1. Introduction

Dengue is an acute and one of the most important arboviral infections with potential fatal complications. Dengue is caused by four *flavivirus* serotypes (DEN-1, DEN-2, DEN-3 and DEN-4). All four serotypes can cause a spectrum of illnesses ranging from inapparent or mild febrile dengue fever to severe and fatal haemorrhagic disease (Gubler, 1998; Whitehorn *et al.*, 2010; Innis, 1995). It is mainly transmitted by *Aedes aegypti* mosquito and also by *Ae. albopictus* (Whitehorn *et al.*, 2010).

It is one of the fastest emerging vector-borne diseases, with a drastic increase of cases in last two decades (CDC, 2014) and an approximately 50% of the world’s population is at risk of dengue virus (DENV) infection (WHO, 2004). Dengue fever has been recorded in more than 100 tropical and sub-tropical countries of the world (WHO, 2012a). Dengue fever represents high disease burden in endemic countries (Gubler *et al.*, 1999; Beatty *et al.*, 2011; Shepard *et al.*, 2013). The endemic situation of dengue in India is reflected by the occurrence of major disease outbreaks over the last few decades (Sharma *et al.*, 1998; Pushpa *et al.*, 1998). Since 1967, Delhi has experienced several outbreaks of dengue virus infection (Broor *et al.*, 1997; Dar, 1999; Dar *et al.*, 2006; Gupta *et al.*, 2006) with the last reported 5574 cases and 6 deaths in 2013 (NVBDCP, India). Delhi is now one of the dengue endemic states in north India (Gupta *et al.*, 2012). The dengue virus infection often shows no clinical manifestations or mild illness in humans and is referred to as asymptomatic or in apparent dengue infection (Simmons *et al.*, 2012; WHO, 2009; Endy *et
al., 2011) but their true role in the introduction and subsequent disease spread remains to be clarified (Chastel, 2012). The estimation of dengue infection incidence could be determined by calculating symptomatic and asymptomatic dengue cases.

Despite extensive ongoing efforts, no vaccines for dengue are yet available (Whitehead et al., 2007), (Mazumder et al., 2007). Until there is a vaccine available for prevention of dengue fever, vector control is the primary way to reduce dengue transmission (Guzman et al., 2010). Dengue fever surveillance is a key for effective prevention and control program, but many endemic countries lack such surveillance systems. Most of the surveillance systems are based on the passive detection of symptomatic cases only and hence does not provide information regarding actual number of infected people, and the exact proportion of population at risk of getting secondary infection and DHF (WHO, 1997).

Early detection and case management are two other methods for dengue prevention and control (Guha-Sapir et al., 2005). Improved virological and entomological surveillance are the only tools that can help us not only in prevention of dengue but also in the development of dengue control programs. The investigation of disease and infection measures simultaneous, allows us to understand the dynamic of dengue, determine the proportion of asymptomatic and symptomatic cases, and also to establish the risk factors associated with this disease.

The increasing number of dengue cases is associated with increasing geographic range and intensity of transmission in affected areas (Gubler et al., 1998; Kroeger et al.,
There is a need to outline some important factors responsible for the spread of dengue disease. First, is the presence of *Aedes* mosquitoes; availability of vector breeding sites and detection of dengue virus in *Aedes* mosquitoes. Surveillance of mosquito populations for dengue infection could provide improved risk assessment for dengue infections in humans (Eisen *et al*., 2009). Second, recent demographic changes like uncontrolled urbanization and increasing population density have greatly contributed to the disease spread (Gubler, 1998). The demographic, socio-economic and behavioral factors often turn out to be important factors in dengue disease control. It has been reported that social and economic characteristics like living conditions plays an important role in dengue prevention and control (Sutherst 2004). Third, the distribution and dynamics of dengue infections are known to be influenced by the climatic conditions like rainfall, temperature and humidity etc. (Hales *et al*., 2002; Promprou *et al*., 2005; Wu *et al*., 2007).

Therefore keeping all these factors in mind we undertook this extensive epidemiological study to examine relationship between seroprevalance, dengue virus, vector density with socio-economic status and also to identify the potential dengue risk areas of Delhi. It is a unique study of its kind and to the best of our knowledge such type of epidemiological study was not done before in Delhi as well as in India.

### 1.1 Statement of the problem

Various dengue outbreaks have been reported from almost all parts of India, including Delhi, the National Capital of India, which experienced many severe outbreaks i.e. 1996, 2006, 2010 and the last reported in 2013. The dengue virus infection often shows
no clinical manifestations or mild illness in humans and is referred to as asymptomatic dengue infection and can be a potential source of disease transmission. The asymptomatic cases are more frequent than the symptomatic cases and their relative number varies according to the geographical areas, the epidemiological context and individual immunological attributes. Currently we know very little about the epidemiology of asymptomatic infections. Their frequency? Factors determining the symptomatic/asymptomatic outcome of infection? Can they infect mosquitoes? The role of individuals with asymptomatic infection in spreading the virus needs to be addressed. Such epidemiological information is crucial to predict local dengue epidemiology as asymptomatic dengue infection represents dengue disease burden that goes undetected. In absence of dengue vaccine, the precise knowledge of virus transmission and early detection of cases is becoming extremely necessary in the effort to work towards prevention of dengue diseases. The prevention can also be achieved by targeting the development of mosquito vectors. A greater understanding of the interactions between mosquitoes and the dengue virus would give a clear picture of the transmission dynamics and would potentially lead to better prediction of epidemics, and thus better control of the disease (Medlock et al., 2009).

In north India, epidemiology of dengue is changing fast and becoming hyper endemic in most of the cities particularly in Delhi (Gupta et al., 2012). This change in epidemiology may be explained by demographic and socio-economic factors that were focused. These changes may help in re-stating the control, prevention and treatment
practices guidelines. In reference to the gradual wider sprawl of dengue at an international level, the factors which might contribute to this spread were examined.

1.2 Purpose of the study

The purpose of the present study was to ascertain those epidemiological characteristics, diagnostic, clinical and entomological aspects of dengue disease that could be associated with the dengue surveillance, and use them to understand how the surveillance can be used as core strategy to prevent the effect of dengue disease. In this study, epidemiological aspects included are proportion of asymptomatic dengue infections, and people at risk of acquiring DHF. The other aim of this study is to gather and investigate the outcomes defining the relationship between dengue epidemiology and demography with socio-economic factors in Delhi. In addition, vectors also play an important role in conducting the dengue disease surveillance. Therefore, it is also important to know the distribution of *Aedes* mosquitoes infected with dengue virus in Delhi. The measures of the larvae density with adult mosquitoes infected with dengue are good indicators to identify areas of greater risk. All these factors can be analyzed and contrasted with the up-to-date knowledge on their relationship with dengue epidemiology, in order to implement control strategies for the prevention of a potential outbreak. The decision and policy makers must be informed about the factors responsible for dengue epidemics and their contribution to its increase. Several paradigms of this disease must be taken into consideration to act in a truly efficient manner against the world’s one of the most severe vector-borne disease. This study will contribute towards an understanding of changing dynamics of dengue fever cases in Delhi.
1.3 Objectives

- To determine the proportion of symptomatic and asymptomatic cases in three population groups i.e. Low, Medium and High Income in Delhi.

- Detection of Dengue virus in *Aedes aegypti* mosquitoes from areas with three populations groups i.e. Low, Medium and High Income in Delhi.

- To conduct *Aedes* mosquitoes breeding survey in non transmission & transmission season, in relation to the above mentioned population groups with symptomatic & asymptomatic cases and to stratify the Low, Medium and High risk areas for dengue transmission in Delhi.