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Review article

Unusual climatic conditions and infectious diseases: observations made by Hippocrates

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ABSTRACT

About 2500 years ago, Hippocrates made noteworthy observations about the influence of climate on public health. He believed that people living in cities with different climate may suffer from different diseases. Hippocrates also observed that abrupt climatic changes or unusual weather conditions affect public health, especially the incidence and severity of various infectious diseases, including gastrointestinal infections, tuberculosis, and central nervous system infections. We believe that Hippocrates' scientific observations are great early historic examples that stress to modern infectious diseases researchers and clinicians the need to study intensively the effect of the occurring global climate changes to infectious diseases in order to help in the prevention of possible epidemics of infections.

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Condiciones climáticas poco habituales y enfermedades infecciosas: observaciones realizadas por Hipócrates

RESUMEN

Hace unos 2.500 años, Hipócrates realizó notables observaciones sobre la influencia del clima sobre la salud pública. Creía que las personas que vivían en ciudades con diferencias climáticas podían padecer distintas enfermedades. Hipócrates observó también que los cambios climáticos bruscos o las condiciones climáticas poco habituales afectan a la salud pública, especialmente en la incidencia y la gravedad de varias enfermedades infecciosas, como las infecciones gastrointestinales, la tuberculosis y las infecciones del sistema nervioso central. Creemos que las observaciones científicas de Hipócrates constituyen importantes ejemplos históricos que indican a los modernos clínicos e investigadores de las enfermedades infecciosas la necesidad de estudiar exhaustivamente el efecto de los cambios climáticos mundiales actuales sobre las enfermedades infecciosas, a fin de ayudar en la prevención de posibles epidemias de enfermedades de este tipo.

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The belief that climate has an important effect on public health is commonly mentioned and stressed in Hippocrates' writings. In chapter 1 of *On Airs, Waters, and Places* Hippocrates suggested that all doctors should be familiar with the position of the town they are practicing in, with respect to the winds that affect the town.¹ He believed that people living in cities with differing orientations against the winds experience different diseases (Chapters 3–6).¹ Interestingly, Hippocrates observed that the overall climate of a

place is not the only factor that affects the health of the population; abrupt climatic changes or unusual weather conditions for a given season and region can also affect health. In addition, he emphasized that the incidence and severity of various infectious diseases can change during unusual or extreme climatic conditions.

Specifically, in chapter 10 of *On Airs, Waters, and Places*, Hippocrates wrote that “if the winter proves dry and northerly, the spring rainy and southerly, the summer will necessarily bring fever, causing ophthalmia and dysenteries. Because whenever heat comes suddenly while earth is still soaked from the spring rains and the south winds, heat is doubled from the rain-soaked earth and the

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burning sun while men's bowels are not being braced nor their mind dried... dysenteries are more likely to come upon women and the most humid constitutions".² Thus, he clearly associated the change from a mild winter and rainy spring to a hot summer with infectious diarrhea. He also suggested humidity as a risk factor for diarrhea. Of note, Hippocrates was producing his medical theories from observations made in the temperate climate of the Mediterranean basin. However, we currently know that a climatic change such as the one described above has some similarities with the beginning of the rainy season in tropical regions. Indeed, a peak in infectious diarrhea during this period of the year in such regions has been reported in several contemporary studies.^{3,4} Personal hygiene and water storage issues may be strong confounders of the effect that the seasonal change itself has on infectious diarrhea.⁵ However, a rise in diarrhea incidence, as described by Hippocrates, does occur during the beginning of the rainy season.

In addition, in *Epidemics I*, chapter I, Hippocrates described an epidemic that occurred in Thasos (a Greek island) during early spring.⁶ He wrote that prior to the epidemic there was a warm winter with droughts and southern winds, which was generally like spring. Earlier in the year, during the late autumn to nearly the beginning of winter, rains were abundant, constant, and soft, with southern winds. The spring, itself, was southerly and cool, with little rain. The summer that followed was cloudy, with no rain. Hippocrates wrote: "Early in spring...many (patients) had swellings beside one or both ears, but confinement to bed was unnecessary. In some cases there was heat (locally) but no harm overall and no suppuration in any of these cases occurred. The swellings were flaccid, big, spreading, with neither inflammation, nor pain...the sufferers were youths, young men, and men who attended wrestling school and sports. Few women were attacked. Many had dry coughs...in some cases after some time painful inflammations occurred in one testicle or both... sometimes accompanied by fever that usually caused much suffering". Obviously, the above represents an elegant early description of a mumps outbreak. Probably the only part of the description that does not fit the typical features of acute viral parotitis is the painless character of the parotid swelling. What is interesting for our focus is that the epidemic started early in the spring, after an unusually warm winter with droughts. Nowadays, this theory cannot be confirmed easily because of the effects that vaccination has on the periodicity of mumps epidemics.⁷ Nonetheless, it is noteworthy that a significant annual pattern was demonstrated for mumps in the United States for the period 1990–2003, in a recent report based on CDC data.⁸ Specifically, there was a clear increase in mumps incidence during April, a finding in agreement with Hippocrates' description.

Furthermore, in chapter II of *Epidemics I* Hippocrates clearly described the seasonality of tuberculosis ("phthisis"), with peaks during a warm year with many autumn rains and a cloudy summer.⁹ He wrote that from beginning to the end of summer, and during the following winter there was a dramatic increase in the incidence and severity of tuberculosis. Many patients with established tuberculosis died during this period, whereas others in whom the diagnosis was in doubt manifested severe symptoms. A recent, large analysis of 57,313 cases of tuberculosis in England and Wales over a 10-year period (1983–92), revealed a peak of tuberculosis in the summer.¹⁰ This pattern differed markedly from that of the other respiratory disorders compared to tuberculosis. The authors of the study attributed this phenomenon to low post-winter trough levels of vitamin D, which affect macrophage function and cell-mediated immunity and could lead to reactivation of dormant mycobacterial infection. Indeed, the association between low vitamin D levels and tuberculosis has been extensively studied.^{11,12} Although it is not clear whether the epidemic described by Hippocrates was the

result of decreased exposure of patients to the sun during that year, it is clear that it was associated with an overall unusual climate for Thasos.

Hippocrates even described a rise in central nervous system infections under specific climatic changes during autumn and winter, in the third part of *Epidemics I*, chapter XVIII.¹³ There were initially "slight southerly rains" during autumn and "winter was northerly with droughts, cold periods, violent winds and snow". Although the exact type of central nervous system infection is not clear, the symptoms described by Hippocrates included "acute fever with slight rigors, sleeplessness, thirst, nausea, slight sweats about the forehead and collar-bones but not generalized, much delirium, fears, dysthymias, and very cold extremities". The infection, called "phrenitis" (a condition of the brain), was lethal after a brief course. Current data support that certain climatic conditions, especially extreme ones, lead to an increased incidence of meningococcal meningitis as well as various types of viral encephalitis. In the so-called meningitis belt of Africa, large epidemics of the disease occur during dry, hot, and windy weather, whereas in East Africa, which is outside this belt, the disease emerges during dry, cold months.^{14–16} High humidity and low temperatures are associated with the appearance of meningococcal epidemics in New Zealand, whereas in Italy low humidity and low temperatures have the same effect.^{17,18} As occurs with meningitis, encephalitis is affected by extreme weather conditions, especially vector-associated encephalitis such as the one caused by West Nile virus. Prolonged heat periods have been repeatedly associated with this form of encephalitis.^{19,20}

All the above are just a few examples of the potential effect that unusual or extreme climatic conditions can have on specific infectious diseases, as described by Hippocrates and interpreted using current medical terms. We, members of four successive generations of Greek physicians with an interest in infectious disease, believe that Hippocrates' scientific observations, put forth 2500 years ago, emphasize the need for intensification of our contemporary efforts to study the effects of the current global climate change on the incidence and severity of various infectious diseases. From another point of view, taken together with the various other effects of climate change on public health, they justify the attempts that are being made to prevent further climate changes. Climate change may have important effects on the epidemiology of infectious diseases, and we should be prepared for them. As modern Greeks say: "better late than never".

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