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# Future outlook & direction of Chikungunya virus associated with carbon emission, increased temperature & Climate change impact.

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**Abstract**— Day by day carbon emission is increasing & due to huge increased amount of carbon emission the global temperature & climate is changing. Owing to this climate changing the vector suitabale temperature & timeframe is goin to be increased in Europe. Although COP26 agenda like limiting carbon emission to keep global warming below 2-1.5, raised a fund of 100 billion pledge to support the vulnerable countries, climate fund toward adaptation, finalizing the Paris Agreement & mechanism for loss & damage have been declared but still the program like Worldwide carbon taxation & SBTi is not effectively implemented. Besides most of the countries are not aware of tracking scope 1, 2, & 3 energy emissions, implementing abatement process due to lack of fund & consequently the global warming & climate change is still not effectively manageable. As a result, the virus like Chikungunya, SARS COV 2, get the suitable temperature to grow, spread, create new variation & replicate itself. So, in this research my objective is to identify the vulnerable impact of climate change on Future outlook & direction of Chikungunya virus.

**Index Terms**— CDC-Centers for Disease Control and Prevention, COP26-26th Conference of the Parties, CHIKV-Chikungunya Virus, GHG-Greenhouse gases, SARS COV 2-Severe Acute Respiratory Syndrome Coronavirus 2; SBTi, The Science Based Targets initiative; (+)ssRNA-Positive-strand RNA viruses; RNA-Ribonucleic acid.

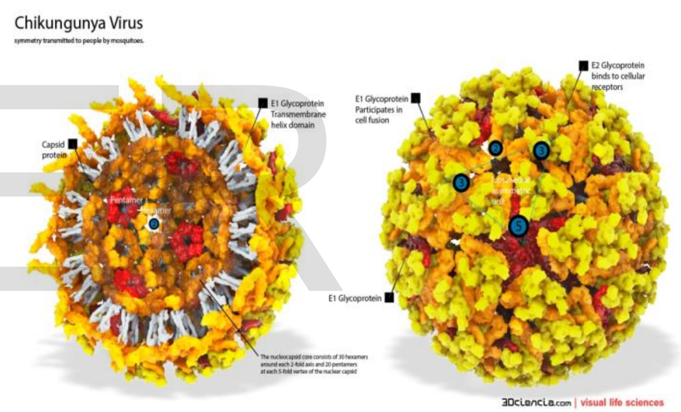
## 1 Introduction

Chikungunya is an infection caused by the chikungunya virus (CHIKV).[2] Symptoms include fever and joint pain.[3] These typically occur two to twelve days after exposure.[2] Other symptoms may include headache, muscle pain, joint swelling, and a rash. Most people are better within a week; however, occasionally the joint pain may last for months.[3] The risk of death is around 1 in 1,000.[4] The very young, old, and those with other health problems are at risk of more severe disease.[3]

The virus is spread between people by two types of mosquitos: Aedes albopictus and Aedes aegypti.[2] They mainly bite during the day.[5] The virus may circulate within a number of animals including birds and rodents. Diagnosis is by either testing the blood for the virus's RNA or antibodies to the virus. The symptoms can be mistaken for those of dengue fever and Zika fever.[2] After a single infection it is believed most people become immune.[3]

The best means of prevention is overall mosquito control and the avoidance of bites in areas where the disease is common.[4] This may be partly achieved by decreasing mosquitoes' access to water and with the use of insect repellent and mosquito nets. There is no vaccine and no specific treatment as of 2016.[2] Recommendations include rest, fluids, and medications to help with fever and joint pain.[2][3]

While the disease typically occurs in Africa and Asia, outbreaks have been reported in Europe and the Americas since the 2000s. In 2014 more than a million suspected cases occurred.[2] In 2014 it was occurring in Florida in the continental United States but as of 2016 there was no further locally acquired cases.[6][7] The disease was first identified in 1952 in Tanzania.[2] The term is from the Kimakonde language and means "to become contorted".[2]




**What is Chikungunya Virus**:
Chikungunya is a mosquito-borne viral disease first described during an outbreak in southern Tanzania in 1952. It is an RNA virus that belongs to the alphavirus genus of the family Togaviridae. The name "chikungunya" derives from a word in the Kimakonde language, meaning "to become contorted", and describes the stooped appearance of sufferers with joint pain (arthralgia).

**Aim of the study:**

1. Future Outlook & direction of Chikungunya
2. Viral replication study of Chikungunya
3. Updated transmission of Chikungunya
4. Vaccine study of Chikungunya

**History:**
The word 'chikungunya' is believed to have been derived from a description in the Makonde language, meaning "that which bends up", of the contorted posture of people

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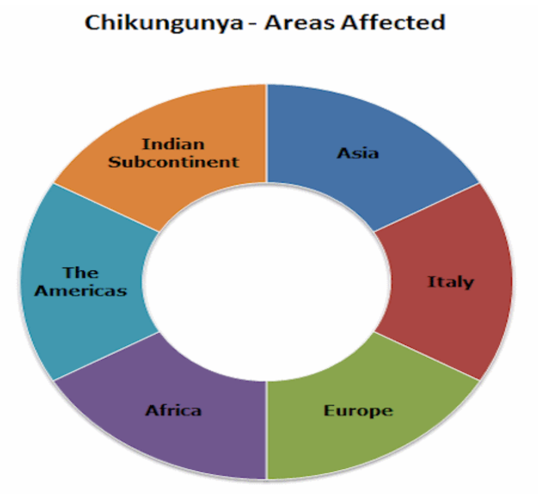
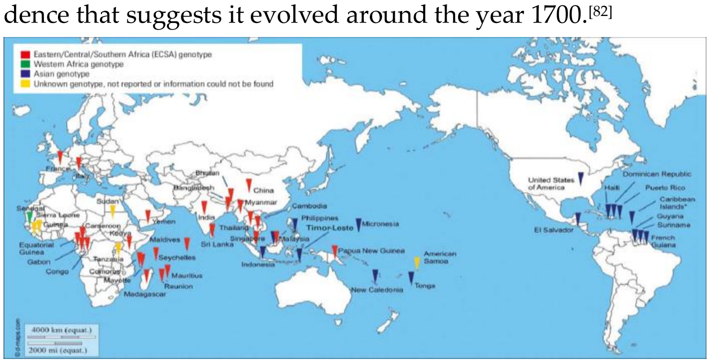
affected with the severe joint pain and arthritic symptoms associated with this disease.[77] The disease was first described by Marion Robinson[78] and W.H.R. Lumsden[79] in 1955, following an outbreak in 1952 on the Makonde Plateau, along the border btween Mozambique and Tanganyika (the mainland part of modern-day Tanzania).




According to the initial 1955 report about the epidemiology of the disease, the term 'chikungunya' is derived from the Makonde root verb kungunyala, meaning to dry up or become contorted. In concurrent research, Robinson glossed the Makonde term more specifically as "that which bends up". Subsequent authors apparently overlooked the references to the Makonde language and assumed the term to have been derived from Swahili, the lingua franca of the region. The erroneous attribution to Swahili has been repeated in numerous print sources.[80] Many erroneous spellings of the name of the disease are also in common use.

Since its discovery in Tanganyika, Africa, in 1952, chikungunya virus outbreaks have occurred occasionally in Africa, South Asia, and Southeast Asia, but recent outbreaks have spread the disease over a wider range.

The first recorded outbreak of this disease may have been in 1779.[81] This is in agreement with the molecular genetics evidence that suggests it evolved around the year 1700.[82]

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**DISEASE OUTBREAKS:**

Chikungunya occurs in Africa, Asia, and the Indian subcontinent. Human infections in Africa have been at relatively low levels for several years, but in 1999–2000 there was a large outbreak in the Democratic Republic of the Congo, and in 2007 there was an outbreak in Gabon.

Starting in February 2005, a major outbreak of chikungunya occurred in islands of the Indian Ocean. Many imported cases in Europe were associated with this outbreak, mostly in 2006 when the Indian Ocean epidemic was at its peak. A large outbreak of chikungunya in India occurred in 2006 and 2007. Several other countries in South-East Asia were also affected. Since 2005, India, Indonesia, Maldives, Myanmar, and Thailand have reported over 1.9 million cases. In 2007 transmission was reported for the first time in Europe, in a localized outbreak in north-eastern Italy. There were 197 cases recorded during this outbreak and it confirmed that mosquito-borne outbreaks by Ae. Albopictus are plausible in Europe.

In December 2013, France reported 2 laboratory-confirmed autochthonous cases in the French part of the Caribbean Island of St Martin. Since then, local transmission has been confirmed in over 43 countries and territories in the WHO Region of the Americas. This is the first documented outbreak of chikungunya with autochthonous transmission in the Americas. As of April 2015, over 1 379 788 suspected cases of Chikungunya have been recorded in the Caribbean islands, Latin American countries, and the United States of America. 191 deaths have also been attributed to this disease during the same period. Canada, Mexico, and USA have also recorded imported cases.

On 21 October 2014, France confirmed 4 cases of locally acquired chikungunya infection in Montpellier, France. In late 2014, outbreaks were reported in the Pacific islands.

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Currently chikungunya outbreak is ongoing in Cook Islands and Marshall Islands, while the number of cases in American Samoa, French Polynesia, Kiribati, and Samoa has reduced. WHO responded to small outbreaks of chikungunya in late 2015 in the city of Dakar, Senegal, and the state of Punjab, India.

In the Americas in 2015, 693 489 suspected cases and 37480 confirmed cases of chikungunya were reported to the Pan American Health Organization (PAHO) regional office, of which Colombia bore the biggest burden with 356 079 suspected cases. This was less than in 2014 when more than 1 million suspected cases were reported in the same region.

In 2016 there was a total of 349 936 suspected and 146 914 laboratory confirmed cases reported to the PAHO regional office, half the burden compared to the previous year. Countries reporting most cases were Brazil (265 000 suspected cases), Bolivia and Colombia (19 000 suspected cases, respectively). 2016 is the first time that autochthonous transmission of chikungunya was reported in Argentina following an outbreak of more than 1 000 suspected cases. In the African region, Kenya reported an outbreak of chikungunya resulting in more than 1 700 suspected cases. In 2017, Pakistan continues to respond to an outbreak which started in 2016.

**More about disease vectors:**

Both Ae. aegypti and Ae. albopictus have been implicated in large outbreaks of chikungunya. Whereas Ae. aegypti is confined within the tropics and sub-tropics, Ae. albopictus also occurs in temperate and even cold temperate regions. In recent decades Ae. albopictus has spread from Asia to become established in areas of Africa, Europe and the Americas.

The species Ae. albopictus thrives in a wider range of water-filled breeding sites thanAe. aegypti, including coconut husks, cocoa pods, bamboo stumps, tree holes and rock pools, in addition to artificial containers such as vehicle tyres and saucers beneath plant pots. This diversity of habitats explains the abundance of Ae. albopictus in rural as well as peri-urban areas and shady city parks.

Ae. aegypti is more closely associated with human habitation and uses indoor breeding sites, including flower vases, water storage vessels and concrete water tanks in bathrooms, as well as the same artificial outdoor habitats as Ae. albopictus.

In Africa several other mosquito vectors have been implicated in disease transmission, including species of the A. furcifer-taylori group and A. luteocephalus. There is evidence that some animals, including non-primates, rodents, birds and small mammals, may act as reservoirs.

**SIGNS AND SYMPTOMS:**

Chikungunya is characterized by an abrupt onset of fever frequently accompanied by joint pain. Other common signs and symptoms include muscle pain, headache, nausea, fatigue, and rash. The joint pain is often very debilitating, but usually lasts for a few days or may be prolonged to weeks. Hence the virus can cause acute, subacute, or chronic disease.

Most patients recover fully, but in some cases joint pain may persist for several months, or even years. Occasional cases of eye, neurological and heart complications have been reported, as well as gastrointestinal complaints. Serious complications are not common, but in older people, the disease can contribute to the cause of death. Often symptoms in infected individuals are mild and the infection may go unrecognized or be misdiagnosed in areas where dengue occurs.

- Most people infected with chikungunya virus will develop some symptoms.
- Symptoms usually begin 3–7 days after being bitten by an infected mosquito.
- The most common symptoms are fever and joint pain.
- Other symptoms may include headache, muscle pain, joint swelling, or rash.
- Chikungunya disease does not often result in death, but the symptoms can be severe and disabling.
- Most patients feel better within a week. In some people, the joint pain may persist for months.
- People at risk for more severe disease include newborns infected around the time of birth, older adults (≥65 years), and people with medical conditions such as high blood pressure, diabetes, or heart disease.
- Once a person has been infected, he or she is likely to be protected from future infections.

**SIX ESSENTIAL KEY FACTS OF CHIKUNGUNYA VIRUS:**

- Chikungunya is a viral disease transmitted to humans by infected mosquitoes. It causes fever and severe joint pain. Other symptoms include muscle pain, headache, nausea, fatigue, and rash.
- Joint pain is often debilitating and can vary in duration.
- The disease shares some clinical signs with dengue and zika and can be misdiagnosed in areas where they are common.
- There is no cure for the disease. Treatment is focused on relieving the symptoms.
- The proximity of mosquito breeding sites to human habitation is a significant risk factor for chikungunya.

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- The disease mostly occurs in Africa, Asia, and the Indian subcontinent. However, a major outbreak in 2015 affected several countries of the Region of the Americas.

**Epidemiology:**

Chikungunya is generally spread through bites from *Aedes aegypti* mosquitoes, but the chikungunya virus strains in the 2005-2006 Reunion Island outbreak contained a mutation that facilitated transmission by *Aedes albopictus* (Tiger mosquito). Enhanced transmission of chikungunya virus by *Aedes albopictus* could mean an increased risk for chikungunya outbreaks in other areas where the Asian tiger mosquito is present. A recent epidemic in Italy was likely perpetuated by *Aedes albopictus*. Currently, chikungunya fever has been identified in more than 50 countries.

*Figure 1: Countries and territories where chikungunya cases have been reported (without imported cases; as of March 10, 2015)*

Period before 2004: Chikungunya likely originated in Africa (see also section History of Chikungunya), where the virus is spread via a sylvatic cycle in which the virus largely resides in other primates in between human outbreaks. In 1952, the first outbreak of chikungunya was reported in the Makonde Plateau. The first significant urban outbreaks of chikungunya were reported in the early 1960s in Bangkok and from 1963 through 1973 in India. The chikungunya virus was detected mainly in the Indian cities Calcutta, Maharashtra and Yellore. Minor outbreaks periodically occurred over the next 30 years, but no major outbreaks were recorded. In 1969, chikungunya was detected in Sri Lanka and in 1975 the disease was reported in Vietnam and Myanmar. Another outbreak was reported in Indonesia in 1982.

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Period 2004-2005: In 2004, Kenya experienced two major outbreaks of chikungunya. This outbreak started a four-year period in which the virus spread throughout numerous islands of the Indian Ocean, India, and parts of Southeast Asia. The first outbreak in Lamu, Kenya resulted in an estimated 13,500 cases, which represents more than 70% of the population of the island. The second outbreak occurred in the city of Mombasa a few months after the first cases in Lamu. By January 2005, an outbreak of chikungunya was detected in the Comoros. Over the next several months, the outbreak on the main island led to around 225,000 infections with chikungunya. Entomological investigations detected that Aedes aegypti mosquitoes were carriers of the chikungunya virus.

Period 2005-2006: The largest outbreak of chikungunya ever recorded at the time occurred on the island of Réunion in the western rim of the Indian Ocean from late March 2005 to February 2006. At its height, the incidence peaked at about 25,000 cases per week or 3500 daily in early 2006. By mid-December, when southern hemisphere summer temperatures are favorable for the mosquito vector, the incidence began to rise dramatically into the first two months of 2006. Although confirmed cases were much lower, some estimates based on extrapolations from the number detected by sentinel physicians suggested that as many as 110,000 of Réunion's population of 800,000 people may have been infected. Twelve cases of meningoencephalitis cases were confirmed to be associated with chikungunya infection. Other countries in the southwest Indian Ocean reported cases as well, including Mauritius and the Seychelles, and in Madagascar, the Comoros, and Mayotte.

Other outbreaks of chikungunya fever subsequently occurred in other Indian Ocean countries, including Gabon, Madagascar, the Maldives, Mauritius, Mayotte, and the Seychelles (see figure 2). The epidemic also spread to India, where it is estimated that more than 1.5 million people were infected between February and October 2006. During this period, the WHO Regional Office for South-East Asia has reported 151 districts in 8 states/provinces of India affected by chikungunya fever. The affected states are Andhra Pradesh, Andaman and Nicobar Islands, Tamil Nadu, Karnataka, Maharashtra, Gujarat, Madhya Pradesh, Kerala and Delhi. The persistence number of infections in India is probably attributable to a large amount of immunologically naive people, who help sustain viral transmission. Several other countries in South-East Asia were also affected.

Mutation of the virus: The primary mosquito responsible for the transmission of chikungunya virus was Aedes aegypti. However, these mosquitoes were present in only limited numbers on the island of La Reunion due to massive dichlorodiphenyltrichloroethane usage. The albopictus mosquito was present, and this resulted in an ecological pressure. Studies revealed that the chikungunya virus in La Reunion had a single point mutation in the E1 glycoprotein that increased infectivity in Aedes albopictus. There was a replacement of

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alanine at position 226 with valine (E1-A226V). Within a year, the mutated virus was present in La Reunion Island, and Aedes apparently vectored the large epidemic infecting one third of the Island's population. The E1-A226V mutation also enabled an increase in infectivity of Aedes albopictus when compared to its infectivity of Aedes aegypti. Aedes albopictus has become the new preferred and more lethal vector for chikungunya virus.

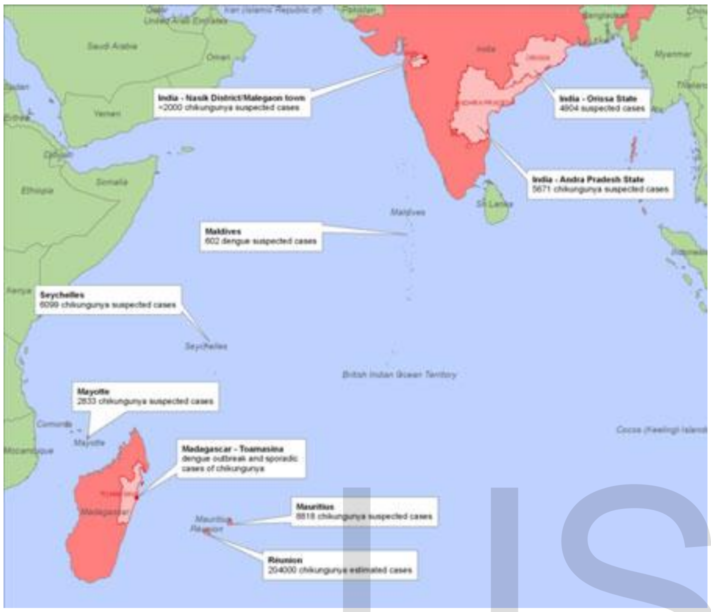


Figure 2: Chikungunya and Dengue virus in the Indian Ocean, Status as of 17 March 2006. Dark red indicates countries wth occurence of dengue and/or chikungunya. Light red is affected areas. Source: WHO

Period 2007-2012:

In 2007 the virus caused the first autochthonous epidemic outbreak in the north-east of Italy, with more than 200 human infections. Since 2008, infections were also reported from Singapore, Malaysia, Thailand, and Australia. By the end of September 2009, there were more than 42,000 cases during the previous year in 50 provinces in the south of Thailand, including the popular tourist destination of Phuket. About 14 years had lapsed since the last appearance of the disease. Outbreaks in the Pacific Islands began in New Caledonia in 2011 and have since occurred in a number of Pacific countries. An outbreak occurred in Cambodia with at least 1500 confirmed cases. Provinces for which affection was confirmed were: Preah Vihear, Battambang, Kampong Thom, Kampong Chhnang, Kandal, Kampong Speu and Takeo.

Period 2013-2014:

In December 2013, it was confirmed that chikungunya was being locally transmitted in the Americas for the first time in the French Caribbean dependency of St. Martin, with 66 confirmed cases and suspected cases of around 181. It is the first time in the Americas that the disease has spread to humans from a population of infected mosquitoes. By mid-January 2014, several cases had been confirmed in five countries: St. Martin, St. Barthelemy, Martinique, Guadeloupe, and the British Virgin Islands. At the start of April, at least ten nations had reported cases. By the start of May, there were more than 4,100 probable cases, and 31,000 suspected cases spanning 14 countries, including French Guiana, the only non-island nation with at least one reported case. On May 1, the Caribbean Public Health Agency declared a Caribbean-wide epidemic of the virus.

On June 2014 six cases of the virus were confirmed in Brazil, two in the city of Campinas in the state of São Paulo. The six cases are Brazilian army soldiers who had recently returned from Haiti. The information was officially released by Campinas municipality, which considers that it has taken the appropriate actions. Brazil has reported by the end of 2014 a local transmission of a different strain (genotype) of chikungunya, that has never been documented in the Americas. This is an African genotype, but oddly fails to explain if its South African or West African. The new genotype (in the Americas) is more severe than the Asian genotype which is currently spreading through the Americas, and immunity to one genotype does not confer immunity to others. French Polynesia is among other regions experiencing ongoing outbreaks.

On 15 July 2014, over 400 chikungunya cases had been reported in Puerto Rico and health authorities believed the number of actual cases was much higher. By the end of October, that number had increased to 2,974 confirmed cases with over 10,000 cases suspected. The first cases in Colombia were officially confirmed in July 2014. The total of confirmed cases in Colombia during 2014 were 83,588, of which 7 led to deaths

On July 17, 2014, the first chikungunya case acquired in the United States was reported in Florida by the CDC in a man who had not recently traveled outside the United States. Shortly after another case was reported of a person in Florida being infected by the virus, not having traveled outside the U.S. These were the first two cases where the virus was passed directly by mosquitoes to persons on the U.S. mainland. Aside from the locally acquired infections, there were 484 other cases reported in the United States as of 5 August 2014.

In September 2014, Venezuela stated that there could be between 65,000 and 117,000 Venezuelans infected with chikungunya. On 7 November 2014 Mexico reported an outbreak of chikungunya, acquired by local transmission, in southern state of Chiapas. Health authorities have reported a cumulative load of 39 laboratory-confirmed cases. By November 2014 the Pan American Health Organization reported about 800,000 suspected chikungunya cases in the Caribbean alone.

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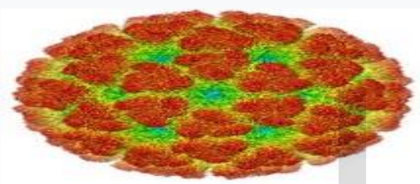
Period after 2014:As of January 2015 at least one major city (Medellín) in Colombia has issued sanitary alerts due to the expanding epidemic. By January 2015 the epidemic is considered to be in the initial expansion phase and it is expected by the Colombian National Health Institute (Instituto Nacional de Salud - INS) that the total number of cases will reach around 700,000 by the end of 2015 due to the in-country massive travel of tourists to and from regions where cases of the disease have been confirmed and the vector is indigenous. It is expected that the disease will become endemic and sustain itself, with a pattern of outbreaks similar to dengue fever.On 24 September 2015, the Ministry of Health and Social Protection of Colombia officially declared the country free of Chikungunya. There were 441,000 reported cases but the government stimated the infected to reach the 873.

**Virology:**

**Chikungunya virus**



Cryoelectron microscopy reconstruction of chikungunya virus. From EMDB entryEMD-5577[31]

**Virus classification**

| | |
|---|---|
| Group: | Group IV ((+)ssRNA) |
| Order: | Unassigned |
| Family: | Togaviridae |
| Genus: | Alphavirus |
| Species: | Chikungunya virus |



Chikungunya virus (CHIKV), is a member of the alphavirus genus, and Togaviridae family. It is an RNA virus with a positive-sense single-stranded genome of about 11.6kb.[32] It is a member of the Semliki Forest virus complex and is closely related toRoss River virus, O'nyong'nyong virus, and Semliki Forest virus.[33] Because it is transmitted by arthropods, namely mosquitoes, it can also be referred to as an arbovirus (arthropod-borne virus). In the United States, it is classified as acategory C priority pathogen,[34] and work requires biosafety level III precautions.[35]

**Transmission:** 4.1 Mosquito:

Chikungunya has been identified in over 60 countries in Asia, Africa, Europe, and the Americas.

The virus is transmitted from human to human by the bites of infected female mosquitoes. Most commonly, the mosquitoes involved are Aedes aegypti and Aedes albopictus, two species which can also transmit other mosquito-borne viruses, including dengue. These mosquitoes can be found biting throughout daylight hours, though there may be peaks of activity in the early morning and late afternoon. Both species are found biting outdoors, but Ae. aegypti will also readily feed indoors.

After the bite of an infected mosquito, onset of illness occurs usually between 4 and 8 days but can range from 2 to 12 days.

The chikungunya virus is transmitted from human to human by the bites of infected female mosquitoes. Mostcommonly, the mosquitoes involved are Aedes aegypti and Aedes albopictus, two species which can also transmit other mosquito-borne viruses, includingdengue, zika and chikungunya (see figure 1). These mosquitoes can be found biting throughout daylight hours, although there may be peaks of activity in the early morning and late afternoon. Both species are found biting outdoors, but *Ae. aegypti* will also readily feed indoors.

| | Dengue | Zika | Chikungunya |
|---|---|---|---|
| Mosquitoes | *Aedes aegypti* *Aedes albopictus* | *Aedes aegypti* *Aedes albopictus* | *Aedes aegypti* *Aedes albopictus* |
| From mother to child | Evidence of transmission from an infected mother to her fetus | Rarely around time of birth, but it is possible that the virus could be passed to her fetus during pregnancy | Rarely from mother to newborn around the time of birth |
| Breastfeeding | No evidence | No evidence | No evidence |
| Blood | Rare cases known of transmission via blood transfusions from infected donors | Spread of the virus through blood transfusion have been reported | No evidence, but in theory possible |
| Sexual | No evidence | Spread of the virus through sexual contact have been reported | No evidence |

Figure 2: Comparisment of Dengue, Zika and Chikungunya transmission routes.

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Chikungunya viruses are mainly transmitted to humans through the bites of infective femaleAedes mosquitoes. The mosquitoes generally acquire the virus while feeding on the blood of an infected person. After virus incubation for eight to ten days, an infected mosquito is capable, during probing and blood feeding, of transmitting the virus for the rest of its life. There is no way to tell if a mosquito is carrying the chikungunya virus. Infected female mosquitoes may also transmit the virus to their offspring by transovarial (via the eggs) transmission, but the role of this in sustaining transmission of the virus to humans has not yet been defined. Infected humans are the main carriers and multipliers of the virus, and serving as a source of the virus for uninfected mosquitoes. The virus circulates in the blood of infected humans for several days, at approximately the same time that they have chikungunya fever (see alsoclinical symptoms). Aedes mosquitoes may acquire the virus when they feed on an individual during this period. In parts of Asia and Africa,

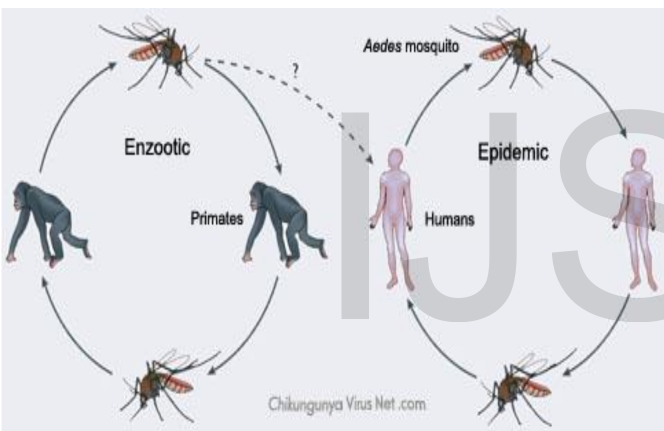




Figure 2. Transmission of chikungunya viruses. Source: PLoS Negl Trop Dis. 2010 Apr 27

The Aedes mosquito prefers to breed in water-filled receptacles, usually close to human habitation. They often rest in dark rooms (e.g. in bathrooms and under beds) and breed in small pools that collect in discarded human waste (see figure 3). Although they are most active during daylight hours, biting from dawn to dusk, mosquitoes will feed throughout the day indoors and during overcast weather.

**4.2 NON-MOSQUITO:**

**Rarely, from mother to child:**

Chikungunya virus is transmitted rarely from mother to newborn around the time of birth.

- To date, no infants have been found to be infected with chikungunya virus through breastfeeding. Because of the benefits of breastfeeding, mothers are encouraged to breastfeed even in areas where chikungunya virus is circulating.

**Rarely, through infected blood:**

- In theory, the virus could be spread through a blood transfusion. To date, there are no known reports of this happening.

**Mechanism:**

The chikungunya virus is passed to humans when a bite from an infected mosquito breaks the skin and introduces the virus into the body. The pathogenesis of chikungunya infection in humans is still poorly understood, despite recent outbreaks. It appears that in vitro, chikungunya virus is able to replicate in human epithelialand endothelial cells, primary fibroblasts, and monocyte-derived macrophages. Viral replication is highly cytopathic, but susceptible to type-I and -II interferon.[40] In vivo, in studies using living cells, chikungunya virus appears to replicate in fibroblasts, skeletal muscle progenitor cells, and myofibers.[26][41][42]

The type-1 interferon response seems to play an important role in the host's response to chikungunya infection. Upon infection with chikungunya, the host's fibroblasts produce type-1 alpha and beta interferon (IFN-$\alpha$ and IFN-$\beta$).[43] In mouse studies, deficiencies in INF-1 in mice exposed to the virus cause increased morbidity and mortality.[43][44][45] The chikungunya-specific upstream components of the type-1 interferon pathway involved in the host's response to chikungunya infection are still unknown.[46] Nonetheless, mouse studies suggest that IPS-1 is an important factor,[46] and that IRF3 and IRF7 are important in an age-dependent manner.[47][48] Mouse studies also suggest that chikungunya evades host defenses and counters the type-I interferon response by producing NS2, a nonstructural protein that degrades RBP1 and turns off the host cell's ability to transcribe DNA.[49] NS2 interferes with the JAK-STAT signaling pathway and prevents STAT from becoming phosphorylated.[50]

In the acute phase of chikungunya, the virus is typically present in the areas where symptoms present, specifically skeletal muscles, and joints. In the chronic phase, it is suggested that viral persistence (the inability of the body to entirely rid itself of the virus), lack of clearance of the antigen, or both, contribute to joint pain. The inflammation response during both the acute and chronic phase of the disease results in part from interactions between the virus and monocytes and macrophages.[11] Chikungunya virus disease in humans is associated with elevated serum levels of specific cytokines and chemokines. High levels of specific cytokines have been linked to more severe acute disease: interleukin-6 (IL-6), IL-1$\beta$, RANTES, monocyte chemoattractant protein 1 (MCP-1), monokine induced by gamma interferon (MIG), and interferon gamma-induced protein 10 (IP-10). Cytokines may also contribute to chronic chikungunya virus disease, as persistent joint pain has been associated with elevated levels of IL-6 and granulocyte-macrophage colony-stimulating fac-

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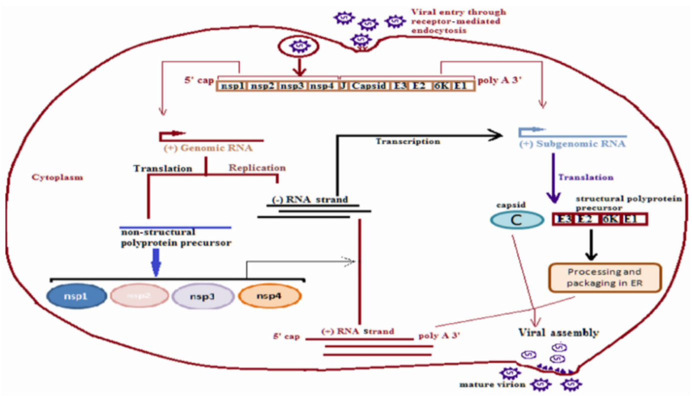
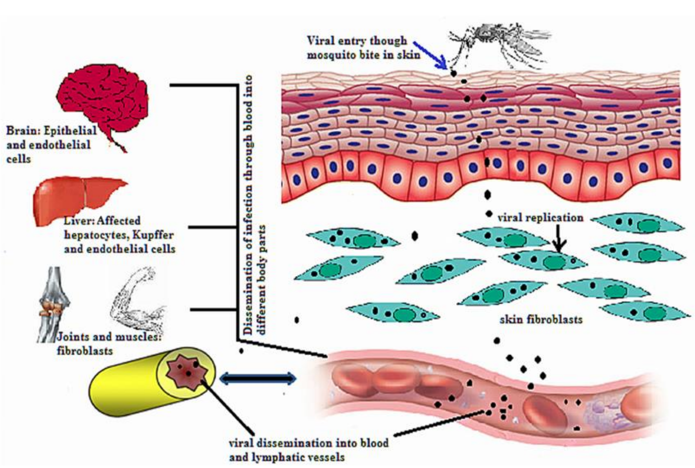
tor (GM-CSF).[36] In those with chronic symptoms, a mild elevation of C-reactive protein (CRP) has been observed, suggesting ongoing chronic inflammation. However, there is little evidence linking chronic chikungunya virus disease and the development of autoimmunity.

**Chikungunya virus replication cycle:**




Chikungunya virus replication cycle. The CHIKV enters the host cell through receptor-mediated endocytosis forming an endosome. The endosome enters the host cell and genome of the virus then replicates in the cytoplasm. The CHIKV genome carries non-translated region (NTR) at both 3 and 5 ends and non-coding junction region (J region) between the genes coding for structural and non-structural proteins. The replicated negative strand of RNA is transcribed into positive sense sub genomic RNA, also known as 26S RNA, that serves as mRNA for structural proteins. The genomic and sub genomic RNAs are translated into polyprotein precursors that finally cleave into non-structural proteins (nsp1, nsp2, nsp3 and nsp4) and structural proteins (capsid, E1 and E2). The positive RNA strand, structural proteins and capsid proteins finally assemble into the mature virion. ER, endoplasmic reticulum. [97]




A schematic representation of the systemic Chikungunya virus dissemination. The Chikungunya virus enters the host cell by the mosquito bite. The virus then replicates into fibroblasts of skin and enters nearby lymph nodes through which it disseminates into the blood. The Chikungunya virus further migrates to different organs and tissues through blood vessels. [98]

**Research Methodology:**

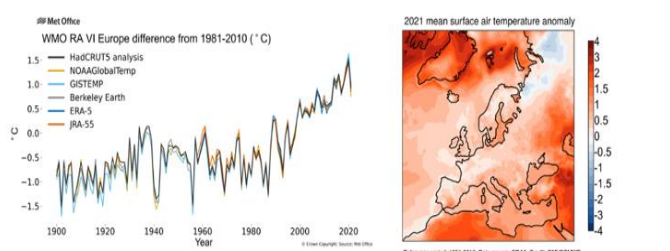
This is a data analysis base research work & during the work three research methodology has been used:

1. COSMO-CLM
2. ERA5 Reanalysis
3. Data comparison

Geneva, 2 November (WMO) _ Temperatures in Europe have increased at more than twice the global average over the past 30 years – the highest of any continent in the world. As the warming trend continues, exceptional heat, wildfires, floods, and other climate change impacts will affect society, economies and ecosystems, according to a new report from the World Meteorological Organization (WMO).

The State of the Climate in Europe report, produced jointly with the European Union's Copernicus Climate Change Service, focused on 2021. It provides information on rising temperatures, land and marine heatwaves, extreme weather, changing precipitation patterns and retreating ice and snow.

Temperatures over Europe have warmed significantly over the 1991-2021 period, at an average rate of about **+0.5 °C** per decade. As a result, Alpine glaciers lost 30 meters in ice thickness from 1997 to 2021. The Greenland ice sheet is melting and contributing to accelerating sea level rise. In summer 2021, Greenland saw a melt event and the first-ever recorded rainfall at its highest point, Summit station. [101]




*Annual average temperature anomaly for 1900-2021 compared to the 1981-2010 reference period for land-only over Europe. Credit: UK MetOffice. Right: Annual average surface air temperature anomaly (°C) for 2021 compared to the 1981-2010 reference period. Data: ERA5 reanalysis. Credit: Copernicus Climate Change Service/ECMWF*

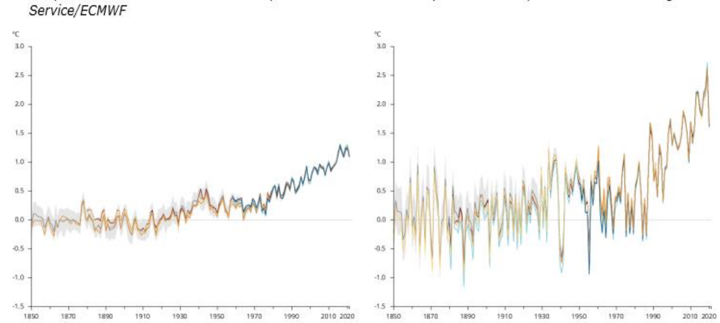


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Figure: Global (left) and European land (right) average near-surface temperatures relative to the pre-industrial period 1850-1900

Trends in global temperature are an important indicator of the magnitude of climate change and its possible impacts. Global annual near surface temperature has been rising steadily since the end of the 19th century. The rate of increase has been particularly high since the 1970s at about 0.2°C per decade. In this period, global temperature has risen faster than in any other 50-year period over at least 2000 years, with the past 7 years (2015–2021) being the warmest on record. All temperature datasets used here place the year 2021 as one of the six warmest years on record, with anomaly ranges between 1.09°C and 1.16°C above pre-industrial levels. Anthropogenic activities, particularly greenhouse gas (GHG) emissions, are largely responsible for this warming.

To prevent serious environmental, economic, and societal impacts of climate change, all signatories to the United Nations Framework Convention on Climate Change (UNFCCC) committed in the 2015 Paris Agreement to limiting global temperature increase to well below 2°C above pre-industrial levels by 2050 and to pursuing efforts to limit the increase to 1.5°C. The observed warming up to now already amounts to more than half of the maximum 2°C increase that would be compatible with the Paris Agreement.

Climate modelling has been used to estimate future climate change for different emissions scenarios and socio-economic pathways underlaying these scenarios (Shared Socioeconomic Pathways, SSP). Without significant efforts to curtail emissions, the increase in global temperature will continue rapidly, and even accelerate.

Global temperatures are projected to increase by 2.1-3.5°C above pre-industrial levels under SSP2-4.5 and by 3.3-5.7°C under SSP5-8.5 by the end of the 21st century. The only scenarios with a chance to stay within the limits established by the Paris Agreements are SSP1-1.9 with projected warming of 1.0–1.8°C and SSP1-2.6 with ranges between 1.3 to 2.4°C till the end of the 21st century compared to pre-industrial levels. These scenarios assume a drastic reduction in emissions in the coming decades and the decline of $CO_2$ emissions to zero and subsequently negative net emissions around the year 2050 (scenario SSP1-1.9) or around 2080 (scenario SSP1-2.6).

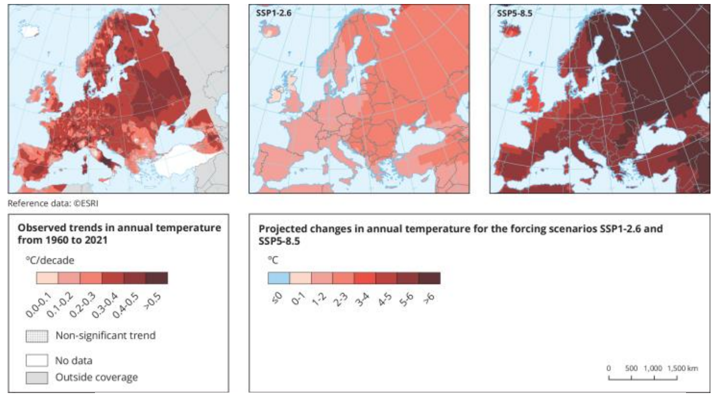


**Figure:** Observed annual mean temperature trend from 1960 to 2021 (left panel) and projected 21st century temperature change under different SSP scenarios (right panels) in Europe

Europe is warming faster than the global average. The mean annual temperature over European land areas in the last decade were 1.94 to 2.01°C warmer than during the pre-industrial period. The year 2020 was the warmest year in Europe since the instrumental records began according to all datasets used, with the range of anomaly between 2.51°C and 2.74°C above the pre-industrial levels. Particularly high warming has been observed over eastern Europe, Scandinavia and at eastern part of Iberian Peninsula.

Projections from the CMIP6 initiative suggest that temperatures across European land areas will continue to increase throughout this century at a higher rate than the global average. Land temperatures in Europe are projected to increase further by 1.2 to 3.4° under the SSP1-2.6 scenario and by 4.1 to 8.5°C under the SSP5-8.5 scenario (by 2071-2100, compared to 1981–2010). The highest level of warming is projected across north-eastern Europe, northern Scandinavia and inland areas of Mediterranean countries, while the lowest warming is expected in western Europe, especially in the United Kingdom, Ireland, western France, Benelux countries and Denmark. [102]

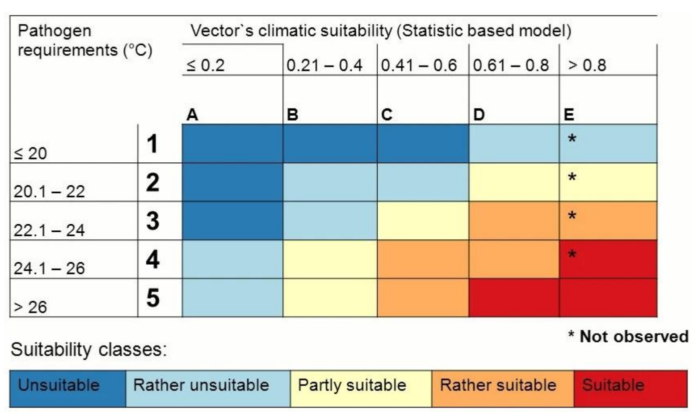


**Figure: Pathogen temperature requirement & suitability.**[100]

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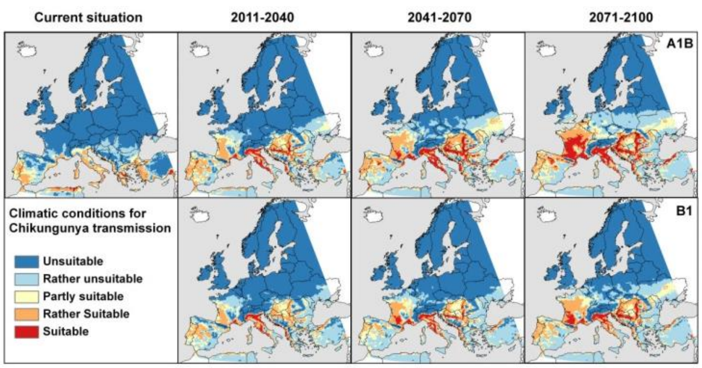
Climatic-derived risk classes for Chikungunya transmission. Temperature requirements for the occurrence of Chikungunya virus were obtained from the analysis of Tilston et al. [103]. Chikungunya virus occurrences are observed for values of the mean monthly temperature in different regions. Virus information is combined with the spatial climatic suitability of the vector *Aedes albopictus* from Fischer et al. [104].




Risk map for Chikungunya transmission in Europe generated by combining temperature requirements of the Chikungunya virus with the climatic suitability of the vector *Aedes albopictus* . Projections for different timeframes are based on two emission scenarios (A1B and B1) from the Intergovernmental Panel on Climate Change, implemented in the regional climate model COSMO-CLM. [100]

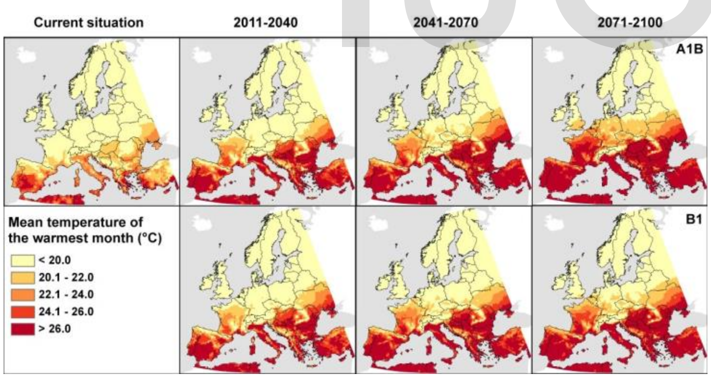



Figure: Fulfilling of temperature requirements for the Chikungunya virus in Europe. Projections for different timeframes are based on two emission scenarios (A1B and B1) from the Intergovernmental Panel on Climate Change, implemented in the regional climate model COSMO-CLM. [100]

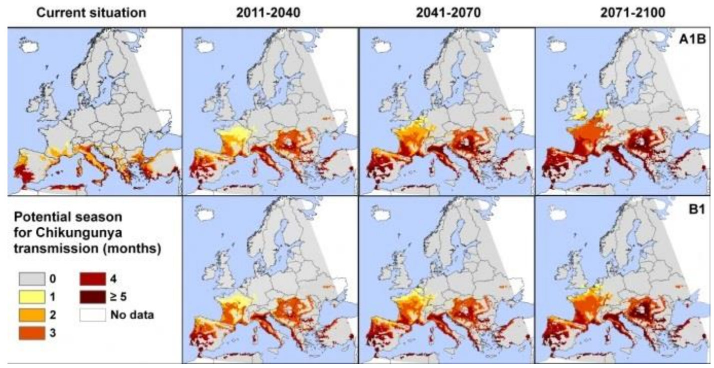



Figure: Number of months with mean temperature ≥20°C as minimum requirement for the transmission of Chikungunya virus. Projections for different timeframes are based on two emission scenarios (A1B and B1) from the Intergovernmental Panel on Climate Change, implemented in the regional climate model COSMO-CLM. [100]

Result & Discussion:
Due to huge amount of carbon emission, no obligation on carbon taxes worldwide, no long-term sustainable strategy for GHG emission reduction plan worldwide factory level, the temperature in Europe from 1991-2021 on an average have been increase +0.5 degree Celsius on every decade.
On the contrary, from research methodology its clear that the temperature is gradually increasing & varying month to month & season to season. So, the vector climate suitability is expected to be increased in Europe & within 2041 to 2070 western Europe may have at least 3 month & within 2070 to 2100 it may vary one month to 5 months.

Mitigation measures:
1. COP26
2. Paris Agreement
3. Carbon taxation
4. GHG Reduction

## Treatment:

There are no specific treatments for chikungunya. There is no vaccine currently available. Chikungunya is treated symptomatically, usually with bed rest, fluids, and medicines to relieve symptoms of fever and aching such as ibuprofen, naproxen, acetaminophen, or paracetamol. Aspirin should be avoided. Infected persons should be protected from further mosquito exposure during the first few days of the illness so they can not contribute to the transmission cycle. Since chikungunya is cured by immune system in almost all cases there is no need to worry.
Chloroquine is gaining ground as a possible treatment for the symptoms associated with chikungunya, and as an anti-inflammatory agent to combat the arthritis associated with chikungunya virus. A University of Malaya study found that for arthritis-like symptoms that are not relieved by aspirin and non-steroidal anti-inflammatory drugs (NSAID), chloroquine phosphate (250 mg/day) has given promising results. There is a debate about the appropriateness of chloroquine as treat-

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ment for chikungunya. Unpublished studies in cell culture and monkeys show no effect of chloroquine treatment on reduction of chikungunya disease.
According to homeopathic experts' effective drugs are available to prevent as well as to speed up recovery from chikungunya. In some of the south Indian cities this type of treatment is tried out. It is claimed that the medicine Eupatorium perf can prevent chikungunya infection. Other medicines prescribed for the disease include Pyroginum, Rhus-tox, Cedron, Influenzinum, China and Arnica.
**There is no vaccine to prevent or medicine to treat chikungunya virus.**
**Treat the symptoms:**

- Get plenty of rest.
- Drink fluids to prevent dehydration.
- Take medicine such as acetaminophen (Tylenol®) or paracetamol to reduce fever and pain.
- Do not take aspirin and other non-steroidal anti-inflammatory drugs (NSAIDS until dengue can be ruled out to reduce the risk of bleeding).
- If you are taking medicine for another medical condition, talk to your healthcare provider before taking additional medication.
- If you have chikungunya, prevent mosquito bites for the first week of your illness.

During the first week of infection, chikungunya virus can be found in the blood and passed from an infected person to a mosquito through mosquito bites.

- An infected mosquito can then spread the virus to other people.

### 9.2 Prevention and control:

The proximity of mosquito vector breeding sites to human habitation is a significant risk factor for chikungunya as well as for other diseases that these species transmit. Prevention and control rely heavily on reducing the number of natural and artificial water-filled container habitats that support breeding of the mosquitoes. This requires mobilization of affected communities. During outbreaks, insecticides may be sprayed to kill flying mosquitoes, applied to surfaces in and around containers where the mosquitoes land, and used to treat water in containers to kill the immature larvae.
For protection during outbreaks of chikungunya, clothing which minimizes skin exposure to the day-biting vectors is advised. Repellents can be applied to exposed skin or to clothing in strict accordance with product label instructions. Repellents should contain DEET (N, N-diethyl-3-methylbenzamide), IR3535 (3-[N-acetyl-N-butyl]-aminopropionic acid ethyl ester) or icaridin (1-piperidinecarboxylic acid, 2-(2-hydroxyethyl)-1-methylpropylester). For those who sleep during the daytime, particularly young children, or sick or older people, insecticide-treated mosquito nets afford good protection. Mosquito coils or other insecticide vaporizers may also reduce indoor biting.
Basic precautions should be taken by people travelling to risk areas and these include use of repellents, wearing long sleeves and pants and ensuring rooms are fitted with screens to prevent mosquitoes from entering.

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