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## RESEARCH ARTICLE

# WATER RESOURCES HELPS IN THE EXPANSION OF MOSQUITOES COLONIES

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## ARTICLE DETAILS

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## ABSTRACT

In Pakistan, water storage bodies are often the most plentiful and active habitats of immature stages of mosquitoes. Mosquitoes are blood feeding type of vectors that bite a particular host and suck blood. As a result, these vectors transmit disease causing agents to the host system. The most common mosquitoes borne viral diseases in Pakistan are Chicken gunya, Dengue fever, west Nile and Zika fever. These diseases are common in low and poor living standard areas. Death rate increases due to more attack of these fatal diseases. Mosquitoes breeding sites are water bodies, discarded tyres, water tanks, bottles, cups and ant traps. Various environmental agents i.e. temperature fluctuations and water resources, now increase the rate of mosquitos in most areas of Pakistan. There is a lack of basic medical education and knowledge about its prevention techniques in mosquito affected areas in Pakistan. The purpose of this review is to highlight the current status of emerging mosquito borne viral diseases in Pakistan, i.e. Chicken gunya, Dengue fever, est Nile and Zika fever. There is more need of prevention strategies and understanding about factors involved in spreading of mosquito borne diseases.

## KEYWORDS

Vector Borne, Mosquito, Chicken Gunya, Dengue Fever, West Nile, Zika Fever.

## 1. INTRODUCTION

Mosquitoes breed in stagnant, fresh, standing water often found around the home. Buckets, discarded tires, and other artificial containers which hold stagnant water in tin cans. Bird baths, clogged rain gutters, and plastic wading pools holding stagnant water in unmanaged pools (Haas-Stapleton, 2019).

Pakistan is an intensively irrigated country where the province of Punjab was considered one of the most malaria areas during the colonial era and suffered some of the most severe epidemics on the Indian subcontinent. Epidemics of malaria in this area are clearly linked to the extensive new irrigation network and above-average rainfall (Akhtar et al., 1996). Mosquitoes are small and midge like insects belonging to culicidae family. There are 3500 mosquitoes species that are identified all over the world 104 species are recorded from Pakistan and Bangladesh (Ashfaq et al., 2014). Culex, anopheles, and Aedes are common pathogenic genera's (Wajiha et al., 2017). These are flying, blood feeding and common vector for taking and transmitting microorganisms to host population. Morbidity and mortality rate of these diseases are very high, about 2.5 billion people are at risk to dengue every year. Biodiversity of mosquitoes is not well known in Pakistan (Ashfaq et al., 2014). A researcher identifies the biodiversity of mosquitoes by using the morphological characters in Pakistan, particularly which are important for the transmission of viral diseases (Reisen et al., 1982; Mousson et al., 2005).

However, Pakistan is a hotspot for vector mediated diseases (Ashfaq et al., 2014). Outbreaks of dengue generated the interest to study the

distribution of mosquito in the Pakistan (Mukhtar et al., 2011; Rasheed et al., 2013). In Pakistan the mosquito borne arboviral diseases are misdiagnosed due to the absence of diagnostic facilities, correct diagnosis is very vital, for the treatment, prognosis and prevention (Khan et al., 2016; Lee et al., 2018). It is very important to study the species composition and density of local mosquito's population to form good management plans to eradicate the mosquito borne diseases (Mwangangi et al., 2013; LaDeau et al., 2013). Flavivirus genus has more than 70 viruses that are transmitted through arthropod which causes the variety of clinical diseases (Hanley et al., 2013; Badawi et al., 2018). Different type of diseases caused by the different genera's of mosquitoes such as dengue fever, yellow fever, chicken gunya and Zika fever are transmitted by Aedes, and malaria is caused by anopheles.

Mosquitoes play vital role in the transmission of diseases (Ashfaq et al., 2014). In mosquitoes borne transmission with a possible human to human transmission by the transfusion of infected blood or transplantation of infected tissue and non-human transmission (Roehrig et al., 2001). Mosquitoes breeding sites are water bodies, discarded tyres, water tanks, bottles, cups and ant traps (Rattanarithikul et al., 2005; Dom et al., 2013). Physical and environmental factors i.e. temperature, vegetation, water currents, water sources, or water quality and climate changes are causes of the mosquito spread (Wajiha et al., 2017). Pakistan is a subtropical country and has very high fauna of vectors like mosquitoes, due to the presence of agricultural land, open network system of irrigation, and river provides breeding to these vectors (Ilahi et al., 2013). The purpose of this review is to highlight the current status of emerging mosquito borne

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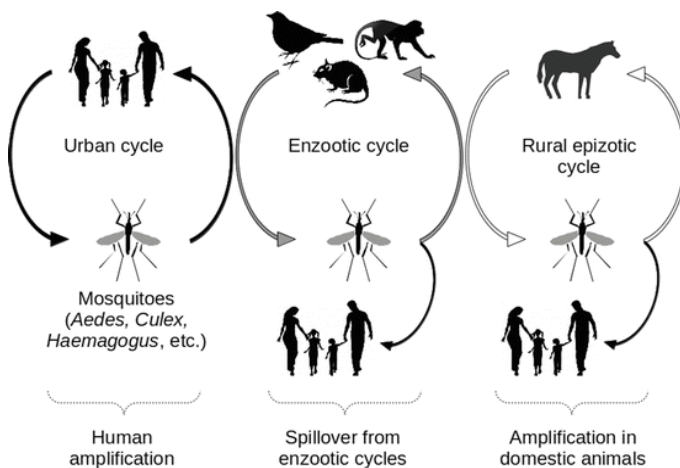
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diseases in Pakistan, like chicken gunya, dengue fever, West Nile, Zika and Malaria.

### 1.1 Chicken gunya

First case of chicken gunya was diagnosed in December 2016 in Pakistan (Badar et al., 2019). But anti- CHIKV antibodies were present in rodents and human era since 1980 (Darwish et al., 1983). The importance of this disease in Pakistan is in two folds, firstly the misdiagnosis because its symptoms are similar to dengue fever and secondly, India has worst outbreak (Sahibzada et al., 2018). This is highly important to differentiate between dengue and chicken gunya for the better treatment and control measures (Chang et al., 2010). Due to the carelessness of many people are suffering from chicken gunya in populated areas of Pakistan such as Malir, Shah Faisal, Saudabad and neighborhood of the city published by The Express Tribune on 16th September, 2016 (Sahibzada et al., 2018). The few patients of chicken gunya were also reported in Lahore during 2011 dengue outbreak. The ministry of national health services, regulation and coordination 1<sup>st</sup> time declared officially on 26 December, 2016 to the WHO (Raza et al., 2017; Mehdi et al., 2019). Based on the findings WHO concluded an epidemic of chicken gunya in Pakistan (WHO, 2009). The chicken gunya is a viral disease of arbovirus which is a single- stranded, enveloped ribonucleic acid virus (Mohan et al., 2010). It is transmitted by two mosquito species *Aedes albopictus* and *Aedes aegypti* this virus belongs to the family togaviridae and genus alpha virus on the basis of antigenic properties, CHIKV is divided into different sero-complexes (Robinson et al., 1955; Calisher et al., 1988). Arbovirus consists of two distinct transmission cycles, urban cycle and sylvatic cycle. Sylvatic cycle concerns with the transmission of virus into non-human hosts like monkey or rodents. But in the urban cycle transmission mainly concern from mosquitoes to humans in urban environment (Mayer et al., 2017). This virus can also be vertically transmitted from mother to fetus and also by blood transfusion as shown in figure 1 (Ali et al., 2018; Madariaga et al., 2016).



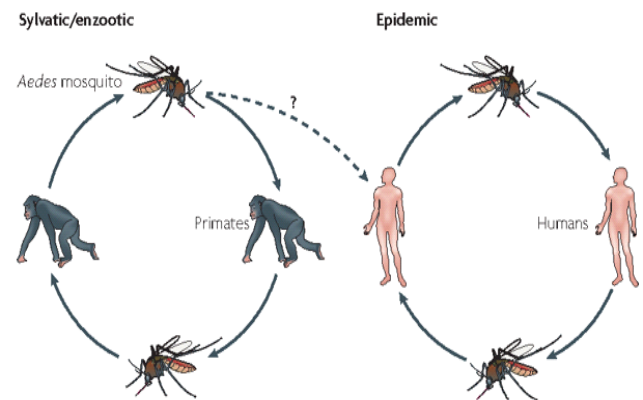
**Figure 1:** Shows Five Phases of CHIKV Transmission (Navarro et al., 2017)

The five phases of CHIKV transmission are visualized in figure 01. Horizontal transmission between CHIKV *Aedes* mosquitoes. Vertical transmission within vectors, it takes 10 days approximately arising of new infected progeny of vector. CHIKV replicate and reach the mosquito's salivary glands within 7 to 10 days for transmission to susceptible human. Horizontal transmission in human during sexual intercourse. Vertical transmission in human which lead to transmission of disease to newborn. Chicken guniya starts when infected mosquito bite and replication of virus occurs in midgut of mosquito. Lymphoid and myeloid both type of cells host for viral replication. These viruses enter the host cells by the receptor mediated endocytosis but the specific receptors are unknown. Cholesterol level of host cells membranes play vital role in transmission of viruses into cells. By limiting the cholesterol level 65% reduction in infectivity was observed (Meaney-Delman et al., 2016). These viruses infect the host cell by inhibiting the optimal level of cellular replication and hijack the host cell machinery for genome replication and synthesis of viral proteins. CHIKV replicates at very high level in the host cell and produce cytopathic effects (Yusuf et al., 2016). CHIKV mediates apoptosis in Hela cells and primary fibroblast by activating both intrinsic and extrinsic pathways. Intrinsic pathway involves mitochondria that was recorded by the activation of caspase-8. The extrinsic pathway activators are not known until now (Musso et al., 2014). It takes approximately one week to initiate the appropriate adaptive immune response and the adaptive immune responses against CHIKV is generated by pattern recognition receptor,

tool like receptor 3, 7 and 8 (Fox et al., 2016). Chicken gunya is characterize by high grade fever, arthralgia mainly of distal joints, skin rash, muscles pain, fatigue, headache, nausea, gastrointestinal, cardiac, neurological complications, arthritis, depression, mood disturbance, impaired memory and blurred vision (van Aalst et al., 2017; Patel et al., 2016). Chicken gunya can be diagnose by measuring Anti-CHIKV immunoglobulin M (IgM), anti- CHIKV IgG antibodies detection, ELISA and chromatographic techniques (Mathew et al., 2017; Prince et al., 2015). The protection from chicken gunya during its outbreak can be done by wearing complete cloths, or by using repellents on exposed skin, the best prevention strategy is to inhibit the mosquito breeding. Paracetamol and fluid intakes are recommended treatments but avoid the non-steroidal anti-inflammatory drugs because these can cause bleeding (Wahid et al., 2016). Recombinant vaccines for CHIKV are different at stages of development in mouse and macaque animal models (Butt et al., 2016).

### 1.2 Dengue Fever

The oldest record of dengue fever present in a Chinese encyclopedia (Chouin-Carneiro et al., 2016). Dengue fever is very important vector borne disease in Pakistan, which causes by single stranded RNA virus which has four antigenically different serotypes: DEN-1, DEN-2, DEN-3, and DEN-4 [44]. It is the tropical emerging disease of dengue virus (Atique et al., 2016). Dengue virus belongs to family flavivirida (Yung et al., 2015; Chatchen et al., 2017). There are two definite cycle of such as endemic/epidemic cycle and sylvatic/ zoonotic cycle as shown in figure 2 (Guzman et al., 2006).



**Figure 2:** Shows Two Phases of Dengue Fever Transmission (Guzman et al., 2010)

There are two cycles of DENV transmission in figure 02. Endemic Cycle involves the human host viruses transmitted by *A.aegypti*, *A.albopictus*. Sylvatic transmission cycle involves monkeys and many different *Aedes* mosquitoes.

It is commonly transmitted through a mosquito *Aedes aegypti* and its secondary vector is *Aedes albopictus* (Barraud et al., 1934; Atique et al., 2016). The *Aedes* mosquito has its specific time of bite which is after the dawn and before the dusk (Bota et al., 2014). This vector was first collected from Peshawar, Dera Ismail Khan, Lahore, Larkana, and Karachi in 1934 by Barraud (Barraud et al., 1934). *Aedes aegypti* was also isolated from Kohat-Hango by Qutubuddin in 1949 (Qutubuddin et al., 1960). Due to malaria control program the dengue vector eradicated after the 1950 (Suleman et al., 1996). Dengue fever was re-introduced in Pakistan into two events 1<sup>st</sup> in south areas of Pakistan in 1980s and second in north areas of Pakistan in 1993 (Kamimura et al., 1986). Before 1994 the prevalence of dengue was undocumented in Pakistan (Patel et al., 2016). But the serosurveys was also launched in 1960-1980 in different provinces of Pakistan during these surveys test conducted were positive for the neutralizing and Hemagglutination antibodies (Paul et al., 1998). First case of dengue infection was reported in 1982 from Punjab, Pakistan (Haroon et al., 2019). In 1994 the 1<sup>st</sup> epidemic of dengue fever was reported in Pakistan (Jahan et al., 2011). A grand survey was conducted in 2000 in five districts of Sindh for the presence of *Aedes aegypti* the survey confirmed the increase in the presence of *Aedes aegypti* after the break of some years another outbreak of serotype 3 was reported in 2005 in Pakistan (Rasheed et al., Jamil et al., 2007). Before 2006 dengue was not common in Pakistan from this year disease extended its spectrum from south to the north of Pakistan (Tang et al., 2008). In 2013 Pakistan face the worst outbreak of dengue fever (Wasim et al., 2014). Moreover, dengue is prevalent all over the world about 50-100 million cases of dengue fever are observed (Muhammad et al., 2016). It is an epidemiologically unstable disease (Kularatne et al., 2015; Hsieh et al., 2009). After the malaria,

dengue fever is the most lethal disease of mosquitoes transmitted diseases, 1-5% is its mortality rate (Agusto et al., 2018; Haroon et al., 2019). When the infected mosquito bites the human it is transmitted into the body through skin (Wiwanitkit et al., 2010).

Infection with dengue causes vast set of symptoms like classical fever, flu like fever, tropical dengue fever, dengue hemorrhagic fever and dengue shock syndrome, muscle and joints pain or retro-orbital pain, headache, thrombocytopenia and low heme- concentration (Gubler et al., 1998; Sherin et al., 2011; Naveed et al., 2018; Khanani et al., 2011). These symptoms start to appear after the 7 days of infection (Hasan et al., 2016). Dengue virus also cause asymptomatic infections that have no clinical signs or symptoms of disease like dengue fever, dengue hemorrhagic fever and prevalence of asymptomatic infection is among the blood donors (Rafique et al., 2017). There is no effective treatment of dengue fever until now some traditional medicines are used for the treatment of dengue fever, safe and effective vaccinations are also not available in market. First vaccine against dengue virus Denvaxia developed by Sanofia Pasture is on phase 3 clinical trail (Agusto et al., 2018; Sherin et al., 2011). The transmission of the dengue fever effected with many factors (Atique et al., 2016). *Aedes aegypti* and *Aedes albopictus* survive better in urban areas, therefore urbanization played important role in providing better breeding site to the disease vectors (Li et al., 2014; Wu et al., 2009). Globalization, frequent travelling, climate changes and metrological parameters like temperature, precipitation and humidity plays a very important role in the transmission of disease (Wesolowski et al., 2015; Raut et al., 2015; Misslin et al., 2016; Cheng et al., 2016). Due to these factors disease intensity increased 30 folds in the past 50 years (Ebi et al., 2016). The elimination of *Aedes* mosquito is very difficult because it can adopt any environmental condition (Ebi et al., 2016).

### 1.3 West Nile Disease

West Nile Disease virus cause by a single stranded, enveloped positive-sense RNA virus. It belongs to family flavivirus (Khan et al., 2018). It is transmitted by culex mosquitoes, family Culicidae (Londono-Renteria et al., 2016). More than 75 mosquitoes species are present infected by WNV in the world. In Pakistan more than 30 species of mosquitoes are present, with most abundant *Culex tritaeniorhynchus* and *Culex quinquefasciatus*. In the mostly present mosquitoes species in Pakistan only *C. quinquefasciatus* is opportunistic that can feed on both humans and birds (Zohaib et al., 2015). It has enzootic transmission cycle between birds and mosquitoes (Misra et al., 2010; Go et al., 2014). WNV infections are mainly spread by the birds, amplifying the virus. Hundreds of avian species can be infected by WNV but mostly with subclinical infections (Rappole et al., 2000). Therefore, the migratory birds are responsible for the spread of WNV over the long distances and wild birds works as amplifier of domestic WNV strains as shown in figure 4 (Paz et al., 2013).

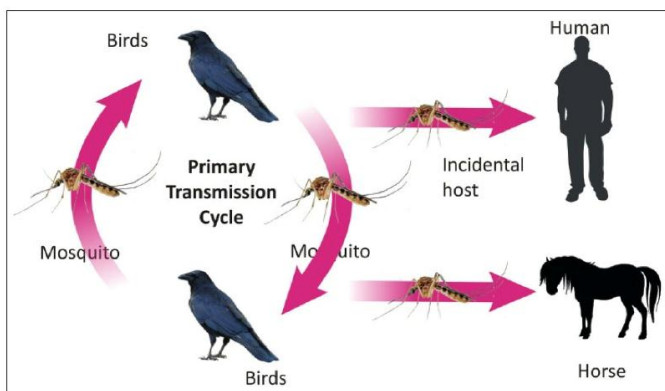


Figure 3: Shows Transmission of WNV (Craven et al., 2001)

There are two transmission categories in figure 03 of WNV based on naturally occurring and accidental vectors. WNV naturally amplifies in bird related and ornithophilic mosquito vectors whereas human as well as horses are accidental hosts.

There are some other important factors which play important role in the distribution and transmission of WNV such as bird trade, mosquito transportation by shipping, or airlines and movement of the peoples (Lopez et al., 2008). The presence of WNV was reported in Pakistan and its neighbor countries (Zohaib et al., 2019). Serological signs in humans and vector capability for west nile disease in Pakistan reported firstly in early 1982 (Akhter et al., 1982; Hayes et al., 1982). Twenty years ago, an epidemiological study was conducted which determines that 40% of humans have antibodies and WNV in Punjab, Pakistan (Khan et al., 2016).

An outbreak is reported recently in Karachi however investigator cannot detect the viral genome (Khan et al., 2018). The major routes of transmission is mosquito bites to humans in WNV infection other routes may be blood transfusion and organ transplantation (Aghaie et al., 2016). Diagnoses can be done on the bases of IgM antibodies in blood serum (Control et al., 2011). Test used for the identification of west nile disease viruses are NS1 and IgM ELISA testing, RT-PCR, Plaque reduction neutralization testing (Khan et al., 2018).

### 1.4 Zika fever

Zika virus causes zika fever and it belongs to family flaviviridae. It is vector borne disease, transmitted by *Aedes* mosquito (Noor et al., 2018; Iqbal et al., 2014). Its varying transmission shows different pattern in different places such as in Africa viral transmission is done by sylvatic transmission cycle, which involves many species of mosquitoes and non-human primates like rhesus monkey, but in Asia sylvatic transmission cycle is yet to be reported (Diallo et al., 2014).

The most likely vector for zika virus transmission is mosquitoes from *Stegomyia* and *Diceromyia* sub-genus of *Aedes*, *Aedes* Africans and *A. fuscifer*. *Aedes aegypti* and *A. albopictus* are primary vector for zika outbreaks as shown in figure 4 (Ciota et al., 2017).

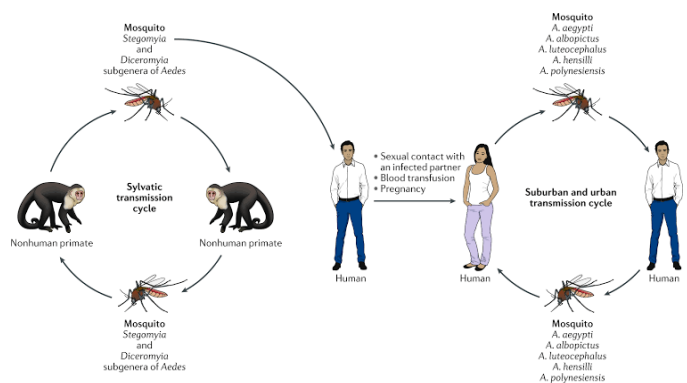


Figure 4: Shows Phases of Zika Fever Transmission (Kurscheidt et al., 2019)

In figure 04 sylvatic transmission cycle mode involves some species of *Aedes* mosquitoes and non-human primates. Urban transmission cycle involves *A. aegypti* and *A. albopictus* and human, which consists of human to mosquitoes and human to human transmission cycle through sexual and blood transfusion.

Virus transmission depend on the vectorial competence like *A. aegypti* and *A. aedes albopictus* show low competence (Santos et al., 2017). High vectorial capacity means high ability to transmit the virus and low vectorial competence means low ability to transmit the virus (Chouin-Carneiro et al., 2016). Existence of *A. aedes* and *A. albopictus* also very important factor for the transmission of zika virus (Diallo et al., 2014). zika virus can also transmit through non mosquito source such as transmission by pregnant mother to fetus (Meaney-Delman et al., 2016). Due to these characteristics of large spectrum of transmission it is serious threat globally. Zika virus was 1<sup>st</sup> identified in rhesus monkey in 1947 and 1<sup>st</sup> infection in human was identified in 1952 (Yusuf et al., 2016). Although in Pakistan there is no clinical cases reported until now but serological diagnostic survey in 1983 showed the presence of antibodies against the Zika virus (Musso et al., 2014). The possible cause may be lack of proper diagnostic facilities in Pakistan and it is much difficult to differentiate between zika virus and other flaviviruses, especially from dengue virus (Wahid et al., 2016). Due to the excessive prevalence of zika virus vector in Pakistan and south Asia, this is call for us to be alarmed (Butt et al., 2016). Analysis of climate, flaviviruses outbreaks, travelling patterns and mosquito biology make us able for the prediction of zika outbreak possibility in Pakistan. People living in the hovel areas where greater change of standing water and open sewage drainage that are very susceptible to breeding of mosquitoes. It predicts that Karachi, Lahore, Islamabad, Multan, Quetta, Gwadar and Peshawar have latent routes of Zika entry (Wahid et al., 2018). The mounting fear of zika epidemic in Pakistan call efforts of scientific community to make plans for eradicating the spread of Zika virus because the outbreak in Pakistan will be very severe than rest of world (Wahid et al., 2016).

## 2. CONCLUSION

Mosquitoes plays a vital role in the transmission of some emerging viral diseases in third world countries especially in Pakistan. Morbidity and mortality rate are sharply increasing in Pakistan. These diseases are

spreading fast due to poor sanitation conditions and lack of eradication strategies. There is also no proper diagnostic and treatment facilities available in Pakistan right now. The proper footsteps should be taken to eradicate their risk to community. Government should organize awareness programs for the betterment of society.

### 3. RECOMMENDATIONS

As mosquito breed in standing water, the management of the Open Water Marsh (OWM) includes the use of shallow ditches, creating a network of water flow within marshes and linking the marsh to a pond or canal. Mosquito breeding grounds can be avoided at home by scraping unused plastic pots, old tires, or buckets; clearing clogged gutters and fixing leaks around faucets; changing water in bird baths frequently (at most every 4 days); and filling or draining puddles, swampy areas, and tree stumps.

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