

Detection of serotype 1-Dengue fever outbreak in Dire Dawa city, Eastern Ethiopia

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Abstract

Introduction: Dengue viruses are members of the *Flavivirus* genus and the *Flaviviridae* family, which are spread by the *Aedes* mosquito and have become a major public health concern around the world. There are four virus serotypes, which are designated as DENV-1, DENV-2, DENV-3, and DENV-4. Infection with any one serotype confers lifelong immunity to that virus serotype.

Objective: The main objective of the study was to describe the clinical and epidemiological situation of the dengue fever outbreak.

Methods: Descriptive cross-sectional study design was used as of line list data report supported by active case search following dengue fever outbreak declaration in Dire Dawa starting August to October 2020.

Results: A total of 436 suspected dengue fever cases were reported. In a total of 60 suspected patient samples collected and tested with RT-PCR, 13 samples were positive for Dengue virus serotype-1 with a 22% positivity rate. The overall attack rate was 130 /100,000 with a zero case fatality rate. 51.4% of Male individuals were affected compared to females (48.6%). Regarding the age group, 20-24 years old individuals were most affected (809 cases/100,000) population with the 27 and 17-29 median age and Interquartile range respectively. The chief complaints of the patients were Fever (100%), Headache (93%), and Joint Pain (90%). Additionally, Entomological indices, the House index (HI) Container index, and Breteau index (BI) were 67.3%, 85.6, and 171.2 respectively.

Conclusion: the outbreak of dengue fever in Ethiopia is still a public health and cyclical problem. This research report revealed that the highest number of cases is dependent on the beginning and end of the rainy season linked to the high density of *Aedes* mosquitoes. All active age groups (20 -24 years old) of both male and female are the most vulnerable groups to Dengue fever due to high exposure to mosquito bites. The environmental management with good practice of dengue fever case management and integrated Arbovirus disease surveillance at level is required.

Keywords: Dengue fever, detection, Ethiopia, outbreak, sero type-1

Introduction

Dengue virus is the predominant vector-borne disease becoming an important public health concern globally and is growing most rapidly in tropical and subtropical countries with the highest prevalence (Mia MS et al. 2013; Soumyajit B et al. 2015). The virus belongs to the genus *Flavivirus*, family *Flaviviridae* with 4 serotypes known as dengue virus type 1, 2, 3, and 4 (Wininger, and Fass 1996).

Dengue virus type 1 (DENV-1) is one of the four serotypes of the arthropod-borne viruses (Arbovirus) that causes Dengue (Theiler and Downs 1973; Karabatsos 1985). Mosquitoes (mainly of the *Aedes* genus) transmit the virus and also infect non-human primates in a sylvatic cycle. This RNA virus causes a fever that may be temporarily incapacitating and characterized by extreme pain and stiffness of the joints, hence known as break-bone fever (Fagbami 1977; Henchal and Putnak 1990; Simmons et al. 2012–5). Recovery from infection is believed to provide lifelong immunity against that serotype. However, cross-immunity to the other serotypes after recovery is only partial and temporary. Subsequent infections (secondary infection) by other serotypes increase the risk of developing severe dengue (WHO 2009).

More than 50% of the world's population is at risk of DENGUE FEVER with over 125 endemic countries. Globally, the incidence of DENGUE FEVER has increased and expanded geographically by 30 folds from the past 50 years. Annually, it is estimated that 50 to 270 million dengue infections occur throughout the world, of which two million cases are severe DHF with 21,000 deaths (Ferreira and Germano 2012; World Health Organization 2009). Guangzhou has become the most heavily affected area in China since the 1990s; the number of reported cases during 2005–2017 accounted for 60.86% of all cases nationally, reaching 81% in 2014 alone, in particular, serious outbreaks dominated by DENV-1 have occurred in the last 20 years (Luo L, et al. 2017; Xiao JP et al. 2016).

In 2001, outbreaks of three different serotypes of DENV-1 occurred almost at the same time in Myanmar and the South Pacific region; these outbreaks could be traced back to multiple introductions from neighbouring regions of Asia (Atchareeya et al. 2004). Similarly, there were DENV-1 outbreaks in Hawaii and Tahiti during 2001–2002 (Imrie et al. 2006). In 2014, Kaohsiung, Taiwan experienced its largest dengue serotype-1 outbreak and in this outbreak, 19 deaths and 132 dengue haemorrhagic fever cases were reported (Sheng-Fan et al. 2015).

Despite the overlapping factors identified, various studies hypothesized general factors to explain the reasons for the emergence of dengue: Firstly, rapid population growth, unplanned urbanization, and increased international travel in combination with vector distribution were assumed to result in the extensive transmission of the dengue virus in Africa. (Gubler 2004). Secondly, urban poverty and minimal capacities for surveillance and control measures remain important precipitating factors of dengue transmission in regions with favourable climate and thirdly, increases in poor, urban populations, break down in public health measures, especially vector control programs, trade, and environmental disturbances (World Health Organization 2009).

In Ethiopia, for instance, during the spring and summer seasons, the prevalence of dengue virus antibody positivity becomes higher with a peak in August. Urban and semi-urban residence, occupation, the presence of uncovered water containers, and lack of mosquito net use were the factors associated with the positivity of DENV antibodies (Woyessa 2014). Early diagnosis and proper case management, the case-fatality rate (CFR) of DHF are generally under 1%, but the CFR may be over 10% once the shock develops. In Africa, specifically in Ethiopia, laboratory diagnostics are not done for most of the febrile illnesses and are taken as malaria. In Ethiopia, DENGUE FEVER was diagnosed only among travelers returning to countries to which dengue was not endemic but never reported as an outbreak locally (Ferreira and Germano 2012).

According to the World Health Organization (WHO 2009) standard case definition, a suspected dengue case was defined as a patient with acute febrile illness with a negative malaria test result, and at least two or more of the following manifestations: headache, rash, myalgia, arthralgia, haemorrhagic manifestations or leukopenia.

During phase one, blood specimens were collected from 60 patients with suspected dengue and tested at the national reference laboratory for DENV non-classification. Confirmed cases were defined as those with positive PCR results for DENV, and probable cases were defined as those with positive DENV NS1 antigen or anti- DENV IgM antibody results. Therefore this report aimed to describe the situation of dengue fever serotype-1 during its outbreak in Dire Dawa city.

Materials and Methods

Area Description: Dire Dawa city administration is found at a distance of 515 km Southeast of Addis Ababa, the capital of Ethiopia. The city is located at the latitude and longitude of 9°36'N 41°52'E, respectively, bordering the regions of Oromia and Somali. The city lies between 1000 to 2000 m above sea level with an average monthly temperature of 24.8°C for confirmation. The warm climate of the City is favourable for the transmission of vector-borne diseases. It has nine operational districts (4 rural and 5 urban districts) that are classified into 9 urban and 38 rural kebeles the smallest administrative unit in

Ethiopia. Moreover, the council has 2 government-owned Hospitals, 15 health centres and 33 health posts. Additionally, there are 3 private hospitals and 21 private clinics. 0.5% of the Ethiopian population lives in the city with 10% under 5 years from a total population living in the city. According to 2019 population projections, Dire Dawa has a total of approximately 506,490 population (68%) in the city (United Nation-World urbanization prospects 2020).

Study Design and data collection: Descriptive line list data analysis was used After the declaration of the dengue fever outbreak in the area (Dire Dawa) National and Regional Public Health Emergency Management and also National Entomological team Performed multi-disciplinary activities to avert and early control of the outbreak like: Active case search in all Kebeles (Lower Administrative Structure), Case management at government and private hospital and clinics. The taskforce established with the stockholders and chaired by the city mayor, enhanced social mobilization, more than 40 health care workers were participated Vector born disease (Dengue, chikungunya virus fever and Malaria) training basically on surveillance and cases management, Identifying mosquito breeding sites and awareness creation for the community. The data collection was done following the outbreak report of DENGUE FEVER. Health facilities (Hospitals, Health centres and Health posts) were visited to check whether all information required is filled on the line list as of coming patients and the samples were taken for confirmation at the laboratory level in EPHI.

Statistical Analysis: The data were checked for competencies and entered and analysed by Microsoft Excel sheet 2019. Descriptive analysis was used to describe the data based on person, place and time and the result was presented by narrations, frequency distributions, bar graphs and histograms.

Result

Clinical and Epidemiological description of dengue fever outbreak: In the current outbreak 436 dengue fever cases were reported from the Dire Dawa city administration. The first cases were reported on August 1st, 2020 and the highest number of cases reported per day was 24, on August 10th, 2020. However, the number of reported cases was declined as of August 18, 2020, however, on commencing September 1st, 2020 the number cases of raised to 21 per day, then after the number of reported cases were declined until September 12, while in the second-highest cases reported on September 14, 2020, which was 22 per day as depicted in Figure 1. From the total self-presented patients in the health facilities, ninety-eight present (428/436) cases were treated as an outpatient and on the other hand, nearly two present (8/436) cases were treated as an inpatient. A total of 60 suspected patient samples was collected and tested for RT-PCR at EPHI Laboratory and 13 of them were positive for Dengue fever virus Serotype 1 and the positivity rate was 22% (13/60).

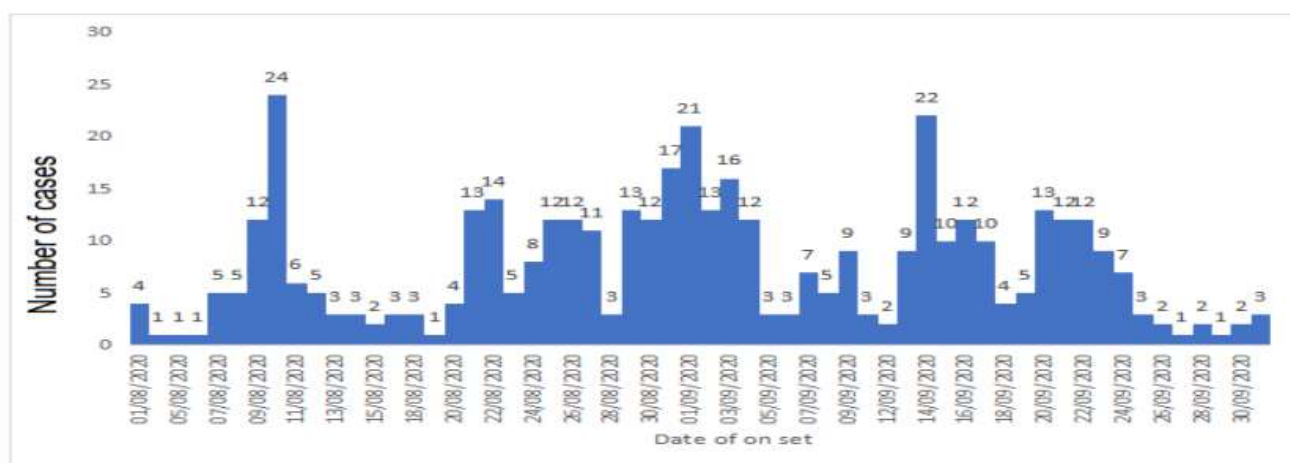


Figure 1: Epidemic curve of dengue fever outbreak in Dire Dawa city administration of Ethiopia, 1st August to 1st October 2020.

Almost all patients Presented in the health facility had Fever (100%), Headache (93%), Joint pain (90%), and Back pain (53%), while other miner clinical feathers like Nasal Bleeding (1.6%) and Vomiting (14%) were shown by the patients (Table 1).

Description by Sex and Age: In a total (436) cases, 224 (51.4%) were males and 212 (48.6%) were females. In the current outbreak, all age groups were reported. However, the highest proportion of cases were between twenty and twenty-four years old (20.9% (91/436)) followed by between twenty-five and twenty-nine years old (14.7% (64/436)) and between Zero to and four years old (8.9% (39/436)) and The Median age of the current outbreak cases is 25 years and (IQR: 17– 38), as indicated in table 2.

Table 1: Clinical feathers seen on suspected Dengue 436 outbreaks in Dire Dawa city, 1st August to 1st October 2020

Clinical features	Response (n=436)	Percentage
Fever	Yes	436 100%
	No	0 0
Joint pain	Yes	395 90.6%
	No	41 9.4%
Headache	Yes	407 93.3%
	No	29 6.7%
Nasal bleeding	Yes	7 1.6%
	No	429 98.6%
Vomiting	Yes	61 14%
	No	375 86%
Back pain	Yes	250 57.3%
	No	186 42.7%

Table 2: Cases distribution by Age group and Sex, Dire Dawa City administration of Ethiopia, 1st August to 1st October 2020

Age group	Number of cases	Female	Male
0-4	39 (8.9)	19 (9)	20 (8.9)
5-9	28 (6.4)	11 (5.2)	17 (7.6)
10-14	32 (7.3)	14 (6.6)	18 (8)
15-19	61 (14)	28 (13.2)	33 (14.7)
20-24	91 (20.9)	52 (24.5)	39 (17.4)
25-29	64 (14.7)	29 (13.7)	35 (15.6)
30-34	31 (7.1)	16 (7.5)	15 (6.7)
35-39	19 (4.4)	12 (5.7)	7 (3.1)
40-44	18 (4.1)	6 (2.8)	12 (5.4)
45-49	16 (3.7)	9 (4.2)	7 (3.1)
>50	37 (8.5)	16 (7.5)	21 (9.4)
Total	436 (100)	212 (48.6)	224 (51.4)

Case fatality and attack rate: The Case Fatality Rate (CFR) of this dengue fever outbreak was zero. The overall attack rate of the outbreak was 130 dengue fever cases per 100,000 population while the Sex-specific

attack rate for the current outbreak was, 266 dengue fever cases per 100,000 male population for Males and 255 dengue fever cases per 100,000 female population for females as shown in Table 3.

Table 3: Characteristics of Dengue cases and attack rate of suspected Dengue cases during the outbreak in Dire Dawa city, 1st August to 1st October 2020

Age categories	population	Attack Rate /100,000 population	number of cases	Percentage
0-4	89,361	44	39	8.9
5-9	79,966	35	28	6.4
10-14	73,966	43	32	7.3
15-19	17,589	347	61	14.0
20-24	11,253	809	91	20.9
25-29	10,960	584	64	14.7
30-34	9,230	336	31	7.1
35-39	7,648	248	19	4.4
40-44	6,012	299	18	4.1
45-49	6,180	259	16	3.7
>50	22,521	164	37	8.5
total	334,686	130	436	100

Of the reported cases, individuals aged between twenty and twenty-four years old were the most affected group by dengue fever with an age-specific attack rate of 809 of 20-24 years which followed by the age of 25 -29 to be attacked by dengue fever. For an individual who was found at age 0-14 and above 50 years old, the attack rate was found to be low and the least affected age group was children between zero to four years old with 44 dengue fever cases per 100,000 population of the attack rate (Figure 2).

Entomological investigation: The Entomological indices were also calculated as House Index (HI), Container Index (CI) and Breteau Index (BI) to identify the most likely risky area for the Arboviral diseases, Dengue, Chikungunya, Yellow fever and others. Accordingly, the current Entomological indices showed that the HI in the inspected houses were found to be very high (67.3%) with 85.6 CI and 171.2 BI.

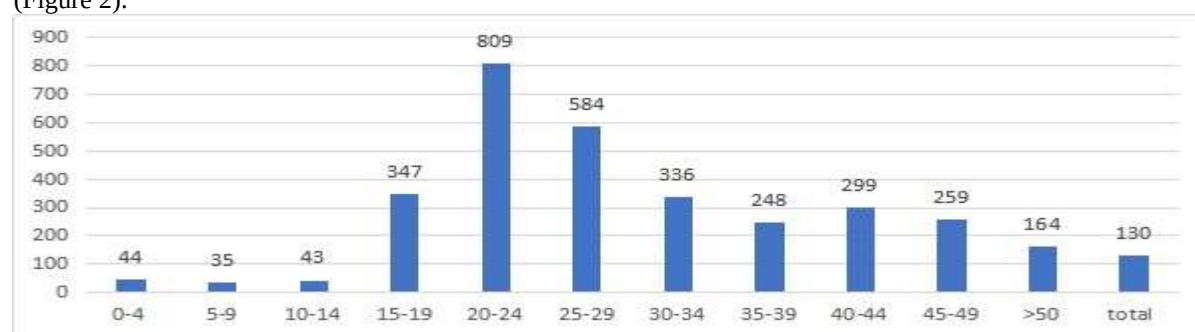


Figure 2: Attack rate of dengue fever outbreak per 100,000 population by age in Dire Dawa city administration of Ethiopia, 1st August to 1st October 2020

Discussion

Our investigation confirmed a dengue fever outbreak in Dire Dawa city administration of Ethiopia from August first to September 30, 2020. Since 2013, Ethiopia has reported more than 12,000 dengue fever cases, but this is likely an underestimate due to the lack of Ethiopian Integrated Disease Surveillance and Response (IDSR) reporting requirements for Dengue Fever virus, limited Regional and National laboratory capability low awareness by health care providers, other prevalent febrile illnesses, and lack of diagnostic testing and systematic surveillance to confirm cases (Amarasinghe et al. 2011). The magnitudes of the dengue fever virus vary from year to year, there is a shortage of information or data on the clinical and epidemiological description. The occurrence of Arboviral disease transmission control with an evidence-based strategic plan is required from different aspects like clinical, epidemiological, and entomological studies. In the current report, both clinical and epidemiological parameters were stressed in line

with basic entomological risk indicators. In the current outbreak, a total of 436 cases have been reported since 1st August 2020 and this paper documented it as the 4th DENGUE FEVER outbreak in Dire Dawa city administration, Eastern part of Ethiopia, highlighting the clinical and Epidemiology of the outbreak.

Descriptive Analysis of this dengue fever outbreak indicated that both sexes were affected. Nevertheless, 51.4% of the cases were males, nearly 2% of cases were hospitalized and the positivity rate was 22%. Similarly, another study conducted in Somali Region revealed that the majority of cases (58%) (Alayu et al. 2019) were males. However, the proportion of hospitalized cases was 34% and the positivity rate was 57.9%, which was different from the current outbreak. In contrary to the current report outbreak investigation conducted in Eastern Ethiopia, the positivity rate was 72% and DENV serotype 2 (DENV 2) was detected.

As shown on the classic propagated epidemic curve (Figure 1), the outbreak was gradually raising before reaching the plateau, which lasts about nine days, indicating a continuous common source epidemic. Then, the second peak of the epidemic is also observed after a month of 1st September 2020, and after fifteen days of the 3rd peak of the epidemic is observed on September 2020, which may indicate delayed public health measures in responding to the outbreak.

This study showed that the median age of the cases was 25 years old (IQR: 17-38) and the highest proportion of cases among the age group of 20-24 years old (20.9%). Similarly, the study conducted in Somali Region, Ethiopia, showed that the highest proportion of cases was among the age group of 20 – 24 years old (23.8%) with the median age of 27 years old (IQR:22-38) (Alayu et al. 2019). Another study on Mozambique outbreak investigation also showed the median age of 28 years (IQR: 18–35) (Massangaie et al. 2014).

In the present investigation, the case fatality and attack rates during the outbreak were zero and 130 per 100,000 population, respectively. This finding is in agreement with the study conducted in the Somali Region, Ethiopia. The case fatality rate and attack rate of the present investigation were zero and 86 per 100,000 population, respectively. In the other round, the sex and age-specific attack rates were 266 cases per 100,000 male population for males and 255 cases per 100,000 female population for females. Higher sex and age-specific cases (809) per 100,000 population were reported for age between 20-24 years old population than the outbreak covered by the present investigation (Alayu et al. 2019). However, the present finding is in contrast to the study from Guangdong, China, which revealed that the case fatality rate was 13.3 deaths per 100,000 cases of dengue fever (Amarasinghe et al. 2011). All cases involved in the present investigation were manifested with fever, and 1.6% of the cases had nasal bleeding, which was contrary to the previous finding in Somali Region, Ethiopia (Fred 2012).

The data analysis indicated that 98% of the dengue fever cases were treated as outpatient consults and nearly two percent of the cases were treated in in-patient departments. Similarly, the previous study in Dire Dawa city entitled with the first acute febrile illness investigation associated with dengue fever in Ethiopia, 2013, revealed that almost all cases were outpatient consults; and only 0.32% cases were admitted (Alayu et al. 2019).

The entomological investigation indicated that all containers such as Barrel Jerry cans, buckets, tires, flowerpots, ditch, were infested by the *Aedes aegypti* mosquito. Studies conducted in Tanzania also show that *Aedes aegypti* breeds in tree holes, leaf axels, gutters, tires, ground pools, discarded pots, plastic rubbers, buckets, pure water nylons and aluminium containers (Philbert and Ijumba 2013).

Conclusion

Currently, dengue fever is a serious public health problem in Africa and it is a newly emerging threat to the countries. In the last decade, the occurrence of dengue fever outbreaks in Dire Dawa city remains a cyclical problem. The present report indicates that the highest proportion of cases were males who were within working and active age group. This may show that they are active and spend most of their time outside of the house, which exposes them to mosquito bite. However, death was not reported on any one of the patients presented with fever during the outbreak. Therefore, environmental management like Integrated Vector Management (IVM), distribution of protective clothes and skin repellents, covering or draining water containers in and around the residency areas are the fundamental elements of early control of dengue fever outbreak. In addition to these, good practice of dengue fever case management, integrating arbovirus disease surveillance in the national public health surveillance system, and sustainable community involvement can improve vector control efforts substantially.

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Conflict of interest: Authors do not have any conflicts of interest in this work.

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