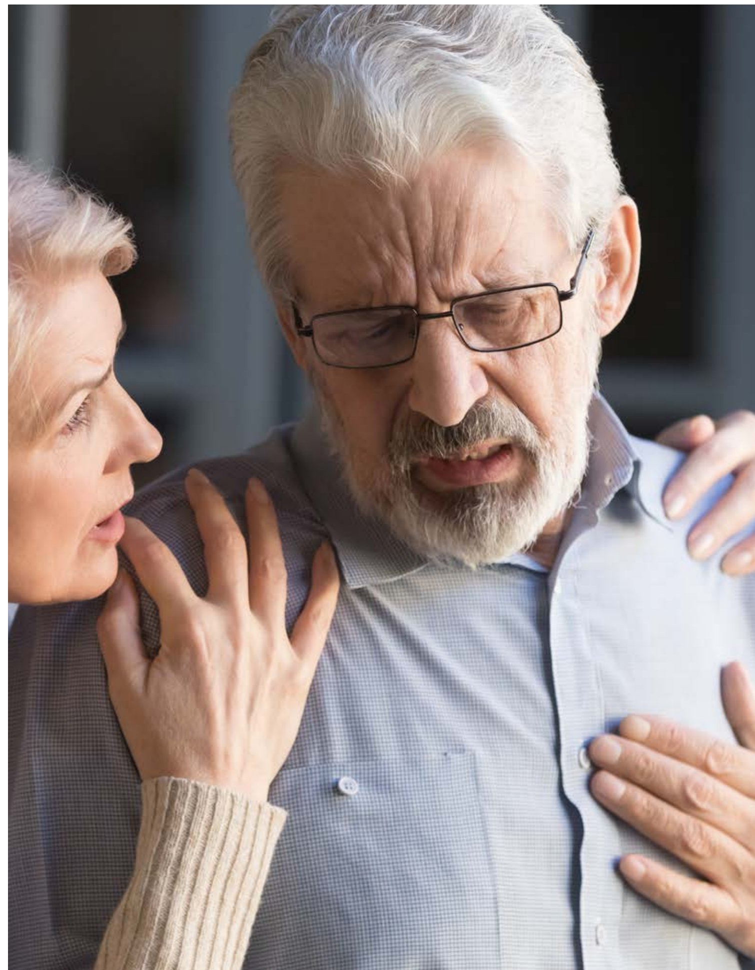
I.3. Infections

I.3.1 Respiratory Infections

The relationship between respiratory infections and climate change is complex [24]. Global warming decreases the number of infections in winter but increases the overall count due to temperature instability. There is evidence that shows how intraday temperature or temperature variation between two consecutive days can increase the relative risk for the development of pneumonia in children and the elderly. This temperature variation can occur in both winter and summer, and a greater variation corresponds to a higher relative risk for pneumonia [25]. It is known that the increase in intraday or two-day temperature difference is directly linked to global warming [1]. The incidence of pneumonia is also increased in relation to precipitation [26].

Another complex interaction related to climate change is the annual influenza epidemics. Studies have shown that after warmer than usual winters, influenza A and B epidemics appear earlier and with more pronounced peaks of contagion [27]. This is likely due to a larger number of susceptible individuals following a previous winter with high ultraviolet radiation and few infections.

Extreme natural phenomena, also linked to climate change, play a role in lung infections. It has been demonstrated that storms can aerosolize soil fungi spores and disseminate them over wide areas. Large outbreaks of coccidioidomycosis have been reported following storms and earthquakes [28, 29], with



seasonality in outbreaks dependent on extreme climate conditions [30].

Pollution also has an impact on respiratory infectious patterns. There is ample evidence that clearly associates high levels of PM_{10} and O_3 with hospital admissions for pneumonia [31, 32].

I.3.2 Vector-Borne Infections

Climate change affects the distribution of vector-borne infectious diseases, mainly transmitted by mosquitoes (such as dengue, chikungunya, hantavirus, malaria, Rift Valley fever, west Nile virus, or zika) [5]. Since the 1990s, five different species of Aedes mosquitoes have been introduced in Europe [33]. It is expected that these species will expand across the continent as temperatures rise due to global warming [34, 35]. Examples of this are the dengue outbreaks in France and Croatia in 2010 [36] or the chikungunya outbreak in France [37]. Studies have demonstrated the involvement of climate change in this phenomenon, observing how different meteorological scenarios increase the probability of dengue outbreaks along the Mediterranean and Adriatic coasts due to global warming [38].

The West Nile virus is another vector-borne disease whose expansion is dependent on global warming [39]. Since 1999, outbreaks of this virus have caused over 39,000 human infections and more than 1,600 deaths in the United States [40]. In Spain, an unprecedented outbreak occurred in Seville during the summer of 2020, resulting in at least 8 deaths [41].

Malaria is another disease that sees its epidemiology modified in the changing climate scenario. High temperatures reached in summer increase the opportunities for transmission by shortening the development period required by the parasite inside the mosquito [42]. For example, after an intense El Niño event in the 1990s that caused torrential rains in the Horn of Africa, an increase in malaria deaths was detected in Kenya and Uganda [43, 44]. Special emphasis is placed on Plasmodium vivax, which has recently re-emerged in Europe, with local transmission reported in Greece [42].

Other vectors to consider are ticks, which transmit Lyme disease. Climatic and land use factors are responsible for the expansion and geographic distribution of I. ricinus ticks, and there is evidence of their expansion in Scandinavia and at unusual altitudes [45, 46]. Climate models in Europe suggest that the expansion of this vector could double in the future [47].

I.3.3 Digestive Infections

Digestive infections caused by the Vibrio family are known to have a pronounced seasonal nature, with a predominance in the warmer months [48]. In fact, vibrio infections are the only ones that are increasing in incidence in the United States[49]. These infections have caused outbreaks in previously disease-free areas in the northwest United States, as well as in northern and western Europe and Israel [50-52]. These outbreaks appear to be closely linked to climate change [53]. Changes in sea surface temperature are considered the main drivers of the impact on coastal ecosystems worldwide [54]. It has been shown that the warming of the sea surface is accompanied by an increase in vibrio concentrations [55]. This warming is responsible for outbreaks of V. parahaemolyticus in Alaska [56] and also in northern Spain [57]. Heatwaves are also clearly associated with an increase in infections caused by this family of microorganisms [51].

I.4. Climate Change and Psychiatric Illness

The threat of climate change is an emotional and psychological stressor. Both individuals and communities are affected by it, either directly through the experience of local phenomena or through exposure to information about global warming and its effects [58]. The American Psychiatric Association (APA) published a position statement in 2017 clearly stating the threat that climate change poses to mental health. Individuals with psychiatric disorders are disproportionately susceptible to the consequences of climate change [59]. The most common symptoms range from mild stress to depressive disorders, anxiety disorders, post-traumatic stress, and suicidal thoughts[60-62]. As is often the case with the consequences of climate change, the most vulnerable populations (children, chronically ill elderly individuals, socioeconomically disadvantaged individuals, immigrants, etc.) are the most disadvantaged and at higher risk for the development of psychiatric and psychological symptoms [63-67]. It is also noteworthy that extreme heat events are particularly relevant for patients receiving antipsychotic drugs. These medications decrease the physiological heat regulation capacity and fluid homeostasis, making them an established risk factor for emergency hospital admissions due to heat-related illnesses [68].

II. Environmental pollution and health

Pollution, particularly, air pollution, is associated with a high-rate mortality. Pollution was responsible in 2019 for approximately 9 million premature deaths, with air pollution contributing for more than 6 million [69]. As often occurs in planetary health, the majority of the mortality attributed to pollution is in the vulnerable population of developing countries [21, 70]. In fact, the importance of pollution equals that of the tobacco pandemic [71]. The constituents of air pollution are in part the same that create the global warming (burning fuels results in fine and ultrafine particles but also in long-lived greenhouse gases and short-lived climate pollutants as methane or hydrofluorocarbons)[1] , but the action of pollution is primarily localized rather than global in nature. The most common gases are CO, SO_2, NO_2 (all of them coming from combustion and diesel emissions) and O_3 (tropospheric ozone). These pollutants are categorized by size in PM_{10} and $PM_{2.5}$ (fine particulate matter whose diameters are less than 10 and 2,5 microns respectively). While PM_{10} primarily affects the airways, $PM_{2.5}$ penetrates deeper and can even enter the circulatory system, leading to oxidative stress and systemic inflammation [72].

Pollution has several effects on health. Regarding the cardiovascular system, several studies had addressed the increased risk of cardiovascular events with long-term and short-term exposure [73, 74]. In fact, mortality is increased in $PM_{2.5}$ long-term exposed individuals from ischemic heart disease, arrhythmias, and heart failure [75]. Additionally, short-term exposure to pollutants like SO_2 and NO_2 has been linked to increased mortality rates, with the risk escalating as pollution levels rise [76,77].

The respiratory system is particularly susceptible to the detrimental effects of pollution, given its direct exposure to the environment. As stated before, lung development could be impaired due to pollution and the prevalence of asthma increases as the level of PM gets higher [78, 79]. There is substantial evidence demonstrating a relationship between traffic-related pollution and the development of asthma and rhinitis in an exposure dependent manner [80, 81]. Asthmatic patients exposed to pollution can also experience non-reversible chronic obstruction with a more pronounced decline in lung function and an increased risk of emergency department visits for exacerbations [82-84]. Furthermore, $PM_{2.5}$ and NO_2 have been associated with increased sensitization to allergens, acting as adjuvants that enhance the allergic response, particularly to birch and grass pollen [85, 86].

COPD patients are also profoundly affected by pollution. While the evidence supporting air pollution as the primary cause of COPD is limited, numerous studies have established a connection between air pollution and the worsening of COPD symptoms, exacerbations, hospitalizations, and even mortality [87, 88]. Moreover, pollution have also been related to higher incidence and death of lung cancer [11, 89]. There is also a direct association between air pollution and lung infections [90-92].

Beyond cardiovascular and respiratory health, pollution has ramifications for various other organs and systems, including its association with increased all-cancer mortality, autoimmune diseases, stroke, dementia, and even suicide[93-96].

III. Miscellaneous

Climate change causes indirect health effects that are difficult to quantify. For example, it has been shown that wildfires caused by global warming, such as those in the northwest United States in 2016, can increase pollution levels up to tenfold, leading to detrimental respiratory effects [97,98].

A significant effect of climate change is observed in the nutritional quality of cereal crops such as rice and oats. There has been a decrease in protein levels as well as a range of micronutrients and vitamins [99-101]. In fact, it is estimated that by 2050, due to global warming, there will be a net increase of 529,000 adult deaths worldwide as a result of reduced access to food (mainly fruits and vegetables) [102]. In this regard, the World Bank estimates that without sustainable development, climate change could expose 100 million people to extreme poverty by 2030 [103].

Climate change also affects migration patterns. For example, asylum applications to the European Union from more than 100 countries increased in a non-linear manner when temperatures deviated from the optimal average (approximately 20 degrees) during the maize growing season, especially when temperatures were higher. It is estimated that with current temperature increase projections, asylum applications could increase by 175% by the end of this century [104]. It is also important to consider migrations that accompany droughts. These migrations can lead to violence, malnutrition, and the spread of certain infectious diseases (respiratory and digestive).

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CHAPTER II
IMPLICATIONS OF HEALTH ACTIVITY ON CLIMATE CHANGE

Both, society and the national health systems themselves recognize a benefactor role for the world of health, this vision has obscured its role as an environmental aggressor. Few health centers have been concerned with determining their carbon footprint, assessing their emissions, or quantifying the quality and quantity of their waste.

I. Determination of the carbon footprint of the Spanish National Health Service (SNS)

It is recommended that the engineering departments of each health center, within their management plans, determine the carbon footprint of the institution following a series of steps: analysis of the starting point, contribution of each source of emissions, time frames to reduce emissions and financing.

Moreover, they should make a schedule with a deadline to reach the zero-emission rate in the most relevant scenarios. All this, with the conviction that reducing emissions costs money and its financing must be ensured.

The Greenhouse Gas Protocol (GHGP) addresses the standardization of its measures for the best comparison between different institutions and for international transparency [1].

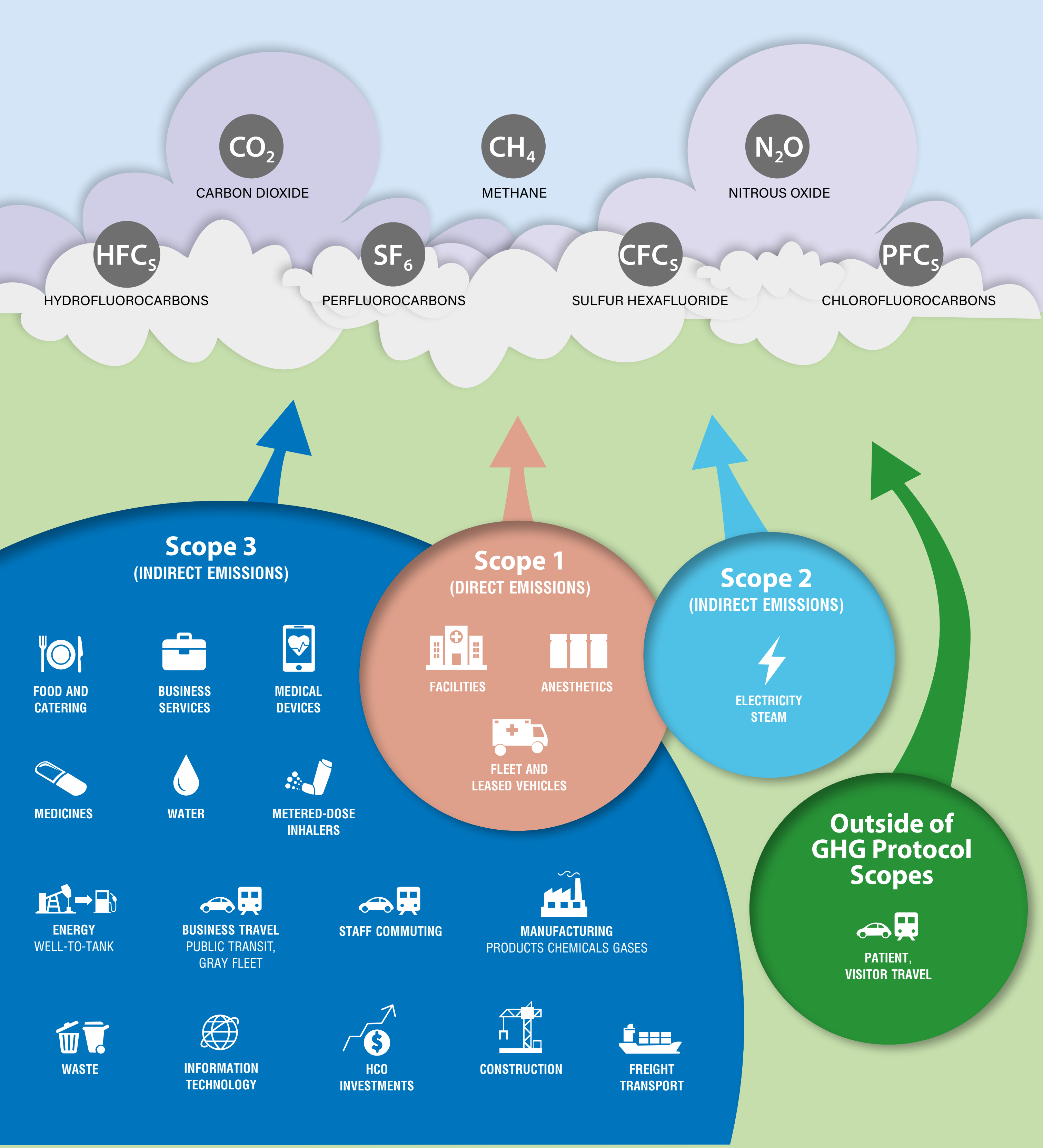
According to their origin, the GHGP classifies the emissions of any institution, in three main areas:

- **GHGP scope 1:** emissions from own sources and under direct control of the institution.
- **GHGP scope 2:** emissions derived from the consumption of energy contracted to third parties, with special attention to electricity consumption.
- **GHGP area 3:** emissions derived from the set of external activities in the transport of goods or services.

Although the emissions derived from other companies or users, outside the institution, but related to its activity, are not accounted for in scope 3 of the GHGP, they should be added to it or accounted for independently.

Within this last group, it is necessary to include the proportional part that corresponds to the institution on the emissions generated in the manufacture of equipment and drugs to which in public tenders it is convenient to require a certification of their environmental impact and give a bonus coefficient related to the same.

MAJOR GREENHOUSE-GAS EMISSIONS



Hardeep Singh, M.D., M.P.H., Matthew Eckelman, Ph.D., Donald M. Berwick, M.D., M.P.P., and Jodi D. Sherman, M.D.
Mandatory Reporting of Emissions to Achieve Net-Zero Health Care. N Engl J Med 2022;387: 2469-76

I.2 The route to decarbonize the SNS.

Actions in this regard must meet criteria that allow a commitment to zero emissions on a certain date, the National Health Service (NHS) of the United Kingdom has imposed the year 2040. For this, it is recommended to plan periodic reductions, five-yearly, and under the premises of the Paris Agreement for Climate Change [2].

The programmed objectives must be: urgent, ambitious, possible, adjusted to innovations and government guidelines. The UN Framework Convention on Climate Change advises the itinerary known as *Race to Zero*: reduce emissions by 50% in 2030 and reach zero emissions in 2050, compared to 2010 levels.

I.2.1 The reduction of emissions in the hospital environment

Newly built hospitals must have a project that allows them to reach zero emissions in the time period that has been foreseen. Its ability to adapt to new technologies that are under development and have future viability must be foreseen.

But, to this day, the greatest effort has to be made to reduce emissions from current hospitals. The reduction of the carbon footprint of the institution must be contemplated within the management plans of each institution with concrete actions, financed and to be carried out in determined terms. The creation, or assignment of functions, to a technical body is recommended to plan a common hospital policy strategy on energy efficiency issues, such as:

- 100% LED lighting.
- Efficiency in air conditioning.
- Replacement works with energy efficient materials.
- Ventilation.
- Centralization policy for refrigerators and freezers.
- Hot water.
- Use of artificial intelligence for energy control and monitoring.
- Use of free spaces (patios, rooftops…) for the installation of renewable energy sources.
- Contract with electricity distributors for 100% renewable energy.

These actions must be implemented in a short period of time, no more than three years, in a small number of hospitals, before making them more extensive.

I.2.2 The reduction of emissions in the field of Primary Care Health

The new Primary Health Centers (PHC) must be projected with the goal of zero emissions as soon as possible and adjusting to the needs required for new future technologies currently under development.

The biggest challenge is to condition the current national PHC network to improve its energy insulation, lighting and air conditioning. Apart from these structural works, the installation of photovoltaic panels and aerothermal pumps represent a significant reduction in GHG emissions.

A group of PHCs should be established as soon as possible as a pilot experience and monitor the evolution of their carbon footprint.

On the other hand, from now on, each PHC should monitor its carbon footprint and its annual evolution.

I.2.3 Mobility and transport

It has been considered that up to 14% of the world's healthcare emissions come from means of transport [3]. To this end, a series of actions are recommended that involve:

- The means of transport, owned or contracted, of the SNS must be 100% electric in a period not exceeding 10 years, committing to a gradual implementation within a schedule.
- Assign high value in public tenders to any concerted company that uses vehicles with ultra-low emissions.
- Promote vehicle electric charging points in health facilities.
- Reduce unnecessary trips by patients and providers, promoting online activity.
- Encourage non-polluting mobility among employees.
- Declare, as far as possible, the sanitary facilities as zero emissions inmobility, preventing the passage of high-emission vehicles.
- Facilitate access to health centers by public transport or by healthy means such as lanes and bike parking or pedestrian paths.

To promote these actions, a mobility plan must be required within the strategic development and agreed management plans.

I.2.4 Supply chain

The SNS must be aware of the power it has to modulate the carbon footprint of its suppliers, influencing through its public budgets the innovation of suppliers and the acquisition of products with a lower carbon footprint in their production, transportation and generation of waste.

This policy implies requiring suppliers:

- Transparent certification of their carbon footprint reduction program.
- Reduction of single-use plastics.
- Promote the use of biodegradable polymers.
- Reduction in the use of paper.
- Reduction of water consumption.
- Recycling of metallic material.
- Reuse of material.
- Electrified transport.

I.2.5 Foods and catering

Fresh, local, zero kilometer, and seasonal foods represent significant savings in emissions in transportation, refrigerated storage, and packaging. This means reaching agreements with local producers to ensure supplies with the involvement of hospital dietetics services. In this sense, the EC has designed a protocol called The Farm to Fork Strategy.

I.3 Medications

Due to the curative role assigned to medicines, there is a false impression that the pharmaceutical industry is a green activity. For this reason, many are surprised to know that the pharmaceutical industry produces more greenhouse gas emissions than the automotive industry [4].

In the UK, pharmaceuticals account for up to 25% of NHS emissions [5]. It can be assumed that in Spain this percentage is similar. Emissions include their industrial production, transportation, release into the environment, and waste.

I.3.1 Industrial production of medicines

Two of the countries with the largest pharmaceutical production, China and India, are among the most polluting in the world. In addition, because it has a minimum rate of renewable energy, its greenhouse gas emissions are higher than those generated in European territory. Although the quality of the drugs that are imported into Europe are endorsed by the European Commission, through the Correct Manufacturing Standards Guide [5], this guide contemplates the quality control of the manufacturing and the traceability of the drugs, but does not the environmental impact of the process. Furthermore, many of these factories are general chemical factories and their sensitivity to public health may not be sufficient.

The intensity of emissions from different pharmaceutical companies differs enormously. In 2015, the most polluting one multiplied by seven the CO_2 equivalent emissions of the cleanest [4].

I.3.2 Transport and supply

The distance of the manufacturers determines the transport of a large number of active ingredients by air or sea which, subsequently, are frequently dosed and packaged in other country. To add up its set of emissions, the carbon footprint of this entire process should be quantified, from the factory exit to its subsequent handling and transfer to the final point, the pharmacies. In the United Kingdom it has been quantified that medicines account for 25% of NHS emissions. Of that 25%, 20% is attributed to its manufacture and the transport and supply chain [6].

In this sense, it would be advisable to promote, as far as possible, the production of drugs in national territory, or in territorial contiguity, and their transport by low-emission vehicles.

Likewise, a green passport for drugs is recommended that assesses their carbon footprint in the manner of energy efficiency color coding and encourages those that generate fewer emissions in public tenders.

I.3.3 Pressurized inhalers

Several respiratory diseases, especially asthma and chronic obstructive pulmonary disease (COPD), are treated with inhaled medication on a daily basis and, in most cases, for life. Four modes of administration are available: 1) GHG pressurized inhalers [pressured metered dose inhaler (pMDI)]. There are some pressurized inhalers with the specificity that they are triggered by the patient's inhalation [breath actuated inhalers (BAI)], their role in GHG emission is the same as pMDI and, therefore, they are assimilated to them. 2) dry powder inhalers (DPI), 3) soft mist inhalers (SMI), and 4) medication nebulized by means of an electric compressor or by pressurized oxygen or air.

The pMDIs carry the drug in compressed gases, in a liquid state, from the family of hydrofluoroalkanes (HFA) also known as hydrofluorocarbons (HFC). Specifically, two gases are used: HFA 134a and HFA 227. Both have an excellent human safety profile. However, they are GHGs with a high potential for global warming, with a lifetime in the atmosphere of 14.6 and 36.5 years, respectively [7,8]. Their long life as GHG endows them with a high cumulative power.

For HFA 227 it has been calculated that one dose (two puffs) has a global warming potential of 1,300 times that of the equivalent mass of CO_2 [9]. It is estimated that between 3.5 and 4% of the NHS's carbon footprint is due to pMDIs and that replacing 10% of pMDIs with DPIs would save 68.6 ktCO_2eq each year [10,11]. On the other hand, a comparative study of the carbon footprint of pMDIs versus DPIs, including their footprint from their production to their consumption, found that the former multiplied by 30 the footprint of the latter [12].

According to the NHS, a pMDI cartridge contains as many GHGs as those produced by a conventional car traveling 300 km [13].

The annual sale of pMDI in Spain is around 15 million units, which represents a GHG release equivalent to 400 tons of CO_2. Currently, many prescriptions in pMDI format can be replaced by the same active principle in DPI or SMI format, devoid of GHG.

Physicians are recommended to maintain a proactive attitude to change their prescription habits from pMDIs to GHG-free devices, always taking into account the circumstances of each patient. Physicians should try to have their first prescriptions for inhalers be in DPI or SMI and change their previous prescriptions in pMDI to these devices, always through dialogue and consensus with their patients [14]. However, pMDIs, always administered through inhalation chambers, should continue to be available due to their usefulness in children under five years of age, in some special situations and for those adult patients who prefer this type of device, to whom they have special adherence, they are 19% of all patients treated with pMDI [15]. Outside of these circumstances, prioritizing DPI, SMI or nebulization over pMDI is recommended by therapeutic guidelines, scientific societies and health authorities [16,17,18,19,20].

On the other hand, pMDI, once exhausted, continue to contain GHGs and should not be thrown away but rather deposited in pharmacies for treatment through specific programs.

I.3.4 Anesthetic gases

Halogenated anesthetics and nitrous oxide (N_2O) are potent greenhouse gases with high global warming potential (GWP). Because they are considered essential medicines, they have not been subjected to a special regulation of environmental emissions. Since they are not metabolized, they are discharged into the atmosphere after use, where the halogenated ones remain between 1 and 14 years and the N_2O 114 years [21].

The GWP scale compares the contribution to global war-

ming of a given gas with the same mass of CO_2 (CO_2eq) and is related to different periods of time, with 100 years being the usual reference of the international body for evaluating scientific knowledge on climate change [Intergovernmental Panel on Climate Change (IPCC)]. Desflurane (2,540) has the highest GWP, followed by isoflurane (510) and sevoflurane (130) [21]. This means that the carbon footprint of the first is 15 times greater than that of the second and 20 times greater than that of the third.

For easier understanding, one hour of anesthesia with desflurane is equivalent to the emissions of a car traveling 643 km, with isoflurane 29 km and sevoflurane 13 km.

Individual anesthetists should: a) Avoid, if possible, desflurane and N_2O. b) Use low-flow anesthesia. c) If possible, use intravenous or regional anesthesia [22,23].

For their part, health institutions must seek to incorporate technological innovations capable of capturing anesthetic gases after use for their absorption and subsequent destruction or reuse [24]. As well as evaluating new anesthetic gases, such as Xenon, without environmental impact.

I.4. Innovation and research

The SNS must be connected with the industry and research centers of excellence, directly or through mixed commissions with the environmental authorities. All this to incorporate innovations that tend to:

- Replace disposable equipment with reusable ones.
- Reduce the consumption of plastics and other products with an environmental impact.
- Advance in technology to capture carbon emissions.
- Reduce the water footprint.
- Be self-sufficient in clean sources of energy.

On the other hand, the SNS's own research must also comply with the regulations aimed at decarbonization. It has been estimated that the 350,000 clinical trials registered on ClinicalTrials.gov will emit 27.5 million tons of CO_2eq. And that half of them are trials of drugs that, in the United Kingdom, have been estimated to account for one fifth of the CO_2 emissions of the NHS [25]. In this sense, the Institute for Health Research (NIHR) has published a guide for CO_2 reduction [26].

From this perspective, projects must be prioritized by ethics committees and funders.

I.5. The strategy and commitment in the decarbonization of health

An inclusive position of all the people and institutions involved must be the basic strategic line in the fight against climate change.

The SNS healthcare as a whole must be aware of the lines of action in its decarbonisation, which must include a schedule towards zero CO_2 emissions, based on three basic premises: new healthcare models, efficient professional teams with leadership capacity and budgetary and financial resources.

I.5.1. New models of health care

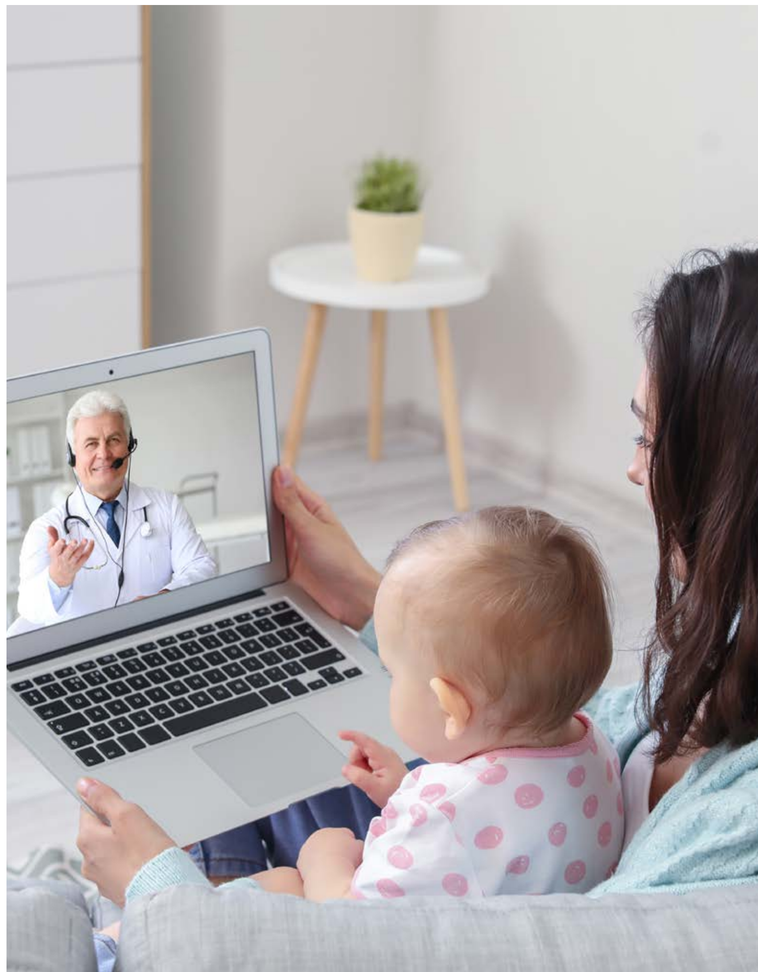
Extra-hospital assistance should be encouraged for all those services that can be attended in the proximity of the citizen. This attitude has been quantified in the United Kingdom, which saves 8.5 million km in unnecessary journeys and 1.7 $ktCO_2eq$ each year [27,28].

To achieve these objectives, it is necessary:

- Promote the health education of the population. Especially about the urgent, the non-urgent and the access routes to face-to-face care.
- Minimize outpatient hospital consultations.
- Create extra-hospital rapid diagnosis centers.
- Implement digital access for patients to their administrative documents, analytical tests and clinical reports.
- Enable digital consultation channels for patient doubts.
- Strengthen local emergency services and telephone triage.

I.5.2. Efficient professional teams with leadership capacity

The standardization of diagnostic decisions, through evaluation of results, not only improves medical care and economic waste, but also translates into a notable decrease in CO_2 emissions.



For this purpose, it will be necessary to promote or create national technology assessment agencies and common care processes, based on benchmarking and clinical evidence, which banish inefficient practices, in the style of the British agency National Institute for Health and Care Excellence (NICE) [29] and the Getting It Right First Time (GIRFT) program [30].

Although most European doctors are supposed to be highly sensitive to climate change, care inertia tends to generate reluctance in the face of new diagnostic and therapeutic attitudes that are sometimes interpreted as purely bureaucratic. In this sense, it is necessary to know these reluctances, face them and channel them. Besides, the institutions must create teams with personal leadership, training and preferential dedication, which plan and lead towards new habits. These teams would be required to submit an annual report on the monitoring of indicators and the achievement of objectives.

These objectives will be difficult to achieve with the sole intervention of the health administration and without the active participation of the professional world, represented in the Colleges of Physicians and Scientific Societies. The administrative field and the professional field must be interrelated through fluid pathways, so that each one understands their role.

I.5.3. Budgetary and financial resources

The commitment to health decarbonization must contemplate large investments for specific objectives that affect: construction of new hospitals or conditioning of existing ones and replacement of large equipment that improves energy efficiency.

On the other hand, the investment goes beyond buildings and equipment. It is necessary to finance the agencies and groups responsible for major decision-making aimed at promoting behavior change among professionals.

In addition, institutions should explore and innovate in alternative investments through other investors and funds.

Likewise, within public tenders, encourage the lowest carbon footprint among all offers.

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CHAPTER III
THE PROFESSIONAL COMMITMENT OF DOCTORS WITH DECARBONIZATION

The Official Colleges of Physicians of Spain (COM), and therefore the General Council of Official Medical Associations of Spain (CGCOM), are public law corporations, contemplated in the Spanish Constitution, and sole and legitimate representatives of the professional performance of the doctor. Its legal personality enables the public administration to delegate functions and participation in representative corporations.

On the other hand, medical scientific societies (MSS) bring together doctors around specific branches of professional development and are responsible for scientific progress, specific training and the promotion of knowledge.

The CGCOM association with the MSS make up the highest leadership within Spanish medicine and this MACC aspires to be the reference platform that articulates the voice of doctors in terms of sustainable development. Likewise, it is offered to health and environmental authorities to collaborate and integrate into interdisciplinary groups committed to the decarbonization of the planet.

This document was initially promoted by CGCOM, the COM of Las Palmas and a group of MSS. The adhesion and reform of the initial project, by the majority of the COMs and MSS implies the endorsement of a large majority of Spanish doctors.

Although the final addressee of the actions promoted in this document is the same, the doctor, the CGCOM addresses all Spanish doctors while the MSSs promote the fight against climate change from the perspective of each medical specialty.

I. The commitment of the general council of official medical associations of Spain

In Spain, millions of medical advices are given daily and no other type of advice improves its compliance rate [1]. On the other hand, no community group has the social capillarity that the healthcare world has [2]. For all these reasons, we give special importance to medical advice and we think that, ethically, it should be put at the service of the fight against climate change.

The CGCOM, reference of the 270,000 doctors who practice in Spain, is committed to raise awareness among all Spanish doctors to combat climate change and take a proactive position in the decarbonization of health, compliance with the 2030 Agenda and the Sustainable Development Goals. To this end, it commits to a series of actions to be carried out over the next four years. Between them,

- Promote medical advice on climate change threats to health [3].

- Promote medical advice on local and seasonal food that avoids long polluting transports, refrigeration and plastics.

- Disseminate among doctors the messages and actions promoted in this regard by the public authorities of the ministries of health and sustainability, establishing concerted action protocols.

- Promote conferences, courses or symposiums to disseminate the threat of climate change among doctors.

- Organize continuous and accredited training on climate change and health.

- Finance research grants on climate change, health and decarbonization of the SNS.

- Collaborate and accept delegated functions from the public bodies that regulate climate change.

- Minimize GHGs that depend on medical prescription: pressurized aerosols and anesthetic gases.

- Minimize GHG and save resources that depend on the work environment (mobility, energy consumption, water savings...).

- Evolve towards a prescription of green medicines that minimize environmental aggression.

- Work towards the correct management of drug residues and sanitary material.

- Collaborate in the reuse of medical material and its circular economy.

- Reduce the carbon footprint of the medical corporations.

II. The commitment of medical scientific societies

Medical scientific societies make up a priority communication channel in the medical world, which by specialties represent the majority of professionals.

The MSS signatories of this document undertake to:

- To promote a session on climate change in their annual congresses.

- To include a section on climate change and the environment in their clinical guidelines and protocols.

- To call for grants for projects related to climate change.

- To train their professionals in each specialty on the impact on health of extreme temperature situations.

- To encourage the prescription of drugs with less environmental impact: "green drugs".

- To promote energy saving, circular economy and appropriate waste management policies in their work environment.

- To collaborate in your workplace with committees or interdisciplinary groups dedicated to the fight against climate change.

- To disseminate among patients the commitment to the planet and the repercussions of climate change on their health [4].

- To promote among patients the correct management of the waste generated by their medications.

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MEDICAL ALLIANCE AGAINST CLIMATE CHANGE