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The El Niño Phenomenon and Its Impact on Public Health

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Letter to Editor

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Keywords: Health Programs; Health Education; Dengue Prevention; Niña Phenomenon; Infectious Diseases

Abbreviations: EFN: El Niño Phenomenon; ENSO: El Niño Southern Oscillation; CL: Cutaneous Leishmaniasis; HFRS: Hemorrhagic Fever With Renal Syndrome; DOBV: Dobrava Virus; PAHO: Pan American Health Organization.

Letter to Editor

The El Niño phenomenon (EFN) is the warm phase of the El Niño Southern Oscillation (ENSO), a major climate event global defined as an increase in sea surface temperature in the eastern tropical Pacific Ocean due to weakening trade winds. This process is related to higher concentrations of humidity and more intense precipitation. On the northern coast of Peru, record values were reached in special events such as the FEN 1982-1983, the FEN 1997-1998 and El Niño Costero 2017. Its dynamics are complemented by the cold phase of ENSO called La Niña [1].

Diseases Related to the El Niño Phenomenon (FEN)

Stagnant waters caused by pluvial flooding can become breeding grounds for mosquitoes that transmit dengue, Zika and malaria; as well as a breeding ground for bacteria, viruses and parasites that cause diseases such as cholera, hepatitis A, typhoid fever and leptospirosis. Under these circumstances, people may experience frequent, watery bowel movements, called diarrhea. In addition, flooding can generate an increase in environmental humidity, which favors the proliferation of fungi and molds, increasing the risk of disease respiratory diseases such as asthma, bronchitis and other infections. Likewise, prolonged contact with contaminated water can also increase the risk of skin infections, such as dermatitis and mycosis [2].

Type of Disease	Disease
Transmitted by vectors	Dengue
	Zika
	Malaria
	Leishmaniasis
	Bartonellosis
Zoonotic diseases	Hantavirus
	Leptospirosis
	Plaguebubonic
Transmitted by the contaminated water and/or food	Anger
	Typhoid Fever
	Shigellosis
Diseases of the skin and mucous membranes	viral warts,rosacea
	Conjunctivitis
Respiratory diseases	Acute respiratory infection
	Influenza
Problems and disorders of mental health	Anxiety
	Depression
	Stresspost-traumatic

Table 1: Diseases related to FEN.
Fountain: Adapted from Hijar G, et al. [3].

Likewise, in high temperature conditions, such as those that occur during FEN, a change in the pattern of infectious diseases can be generated, as well as the development of new diseases, so the diagnostic approach for a viral infection must be done through an adequate preparation of the clinical history, with a thorough history and physical examination that allow a clinical interpretation based on knowledge of

the pathophysiology of these infections, even more so when the necessary technological resources for an etiological diagnosis are not available. Otherwise, as was evident in the Talara epidemic (1997-1998), the limitation of health programs considered the symptom as an illness, making it impossible to make a correct diagnosis [4].

Vector-Borne Diseases

The Dengue virus contains four serotypes (DEN-1, DEN-2, DEN-3 and DEN-4), with the serotypes DEN-2 and DEN-3 being those reported in the majority of severe cases and with death of those affected. Clinical signs manifest according to the infectious serotype, immune response, racial type, etc. [5].

Latin America is one of the most vulnerable regions to dengue outbreaks due, in part, to its weak health system. Peru is a country that has historically been affected by dengue since the re-entry of *A. aegypti* mosquitoes in 1984, the arrival of the American/Asian DENV-2 genotype in 2010, and its outbreak during FEN 2017 [6].

Although the development of dengue depends on multiple sociodemographic, ecological and environmental determinants, the population's knowledge, attitudes and practices regarding transmission and infection represent an important starting point for the prevention of dengue infection. For example, in some coastal regions of Peru, a low level of knowledge and the use of preventive measures without evidence, such as bathing or burning clothes to limit dengue transmission, have been reported; although in the Peruvian jungle, there are higher levels of knowledge and practices against dengue. This highlights the heterogeneity of health education on dengue prevention in the Peruvian population, despite the increasing incidence of cases [6].

In the case of Zika (ZIKV), different serotypes have been identified and grouped by region: African (4 serotypes) and Asian (3 serotypes), being an emerging disease in America and diagnosed for the first time in Brazil in 2015. Reporting months later in indigenous broadcasts in Colombia. ZIKV is not only transmitted by the bite of the Aedes mosquito. Transplacental transmission is frequent, and can cause microcephaly and CNS malformations in the fetus, as well as cause spontaneous abortions.

Sexual transmission also occurs, because the infected man's sperm have a high replicative viral load and viral RNA. The symptoms are similar to those caused by the dengue and chikungunya virus, it has an incubation period of 2 to 7 days, with clinical manifestations of fever, rash maculopapular, non-suppurative conjunctivitis, myalgias and/or arthralgias, which persist between 2 to 7 days [5].

Malaria, the most important and deadliest tropical parasitic disease transmitted by mosquitoes in the world, causes approximately 1 million deaths and affects up to 1 billion people in 109 countries in Africa, Asia and Latin America. In Colombia and Venezuela, cases of this disease increased by more than a third following the dry conditions associated with FEN. In Sri Lanka, before the use of DDT (a synthetic agricultural pesticide used in the life cycle control of malaria), the risk of malaria tripled in the absence of the monsoon, also associated with FEN. Southern African countries have recently experienced malaria epidemics following unusual rains. In western and northwestern India, cases of malaria were recorded during FEN 1998 and much more so during the La Niña phenomenon. Although a significant correlation can be found between malaria cases and temperature, this is not the case between entomological factors (density and parity) with malaria or with climate, as was observed in Colombia during the period 1998-2000 [7,8].

Cutaneous leishmaniasis (CL) is a metaxenic parasitic tropical disease caused by species of the genus Leishmania, being vectorized in America by sandflies of the genus Lutzomyia, although very little studied in this region. Leishmaniasis is one of the diseases with the greatest burden in terms of disability for life, estimated for the year 2003 worldwide at 2.4 million disability-adjusted life years. The population dynamics of transmitting sandflies can be, as in other metaxenic diseases, influenced by climate variability. As in malaria and dengue, the vectors of this disease are susceptible to many environmental and particularly meteorological variations that can affect the life cycle of the insect, such as precipitation, temperature, humidity, among others [9].

The effects of ENSO on sandflies can be observed through the modification of landscapes (more or less vegetation), which will optimize the ecological conditions for the development of these insects. In Colombia, negative vegetation indices were reported during El FEN 2017 (dry season), which was associated with an increase in the abundance of sandflies and the transmission of leishmaniasis, although their abundance decreased during the cold and warm phases of ENSO 2017 in Panama. , but its population variability increased during the cold phase [10].

Bartonellosis or Carrión's disease has been described since the time of pre-Columbian cultures in Peru, Ecuador and Colombia. It was considered that the disease was limited between 500 and 3200 meters above sea level where the vector involved, Lutzomyia sp, lives and where special ecological conditions are present for its development located in Peru in an extensive area located between 2° north latitude and 13° southern latitude, on the western slope of the Andes

and, although the causes of this variation in epidemiology in Peru are unknown, an explanation for these changes could be attributed to the extreme climatic alterations during the FEN in the affected areas, given that Climate changes influence the living conditions, longevity and dynamics of vectors. Concomitantly with the occurrence of FEN 1997 - 1998, the largest number of bartonellosis outbreaks was reported in different parts of Peru, reaching in 1998 the highest number of cases in the last sixty years [11]

Diseaseszoonotic

Hantaviruses are a group of viruses from the Bunyaviridae family, although their transmission occurs through inhalation of aerosols originating from the excreta of infected rodents. The development of heavy rains causes an increase in the supply of foods of plant origin, which produces an increase in rodent populations and the subsequent transmission of hantavirus infection to humans such as that which occurred in the United States in the year 1993 after the FEN. Three endemic foci are currently recognized. In the first, located in Southeast Asia, the Hantaan (HTNV) and Seoul (SEOV) viruses circulate, causing, respectively, severe and moderate forms of hemorrhagic fever with renal syndrome (HFRS). The second covers southeast, northern and central Europe. The most widespread virus in Europe is the Puumala virus (PUUV), which causes epidemic nephropathy, the mildest form of FHSR. Dobrava virus (DOBV) is distributed in central, eastern and southeastern Europe and is responsible for severe forms of FHSR. The third endemic focus includes practically the entire American continent. The pathology caused by these viruses is characterized by a serious cardiopulmonary alteration (hantavirus pulmonary syndrome, HPS) and, to date, at least ten species have been identified as responsible for this disease [12,13].

Leptospirosis is an infectious disease with epidemic potential, mainly after heavy rains, caused by pathogenic bacteria called leptospires that are transmitted, directly or indirectly, from animals to humans. Two species stand out: Leptospira interrogans and Leptospira biflexa; They are antigenically grouped into 23 serogroups, coexisting with other infectious diseases, depending on the season, age group, geographic distribution, and social condition, even sharing a similar clinical picture [14,15].

In leptospirosis endemic areas, such as Peru, transmission increases when coming into contact with water and soil contaminated with the urine of animals infected with the spirochete, mainly rodents, which include dogs and cats, these being The latter two, who usually share common spaces with human beings, can be carriers of the disease for years with the presence of antibodies, thus becoming a means of infection in urban areas that already present the environment conducive to the spread of leptospirosis, as is the case of Lambayeque (Peru) after river rainfall caused by the 2017 El Niño Costero phenomenon [16].

Plague is a re-emerging infectious disease. Its natural reservoir is wild rodents, although rabbits and hares, wild carnivores and domestic cats can also be a source of infection for humans. It is caused by the bacteria Yersinia pestis and transmitted by the flea Xenopsylla cheopis that affects both animals and humans. It is contracted naturally by the interference of people in the zoonotic cycle, or by the introduction of wild rodents or their infected fleas into the habitat of human beings. From the ecological point of view, explosive increases in the abundance or density of a rodent population occur in a short period, as was evident in central Peru after FEN 1998 [17,18].

Diseases Transmitted by Contaminated Water and /or Food

During the FEN, the reversal of currents in the equatorial zone would have been responsible for the transport of the pandemic clone of *V. parahaemolyticus* from Asia to America in 1997. In a study on the cholera disease developed in the State of Aguascalientes (Mexico), it was observed that the *E coli* bacteria have the ability to survive outside a host, in atmospheric water and environmental dust (in humid conditions and warm temperatures). Likewise, another probable line of transmission of the *E. coli* bacteria could be the house fly (Musca domestica), which acts as a mechanical vector of enteropathogenic *E coli*. The presence of these bacteria was also diagnosed, among others, in dozens of cockroach species [19,20].

Typhoid fever is an infectious, acute, potentially fatal disease, where socioeconomic conditions are determining factors in its transmission, so the improvement of living conditions and the provision of antibiotics results in a great reduction in morbidity and mortality from this disease. However, it remains a public health problem in many developing areas in the Africa, South-East Asia, Eastern Mediterranean and Western Pacific regions. According to estimates made in 2019, 9 million people fall ill with typhoid fever each year, of which 110,000 die. The risk of contracting the disease is greater for population groups without access to safe water and adequate sanitation. Children are at highest risk [21,22].

Shigellosis is exclusively transmitted between humans, which invades the intestinal mucosa, characterized by causing dysentery. It can be transmitted via oro-fecal route through direct contact with infected people (predominant mode of transmission), indirect contact through vectors such as flies, fomites, consumption of contaminated food or

water. The importance of its identification lies in being able to establish appropriate and timely treatment, since Shigella disease has been associated with the risk of nutritional deterioration, persistent diarrhea, death and sequelae in children [23,24].

In 2017, it was estimated that around 28 million people lacked access to an improved water source, around 83 million lacked access to sanitation facilities improved. For this reason, in countries with limited resources Where water and sanitation conditions are not optimal, the probability of Shigella infections increases and there is the risk of a major outbreak of diarrheal diseases with a high fatality rate, mainly in children under 5 years of age [24].

Diseases of the Skin and Mucous Membranes

Rosacea is a chronic inflammatory dermatological condition in the central part of the face. Alteration of innate immunity and deregulation of neurovascular mechanisms are triggers associated with external factors for rosacea. The progression of rosacea aggravates inflammatory outbreaks in dermal fibrotic conditions, thus determining the increase in the symptoms of the disease and its subsequent chronicity [25].

In a study carried out in Huánuco (Peru) on the effects of FEN 2017, it is shown that fluctuations in temperature and atmospheric pressure influence the incidence of dermatological conditions such as rosacea. On the other hand, in Colombia, a greater association of rosacea was observed at an altitude of 1,018 m (Cali) and a temperature of 25°C, representing 6.1% of rosacea. These studies demonstrate the influence of climate and altitude on the development of dermatological conditions [25].

Conjunctivitis is of viral etiology and the risk is much higher when people have the habit of constantly rubbing their hands over their eyes under inadequate hygienic conditions. The virus initially irritates one of the affected person's eyes and a few hours later the discomfort affects the other eye. He indicated that permanent tearing and deep redness accompanied by inflammation then occur; after four or five days of intense discomfort, the symptoms tend to disappear gradually. During the FEN there are atmospheric alterations, which produce diseases and attack certain systems, such as in this case vision, as reported in Barranquilla (Colombia) during the period 1997-1998 [26].

Respiratory Diseases

During FEN, episodes of heat and drought can cause cases of influenza, asthma, bronchitis and pneumonia, as well as chronic respiratory diseases. With heat, more ozone and CO2 levels are produced and particulate matter (air pollutants) increases, which irritates the respiratory system and causes difficulty breathing. On the other hand, with sudden changes in temperature (going from cold to hot and vice versa), they can alter respiratory health, causing nasal congestion, permanent secretions and respiratory allergies [27].

In the FEN 2016-2017, in the Peruvian region of Piura, it was reported that the cases in 2017 tripled those in 2016 (1,666 cases, 202 serious cases and two deaths) [28]. In the FEN of 2023, droughts were reported in Colombia that generated forest fires and, with it, an increase in the emission and concentration of particulate matter (specifically fine particles less than 10 microns) and other substances in the environment that They are potentially irritating to the respiratory tract (such as carbon monoxide, nitrogen oxide, among others), which mainly affect surrounding populations or those with comorbidities such as Chronic Obstructive Pulmonary Disease (COPD), rhinitis, asthma and others [29].

Mental Health Problems and Disorders

The weather influences mood in different ways, stress being one of those manifestations. Mood can generate harmful consequences for our body and generate a greater predisposition to diseases. People who become depressed are more susceptible to infections, including developing tuberculosis or developing cancer [30]. According to estimates by the Pan American Health Organization (PAHO), for every 1 °C increase in temperature, mortality and morbidity related to mental health can increase with a range of 1.022 (95% CI: 1.015- 1.029) and 1.009 (95% CI: 1.007-1.015) respectively [31].

It is postulated that, on average, 150 million people are affected by a disaster annually. Of all of them, approximately 33% would develop post-traumatic stress disorder (PTSD) and 20% some other comorbid mental health disorder. There are various reasons why a disaster can be considered a public health problem, for example:

- The great demand for necessary attention due to the deaths, injuries and illnesses it causes,
- Alteration of the infrastructure of basic services such as water, electricity, drainage and communications,
- The increased risk of communicable diseases, and
- The psychosocial consequences on the affected people.

Among all of these, the psychosocial consequences will determine the degree of functionality and recovery of the affected people and community [32].

Unfortunately, in Peru there are no detailed and updated reports on the effects of FEN on the mental health of the population, as evidenced in the report of the Ministry of Health on the phenomenon from 1997 -1998 [33].

Conclusion

The impact of the El Niño phenomenon (FEN) on public health is defined by the vulnerability conditions of the population exposed to vector, zoonotic, and respiratory diseases, among others associated with an increase in temperature and precipitation. It is the conditions of socio-economic, cultural and political deprivation that lead to disasters for the population. As long as the situation of the population's access to water and drainage services, as well as timely assistance to their mental health, is not improved, the dynamics of the FEN will continue to generate serious losses for the population.

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