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Faced with a double challenge: obesity and climate change

Francesc Villarroya, Marta Giralt*

Departament de Bioquímica i Biomedicina Molecular, Facultat de Biologia, Institut de Biomedicina de la Universitat de Barcelona (IBUB), Universitat de Barcelona, E-08028 Barcelona; and Centro de Investigación Biomédica en Red Fisiopatología de la Obesidad y Nutrición (CIBERobn), Instituto de Salud Carlos III, E-28029, Madrid, Spain.

E-mail: mgiralt@ub.edu

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Abstract

The current global obesity epidemic is occurring in parallel with global warming due to climate change. Epidemiological evidence suggests a role for increasing environmental temperatures in increasing rates of overweight and obesity. The suppression, caused by high temperatures, of the energy expenditure necessary for adaptive thermogenesis, may be a mechanism that explains the alteration in energy balance caused by global warming, which favors obesogenesis. Reciprocally, there are data indicating that high rates of obesity around the world are causing, directly and indirectly through increased food production and transportation, an increase in greenhouse gas emissions, thus contributing to global warming. The impact of global warming on obesity highlights the dangers of climate change and points to the need for greater action to slow the process to prevent its harmful effects on global health.

Keywords:

- Obesity
- Climate change
- Global warming
- Thermogenesis

Introduction: obesity and climate change, global epidemics

Climate change has been recognized for decades as a global event with possible harmful effects on human health. It is considered that since the 19th century human activities have been the main driver of climate change, mainly due to the burning of fossil fuels, which generates gas emissions, principally carbon dioxide. These gases have a greenhouse effect in relation to the caloric energy provided by solar radiation, thus leading to an increase in temperatures. Additional activities such as deforestation or massive animal production for food contribute to this phenomenon through the emission of gases such as methane, which also has a high greenhouse effect. The consequence of all this is global warming. The latest data indicate that the Earth's average temperature is currently 1.1°C higher than at the end of the 19th century, before the industrial revolution. It is also higher than that of the last 100,000 years, the last decade being the warmest since there are global temperature records at the planetary level. The latest data from extensive studies published at the end of 2023 confirm the worsening of the situation and especially its strong negative impact on global health [1].

The global epidemic of obesity that we are currently experiencing has developed concomitantly with progressive global warming in recent decades. Is there any relationship between both phenomena? Multiple data indicate that the spread of obesity as a global health problem is significantly enhanced by global warming and there is also evidence that a reciprocal phenomenon could be occurring: the intensification of global warming caused by the worldwide increase in the overweight population and obesity.

Possibly, one of the most relevant recent contributions in identifying the important interaction between the obesity epidemic and climate change has been that provided by the report "The Global Syndemic of Obesity, Undernutrition, and Climate Change" commissioned by the Lancet journal to a commission of 43 experts from 14 countries and published in 2019 [2].

The report concluded that malnutrition in all its forms, including obesity, is the main cause leading to poor health worldwide, and that climate change can be considered a

pandemic because of its wide-ranging effects on human health and on the natural systems we depend on (i.e. planetary health). The study establishes that the three concomitant pandemics that are currently occurring (obesity, malnutrition and climate change) represent a global syndemic that affects the majority of people in all countries and regions of the world. They constitute a syndemia, or synergy of epidemics, because they coexist in time and place, interact with each other to produce complex sequelae, and share common underlying social factors.

In fact, this study was initially mandated to specifically address the obesity epidemic, but experts identified the need to reframe the problem and broaden it to offer recommendations that will collectively address the challenges of the triple burden of the Global Syndemia. Thus, it is proposed to rethink the problem of obesity based on the fact that: a) the prevalence of obesity is increasing in all regions of the world, and no country has managed to reverse it, b) despite the existence of many recommendations to stop and reverse the obesity rates, supported by the World Health Organization for almost three decades, this has not yet resulted in significant changes, c) similarly to the Paris Agreement on Climate Change in 2015, the enormous health burdens and economic challenges caused by obesity are not considered urgent enough to generate public demand or political will to implement the recommendations for effective action, d) obesity has historically been considered in isolation from other major global challenges. The study concludes the need to link obesity with malnutrition and climate change in a single Global Syndemia framework, and thus attack these combined challenges by addressing common solutions. It is concluded that it is essential to understand how and why obesity and climate change interact and thus establish both global and individual addressed actions to prevent this global health challenge [3].

Is global warming promoting the worldwide obesity epìdemic?

Climate change and obesity are major concerns for political leaders around the world. However, what is the evidence of the relationship between climate change and obesity? Can climate change, and especially global warming, exert causal effects leading to obesity? These issues have been addressed in the first instance by means of massive statistical association studies. An example is the study by Trentaglia et al.[4], in which changes in the body mass index (BMI) of children and adults in 134 countries over a period of 39 years were analyzed with the aim of identifying to what extent variations in air temperature affect obesity. The conclusions indicate a strong U-shaped relationship between temperature and BMI, both in children and adults, and especially in women. Thus, a significant association of high BMI levels with environments with extreme temperatures (whether especially hot or especially cold) is detected. This association remained even after taking into account other factors related to obesity, such as gross domestic product per capita, fertility or agricultural productivity. This suggests that the average air temperature is directly related to BMI and can have an independent effect. Already in 2014, a significant relationship between the ambient temperature and the prevalence of obesity, regardless of several other biological and socioeconomic factors, was identified in Spain according to the Di@bet.es study [5].

One factor to be taken into account that may affect these association studies is the fact that they are based on the outdoor temperature, while current human populations spend most (and increasingly) of their time indoors with controlled temperature. In fact, the observation that not only very hot temperatures are associated with obesity but also very cold ones has led to the hypothesis that the latter could be related to a behavior of minimal exposure to the outside temperature in people living in geographical locations with a very cold environment. This would mean that these people would be exposed to many hours of artificially warm indoor temperatures. There is also a phenomenon, with an unclear explanation and systematically observed in statistical studies often conducted by energy companies, and that is that the temperature considered optimal for indoor comfort increases over the years, with the consequent increase in energy consumption for heating. Objective data show that winter indoor temperatures in the US, United Kingdom and other developed countries are on an upward trend, which would result in reduced exposure to seasonal cold, minimizing the need for physiological thermogenesis and reducing energy expenditure. This would be a factor to be taken into account when considering the components that give rise to an "obesogenic environment" in our societies [6].

Ambient temperature, energy balance and obesity.

It is well known that energy expenditure is essential to determine energy balance and, within this parameter, adaptive thermogenesis is a key process. Through studies in preclinical models, it has been shown that alterations in adaptive thermogenesis, if not compensated by parallel changes in food intake, tend to generate a positive energy balance and the subsequent development of obesity. Numerous studies have also shown that "non-shivering thermogenesis", which has its fundamental biochemical basis in the uncoupling between the respiratory chain and oxidative phosphorylation in the mitochondria of brown and beige adipose tissue, is a determining factor in the energy expenditure required to produce heat when required to maintain body temperature [7]. The blockage of this process caused by a warm ambient temperature would provide a pathophysiological explanation of the inducing effect of high environmental temperatures on obesity. Although these concepts are well established in preclinical animal models, it was unclear to what extent they could be applied to humans. First, behavioral habits and the need for complex interventions in long-term quantitative bioenergetics studies in humans make it difficult to obtain reliable quantitative conclusions on the role of cold-responsive, non-shivering, thermogenesis, in humans. On the other hand, the belief that brown adipose tissue, despite being active in childhood, was practically non-existent in adult humans, generated doubts about the role of the adaptive thermogenesis mechanism provided by this tissue in the global human energy balance. However, the discovery over a decade ago of the relevance of active brown adipose tissue in adults as well as the existence of beige cells, thermogenic adipocytes scattered in depots of white adipose tissue, made us reconsider the importance of these processes of adaptive thermogenesis in response to environmental temperature in the human population [8]. In a recent study carried out in Spanish populations from distinct geographical areas, a significant decrease in the expression of genes involved in browning in the adipose tissue of individuals living in areas with high ambient temperatures has been observed [9]. Given the North-South gradient of obesity prevalence in these same regions, such observations could have implications for the relationship between the obesity pandemic and global warming in terms of a stable repression of the thermogenic pattern of genetic expression in individuals living in warm environments.

In summary, we do not have an unequivocal scenario about the mechanisms and processes that are acting in humans in response to global warming and promoting obesity. However, observational studies are strongly consistent in establishing this causality. Likewise, current knowledge about the pathophysiology of energy balance is also consistent with the ability of high temperatures, such as those produced due to global warming, to suppress energy expenditure with the consequent promotion of obesogenesis.

The reciprocal relationship between obesity and climate change: does the obesity epidemic contribute to global warming?

In addition to the evidence of the harmful effects that global warming has on the expansion of overweight and obesity, several studies have also taken a reciprocal approach to investigate whether the expansion of obesity at global level is influencing the intensification of climate change. In 2009, P. Edwards and I. Roberts, researchers at the London School of Hygiene and Tropical Medicine, proposed that overweight people are more likely to contribute to carbon dioxide emissions compared to thin people [10]. According to their estimates, each overweight person generates approximately one ton more carbon dioxide per year than a thin person. Consequently, a thin population of one billion people would emit one billion tons less carbon dioxide per year than an overweight population of the same size. Subsequent studies have proposed that, worldwide, obesity contributes to an additional 49 megatons of carbon dioxide equivalent (CO2eq) per year due to metabolic demands, 361 megatons of CO2eq per year due to the intensification of food production processes, and 290 megatons of CO2eq per year due to the increase in automobile and air transport, all of which related to greater body weight. In total, obesity could be generating approximately 700 megatons of CO2eq per year, approximately 1.6% of global greenhouse gas emissions [11].

Other studies, such as those relating greenhouse gas emissions and the prevalence of obesity in different US states, confirm that, regardless of other factors, the states with the highest rates of obesity are those with the greatest emissions of carbon dioxide and methane [12]. Subsequent

studies have estimated that, after corrections for other types of confounding parameters, transportation, agriculture and livestock generate significant increases in emissions of carbon dioxide and other greenhouse gases when the society has high rates (over 20%) of obesity [13].

Another example that may seem anecdotal, but which exemplifies the impact of the increase in population weight on the consumption of fossil fuels, is evidenced through air transport companies. The Air Safety Agency of the European Union already observed through a study carried out in 2009 (23,000 passengers in 8 European airports) an average increase in weight of between 3 and 5 kg, as well as an additional moderate increase in average weight in an update in 2022 [14]. For airlines, weight equals fuel, and fuel equals cost. IATA defines the cost of weight as: "the additional fuel consumption, based on the additional weight". Samoa Airways, an airline company active in the Pacific Islands, a geographical area with a very high incidence of obesity, as well as Uzbekistan Airlines, established years ago that the price of the travel ticket was scaled proportionally to the weight of the traveler. Recently, Finnair and Air New Zealand have started an anonymous program of voluntary weighing of travelers to "calculate the load" of the planes. Currently, the possibility of establishing the weight of the traveler as one of the air travel parameters is a subject of intense debate [15].

All these data, regardless of considerations about the quantitative precision of the estimates mentioned above, show that promoting the prevention and/or reversal of obesity not only has obvious direct effects on the health of patients but can also generate substantial benefits for the environment and consequently for global health. However, it is also essential to properly use and disseminate objective data on the contribution of the overweight and obese population to the increase in global warming, to avoid inadvertently contributing to the stigmatization of people living with obesity.

Conclusions and perspectives

In summary, it is confirmed that there is a reciprocal and feedback relationship between global warming associated with climate change and the obesity epidemic. The causes are multiple and undoubtedly include processes that are not entirely known about how the energy metabolism is affected by the environmental temperature, as well as the complex sociological and behavioral effects that climate change causes in the population. There is no doubt that our society must make the maximum possible effort to prevent climate change, and this will undoubtedly have a positive impact on the prevention of obesity. Reciprocally, any effective action aimed at the prevention and treatment of obesity can have positive effects not only on individual people but also at a global level, favoring the slowdown of global warming.

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