Economic burden estimation associated with dengue and chikungunya in Gujarat, India

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ABSTRACT

Background: Dengue and chikungunya have been emerging as major vector-borne diseases. The global burden of the diseases is rising as a public health problem. The complexity of disease is governed by multiple constraints including only symptomatic treatment and inflicts heavy social and economic burden on society. The present study is designed to assess the economic burden of dengue and chikungunya infection by calculating cost per patient in Gujarat, India. Methods: A total of 210 patients were enrolled in the study from Ahmedabad and Kheda district of Gujarat from May 2018 to December 2019 of which 150 had dengue and 60 chikungunya infections, subject to the willingness of participation in the survey. Information on wage loss days, cost associated with medicines, diagnosis, special food and travel cost, etc., for the calculation of the direct and indirect costs associated with dengue and chikungunya were collected from these participants using a structured questionnaire. Informed consent was taken before including any participant in the study. Results: In the dengue sample, 86 were males (57.3%) and the rest were females, and in the chikungunya sample, 31 were males (51.7%) and the rest females. The median age of the participants with dengue and chikungunya was 18 (p25 to p75: 8 to 26) and 30 (p25 to p75: 21 to 45) years respectively. Median family income was recorded as Rs 15,000 (p25 to p75: 9000 to 25500) and Rs 12,000 (p25 to p75: 9000 to 18500) for the dengue and chikungunya cases, respectively. The average duration of the illness was observed to be higher in chikungunya (median days (P25 to p75): 15 (7–45)) than dengue (median days (P25 to p75): 10 (5–15)). The median indirect cost in the case of dengue was Rs 1,931 (p25 to p75: 300 to 4500) while Rs 2,550 (p25 to p75: 0 to 5250) was observed for chikungunya cases. Two types of direct cost, namely, direct cost related to medical expenses and direct cost related to other expenses were calculated. Direct cost related to medical expenses was observed to be higher in dengue (Md (P25 to p75): Rs 2,450 (400–5000)) than chikungunya (Md (P25 to p75): Rs 1,500 (150–5200)) while indirect cost related to other expenses were comparable between dengue (Md (P25 to p75): Rs 1,575 (1300–2600)) and chikungunya (Md (P25 to p75): Rs 1500 (850–2850)). The average total cost for one dengue episode was estimated to be Rs 6,860 (3700–12525) whereas it was Rs 7,000 (2550–14000) for one episode of Chikungunya.

Conclusions: Overall, patients have to bear high costs while suffering from dengue and chikungunya infections. Furthermore, the duration of illness while suffering from viral diseases also contributes to the substantial economic burden. Improved knowledge about the impact of the cost and the economic burden associated with dengue and chikungunya will help policymakers allocate and appropriate resources accordingly.

Keywords: Chikungunya, dengue, direct cost, economic burden, indirect cost, medical cost

Introduction

Dengue and chikungunya are mosquito-borne viral diseases that are major causes of morbidity due to infectious diseases worldwide.[1,2] In India, Aedes aegypti is considered as primary and Aedes albopictus as secondary vector for transmission of dengue...
Various studies have been reported about dengue regarding its epidemiology and treatment. But there are very few studies on the economic burden of dengue illness in India. Several studies have estimated the burden of dengue illness in India. Another study, use data from multiple sites and treatment facilities, and take a broad economic perspective. However, few studies are available from India regarding the economic burden of dengue and chikungunya in India. These studies are essential to attract the attention of the policymaker and health care system, and also to raise awareness in the community. There is heterogeneity in the socioeconomic level countrywide; the best way to estimate economic burden is to conduct a prospective study, use data from multiple sites and treatment facilities, and take a broad economic perspective. However, few studies are available from India regarding the economic burden of dengue and chikungunya. Furthermore, with a change in the overall social and economic scenario of the general population in a region, and also due to the distribution of dengue and chikungunya vectors from urban to rural areas, and the ever increasing number of patients, there is a constant need to assess and update the available information on the cost and the economic burden due to these diseases. The current study was planned to assess the economic burden of dengue and chikungunya infections in two districts of Gujarat, India.

### Material and Methods

Gujarat state is located in the western region of the country and has 33 districts. The study was conducted in the Ahmedabad and Kheda districts from May 2018 to December 2019. Ahmedabad is the largest city in the state and every year, it contributes a major chunk to the reported cases of dengue and chikungunya in the state. Kheda is the adjoining district of Ahmedabad, also reporting a large number of cases annually. In the present study, a total of 210 cases of two major vector-borne viral diseases from Ahmedabad and Kheda district were enrolled. A total of 150 dengue and 60 chikungunya cases were surveyed after taking their informed consent. All information was collected using a good designed and tested questionnaire. The questionnaire had three basic components: demographical information, socioeconomical information, and information related to different costs associated with dengue and chikungunya, whether associated directly or indirectly.

### Enrollment

Line listing of dengue and chikungunya patients had been collected from the District Malaria Office/private hospital/laboratory. A dedicated project team visited the place of these individuals and were asked for their consent to participate in the survey; in the case of children, consent was taken from their guardians. The consent form was in the local language so that people understood the possible pros and cons to participating in the study.

### Ethical Clearance: Clearance of Institutional Ethical Committee approval was obtained for the study vide letter No. ECR/NIMR/EC/2018/35 dated 26th Feb 2018.

### Economic burden estimation

There are several costs which are either directly or indirectly associated with dengue and chikungunya. For the appropriate estimation of economic burden due to dengue and chikungunya, the data on all possible costs were collected.

### Indirect cost

The time cost of the ill person and respective caretaker had been considered as an indirect cost which was calculated by total wage loss days of the ill person and caretaker due to illness and multiplied by the per day average income of that person.

### Direct cost

The direct cost included the expenses incurred by the patient which may be the medical cost or non-medical cost. Medical cost involved doctor consultancy charges, medicine charges, diagnosis charges, hospitalization charges, and other medical charges such as physiotherapy, while non-medical cost involved transportation cost (from home to hospital/clinic), special food cost (supplements), general food for indoor treatment, and lodging of caretaker.

The government provides free or low-cost treatment facilities for dengue and chikungunya patients, but patients still pay huge amounts of money on medical and non-medical bills. Various studies have been reported about dengue regarding its epidemiology and treatment. But there are very few studies on the economic burden of dengue and chikungunya in India. These studies are essential to attract the attention of the policymaker and health care system, and also to raise awareness in the community. There is heterogeneity in the socioeconomic level countrywide; the best way to estimate economic burden is to conduct a prospective study, use data from multiple sites and treatment facilities, and take a broad economic perspective. However, few studies are available from India regarding the economic burden of dengue and chikungunya. Furthermore, with a change in the overall social and economic scenario of the general population in a region, and also due to the wide distribution of dengue and chikungunya vectors from urban to rural areas, and the ever increasing number of patients, there is a constant need to assess and update the available information on the cost and the economic burden due to these diseases. The current study was planned to assess the economic burden of dengue and chikungunya infections in two districts of Gujarat, India.
Other information

Some other information was also collected which included the use of family savings during illness, family consumption expenditure gets reduced, a family has to sell the assets for the treatment to meet day-to-day expenditure, a family has to borrow money for the treatment.

Data analysis

Collected data were entered in Microsoft Excel sheet and analyzed using statistical software Stata 15.0 (Stata Corp) and R 3.6. All categorical variables were expressed in number percentage while continuous variables were expressed in median (P25 to p75).

Distribution of socio-economic and demographic indicators

Two hundred ten cases were enrolled (dengue 150 (71.4%) and chikungunya 60 (28.6%)) for economic burden estimation. The majority of dengue patients were from the 5–18 years age group (43.3%), while a majority of chikungunya cases belonged to the age category of 19–30 years (38.3%). Out of 150 dengue cases, 86 were male (57.3%), and among the 60 chikungunya cases, 31 were male (51.7%). Around 61.8% of dengue cases (i.e., 92/150) belonged to the general category followed by 21.5% and 16.7% from OBC and SC/ST/Primitive tribes’ category respectively. In the case of chikungunya, 37.3% (i.e., 22/60) were from the general and OBC categories each, followed by 25.4% were from SC/ST/Primitive tribes. Average (median) family income of dengue cases and chikungunya cases were Rs 15,000 (9,000–25,500) and Rs 12,000 (9,000 to 18,500), respectively. The median duration of illness in dengue and chikungunya was 10 days (p25 to p75: 5 to 15) and 15 days (p25 to p75: 7 to 45) respectively. The average (median) number of wage loss days in dengue was 8 (p25 to p75: 5 to 15) while in chikungunya it was 15 (p25 to p75: 7 to 45). The average (median) number of wage loss days of family members due to illness in dengue was 6 (p25 to p75: 4 to 10) while in chikungunya it was 7 days (p25 to p75: 4 to 15) [Table 1].

Cost estimation due to dengue and chikungunya

Indirect cost

The cost incurred due to wage loss days of the patient as well as their caretaker was considered as an indirect cost, which was calculated by multiplying the average income per day with number of wage loss days. Calculation of indirect cost was done for the patient and their caretaker separately, and the total indirect cost was calculated by summing these two costs [Tables 2 and 3].

Indirect cost due to wage loss days of the patient

The average (median, and mean ± SD) indirect cost due to wage loss days of the patient itself was Rs 0 (p25 to p75: 0 to 800), (1751 ± 5179), and Rs 0 (p25 to p75: 0 to 3150), (3235 ± 8028) for dengue and chikungunya respectively. The overall range of indirect cost due to wage loss days of dengue and chikungunya patients itself was Rs 0–44,000 and Rs 0–54,000 respectively [Table 2]. There was no indirect cost involved in 72.7% of dengue and 56.7% of chikungunya cases. There were around 10.7% of dengue cases and 18.3% of chikungunya cases in which indirect cost due to wage loss days was more than Rs 5,000 [Table 3].

The average (median, and mean ± SD) indirect cost due to wage loss days of dengue patient who took treatment at a private hospital (N = 67) and a government hospital (N = 83) was Rs 0 (p25 to p75: 0 to 750), (2511 ± 7229) and Rs 0 (p25 to p75: 0 to 3150), (3235 ± 8028) for dengue and chikungunya respectively. The overall range of indirect cost due to wage loss days of dengue and chikungunya cases respectively was Rs 0–7229 and Rs 0–8028. The average indirect cost in dengue cases, among private hospitals, was Rs 7229 ± 7229 and in government hospitals was Rs 8028 ± 8028.

Table 1: Baseline Information

| Variables               | Dengue (n=150) | Chikungunya (n=60) |
|-------------------------|---------------|--------------------|
| Gender                  |               |                    |
| Male                    | 86 (57.3%)    | 31 (51.7%)         |
| Female                  | 64 (42.7%)    | 29 (48.3%)         |
| Social category         |               |                    |
| SC/ST/Primitive tribes  | 25 (16.7%)    | 15 (25.4%)         |
| OBC                     | 32 (21.5%)    | 22 (37.3%)         |
| General                 | 92 (61.8%)    | 22 (37.3%)         |
| Religion                |               |                    |
| Hinduism                | 78 (52.0%)    | 47 (79.7%)         |
| Islam                   | 68 (45.3%)    | 12 (20.3%)         |
| Others                  | 4 (2.7%)      | 0                  |
| Economic category       |               |                    |
| BPL                     | 22 (16.2%)    | 15 (25.0%)         |
| APL                     | 76 (55.9%)    | 40 (66.7%)         |
| Antyodaya               | 7 (5.1%)      | 0                  |
| None                    | 31 (22.8%)    | 5 (8.3%)           |
| Patient age (yrs.)      | (Md. (IQR))   |                    |
| <5                      | 18 (8–26)     | 30 (21–45)         |
| 5–18                    | 17 (11.3%)    | 3 (5.0%)           |
| 19–30                   | 65 (43.3%)    | 7 (11.7%)          |
| 31–50                   | 45 (30.0%)    | 23 (38.3%)         |
| 51 and above            | 16 (10.7%)    | 18 (30.0%)         |
| Total family income (Rs) (Md. (IQR)) | 15,000 (9,000–25,500) | 12,000 (9,000–18,500) |
| <10000                  | 40 (26.7%)    | 24 (40.0%)         |
| 10,000–19,999           | 59 (39.3%)    | 22 (36.7%)         |
| 20,000–39,999           | 20 (13.3%)    | 5 (8.3%)           |
| 40,000–49,999           | 16 (10.7%)    | 7 (11.7%)          |
| 50,000 and above        | 15 (10.0%)    | 2 (3.3%)           |
| Number of family members (Md (IQR)) | 5 (4–6) | 4 (4–5) |
| ≤6                      | 129 (86.0%)   | 56 (93.3%)         |
| >6                      | 21 (14.0%)    | 4 (6.7%)           |
| Illness duration (days) | (Md (IQR))    |                    |
| ≤7 days                 | 63 (42.0%)    | 15 (26.3%)         |
| >7 days                 | 87 (58.0%)    | 42 (73.7%)         |
| Wage loss days due to illness (Md (IQR)) | 8 (5–15) | 15 (7–45) |
| ≤7 days                 | 72 (48.0%)    | 15 (26.3%)         |
| >7 days                 | 78 (52.0%)    | 42 (73.7%)         |
| Wage loss days of family members due to illness (Md (IQR)) | 6 (4–10) | 7 (4–15) |
| ≤7 days                 | 90 (63.8%)    | 20 (54.0%)         |
| >7 days                 | 51 (36.2%)    | 17 (46.0%)         |
Table 2: Quantification of different costs associated to illness

| Cost Category                     | Dengue Treatment from private hospital (n=67) | Dengue Treatment from govt. hospital (n=83) | Overall (n=150) | Chikungunya Treatment from private hospital (n=24) | Chikungunya Treatment from govt. hospital (n=36) | Overall (n=60) |
|-----------------------------------|-----------------------------------------------|---------------------------------------------|----------------|-------------------------------------------------|-------------------------------------------------|---------------|
| **Indirect Cost**                 |                                               |                                             |                |                                                 |                                                 |               |
| Consultancy Cost                  | Mean±SD                                       | 3486±12494                                 | 2511±12299     | 3933±8075                                       | 2835±8144                                       | 3030±12979    |
| (p25 to p75)                      | 0 (0–305)                                    | 1.4±11.0                                   | 0 (0–750)      | 0 (0–300)                                       | 0 (0–150)                                       | 0 (0–250)     |
| Min. to Max.                      | 0–85000                                      | 0–100                                      | 0–85000        | 0 (0–100)                                       | 0–10000                                         | 0–10000       |
| Diagnosis Cost                    | Mean±SD                                       | 3541±6528                                  | 2677±3393      | 4718±813                                        | 3372±1556                                       | 3636±1087     |
| (p25 to p75)                      | 1300 (500–4000)                              | 1529±2331                                  | 2044±2901      | 2817±4670                                       | 1033±1676                                        | 1747±3308     |
| Min. to Max.                      | 0–40000                                      | 0–12500                                    | 0–19800        | 0–18000                                         | 0–6000                                         | 0–18000       |
| Hospitalization cost              | Mean±SD                                       | 6149±10074                                 | 5188±8010      | 9584±2007                                       | 5188±8010                                       | 9626±2081     |
| (p25 to p75)                      | 2500 (1000–6000)                             | 2805±4431                                  | 2386±815       | 2403±3381                                       | 2403±3381                                       | 2403±3381     |
| Min. to Max.                      | 0–50000                                      | 0–30000                                    | 0–50400        | 0–12000                                         | 0–12000                                         | 0–12000       |
| **Direct Cost-Medical Cost**      |                                               |                                             |                |                                                 |                                                 |               |
| Transportation cost               | Mean±SD                                       | 1039±2884                                  | 1039±2884      | 1600±453                                       | 1600±453                                       | 1600±453      |
| (p25 to p75)                      | 800 (500–1500)                               | 725±655                                    | 865±779        | 528±492                                        | 528±492                                        | 528±492       |
| Min. to Max.                      | 0–5000                                      | 0–3800                                     | 0–5000         | 0–2000                                         | 0–2000                                         | 0–2000        |
| Special food cost                 | Mean±SD                                       | 1361±1383                                  | 1361±1383      | 996±1305                                        | 996±1305                                        | 996±1305      |
| (p25 to p75)                      | 1000 (800–2000)                              | 949±441                                    | 1100±1045      | 703±495                                        | 703±495                                        | 703±495       |
| Min. to Max.                      | 0–10000                                      | 0–3000                                     | 0–1000         | 0–2000                                         | 0–2000                                         | 0–2000        |
| General food cost while staying   | Mean±SD                                       | 85±499                                     | 85±499         | 90±467                                         | 90±467                                         | 90±467        |
| (p25 to p75)                      | 0 (0–0)                                      | 94±441                                     | 94±441         | 520±983                                        | 520±983                                        | 520±983       |
| Min. to Max.                      | 0–4000                                      | 0–3300                                     | 0–3300         | 0–2000                                         | 0–2000                                         | 0–2000        |
| Other cost                        | Mean±SD                                       | 13±69                                      | 13±69          | 73±817                                         | 73±817                                         | 73±817        |
| (p25 to p75)                      | 0 (0–0)                                      | 120±1098                                   | 120±1098       | 0 (0–0)                                         | 0 (0–0)                                         | 0 (0–0)       |
| Min. to Max.                      | 0–5000                                      | 0–10000                                    | 0–10000        | 0 (0–0)                                         | 0 (0–0)                                         | 0 (0–0)       |
| Total Non-medical Cost            | Mean±SD                                       | 2777±2981                                  | 2777±2981      | 2243±2288                                       | 2243±2288                                       | 2243±2288     |
| (p25 to p75)                      | 2000 (1500–3000)                             | 1812±1393                                  | 2243±2288      | 2458±1562                                       | 2458±1562                                       | 2458±1562     |
| Min. to Max.                      | 0–20000                                      | 0–10000                                   | 0–10000        | 0–7000                                         | 0–7000                                         | 0–7000        |
| Total cost due to illness         | Mean±SD                                       | 24396±3212                                 | 24396±3212     | 6134±5920                                       | 6134±5920                                       | 6134±5920     |
| (p25 to p75)                      | 10100 (6000–27000)                           | 14289±2365                                 | 14289±2365     | 31492±4387                                      | 31492±4387                                      | 31492±4387    |
| Min. to Max.                      | 0–14950                                      | 0–4000                                    | 0–14950        | 0–1600                                         | 0–1600                                         | 0–1600        |
Table 3: Categorization of different indirect cost associated to illness

|                     | Dengue                          | Chikungunya                     |
|---------------------|---------------------------------|---------------------------------|
|                     | Treatment from Private hospital  | Treatment from Govt hospital     | Treatment from Private hospital  | Treatment from Govt hospital     |
|                     | (n=67)                          | (n=83)                          | (n=24)                          | (n=36)                          |
| Time Cost of patient| Nil                              | Nil                             | Nil                             | Nil                             |
| <1000               | 49 (73.1)                       | 60 (72.5)                       | 109 (72.7) [65-79]              | 12 (50.0)                       |
| 1000-1999           | 2 (3.0)                         | 2 (2.4)                         | 4 (2.7) [1-7]                   | 1 (4.2)                         |
| 2000-4999           | 4 (5.9)                         | 3 (3.6)                         | 7 (4.7) [2-9]                   | 0                               |
| 5000-Above          | 3 (4.5)                         | 11 (13.2)                       | 14 (9.3) [5-15]                 | 4 (16.6)                        |
|                     | 9 (13.4)                        | 7 (8.4)                         | 16 (10.7) [7-17]                | 7 (29.2)                        |
| Time cost of caretaker| Nil                             | Nil                             | Nil                             | Nil                             |
| <1000               | 20 (29.8)                       | 36 (43.4)                       | 56 (37.3) [30-45]              | 12 (50.0)                       |
| 1000-1999           | 4 (6.0)                         | 7 (8.4)                         | 17 (11.3) [4-13]                | 1 (4.2)                         |
| 2000-4999           | 14 (20.9)                       | 17 (20.5)                       | 31 (20.7) [15-28]              | 1 (4.2)                         |
| 5000-9999           | 16 (23.9)                       | 19 (25.3)                       | 32 (20.8) [12-25]              | 2 (8.3)                         |
|                     | 11 (16.4)                       | 5 (6.0)                         | 16 (10.7) [7-17]                | 3 (12.5)                        |
|                     | 2 (3.0)                         | 2 (2.4)                         | 4 (2.7) [1-7]                   | 2 (8.3)                         |
| Total indirect cost (patient + caretaker) | Nil                             | Nil                             | Nil                             | Nil                             |
| <1000               | 14 (20.9)                       | 22 (26.5)                       | 36 (24.0) [18-31]              | 3 (12.5)                       |
| 1000-1999           | 4 (6.0)                         | 8 (9.6)                         | 12 (8.0) [5-14]                 | 2 (8.3)                         |
| 2000-4999           | 11 (16.4)                       | 16 (19.3)                       | 27 (18.0) [13-25]              | 6 (16.7)                        |
| 5000-9999           | 17 (25.4)                       | 22 (26.5)                       | 39 (26.0) [19-34]              | 7 (29.2)                        |
|                     | 11 (16.4)                       | 11 (13.2)                       | 22 (14.7) [10-21]              | 5 (20.8)                        |
|                     | 10 (14.9)                       | 4 (4.8)                         | 14 (9.3) [5-15]                 | 7 (29.2)                        |

Indirect cost due to wage loss days of the caretaker(s)

Average (median) indirect cost due to wage loss of caretaker was 1200 (p25 to p75: 0 to 2750) and 0 (p25 to p75: 0 to 2100) for dengue and chikungunya, respectively [Table 2]. There was no indirect cost involved in around 37.3% of dengue and 58.30% of chikungunya cases. There were around 2.7% of dengue cases and 3.3% of chikungunya cases in which indirect cost due to wage loss days was more than Rs 10,000 [Table 3].

Total Indirect cost

On average total indirect cost incurred in the case of dengue were Rs 1,931 (with IQR 300–4500) and chikungunya was Rs 2,550 (with IQR 0–5250) [Table 2]. There was no indirect cost involved in one-fourth of cases irrespective of dengue and chikungunya. There were around 9.3% of dengue and 16.7% of chikungunya cases where the total indirect cost involved was more than Rs 10,000 [Table 3].

The average (median, and mean ± SD) total indirect cost of dengue patient who took treatment at a private hospital (N = 67) and a government hospital (N = 83) was Rs 2,500 (p25 to p75: 930 to 6720), (5188 ± 8010) and Rs 1,500 (p25 to p75: 0 to 3000), (2805 ± 4431) respectively. The minimum to maximum range of indirect cost due to wage loss days of dengue patient itself was Rs (0–30,000) and Rs (0–50,400) in government and private hospital respectively [Table 2].

The average (median, and mean ± SD) total indirect cost of chikungunya patient who took treatment at a private hospital (N = 24) and a government hospital (N = 36) was Rs 4,750 (p25 to p75: 3000 to 12500), (8850 ± 11583) and Rs 1,300 (p25 to p75: 0 to 4100), (2403 ± 3381) respectively. The minimum to maximum range of indirect cost due to wage loss days of chikungunya patient itself was Rs (0–12,000) and Rs (0–54,000) in a government and private hospital respectively [Table 2].

Direct cost
two types of direct costs (viz., direct cost related to medical expenses and direct cost due to other expenses) were estimated in this study [Tables 2 and 4].

Direct Cost related to medical expenses

Consultancy Cost: 82% of cases (123/150) did not spend even a single rupee for consultancy of a doctor in case of dengue infection, while in chikungunya it was 63.3% (38/60). 9.5% of dengue cases and 28.3% of chikungunya cases spent less than Rs 1,000 for the doctor consultation, a very small percentage (5.3% in dengue and 1.7% in chikungunya) spent more than Rs 5,000 on doctor consultation. Median consultation cost in both dengue and chikungunya cases was estimated to be zero [Table 4].
## Table 4: Categorization of different direct (medical and non-medical) costs associated to illness

|                         | Dengue |                  | Chikungunya |                  |
|-------------------------|--------|-----------------|-------------|-----------------|
|                         | Overall (n=150) | Treatment from private hospital (n=67) | Treatment from govt hospital (n=83) | Overall (n=36) | Treatment from private hospital (n=24) | Treatment from govt hospital (n=36) |
| Consultancy cost        |        |                 |             |                 |                 |                             |
| Nil                     | 2 (8.3) | 8 (9.4)         | 12 (8.2) [75-87] | 4 (8.3)         | 36 (100)         | 38 (63.3) [50-75] |
| <1000                   | 17 (19.4) | 11 (16.4) | 3 (3.6) | 14 (9.3) [5-15] | 2 (8.3)         | 17 (70.8)         | 0                        | 17 (28.3) [18-41] |
| 1000-1999               | 5 (20.8) | 4 (6.0) | 0 | 4 (2.7) [1-7] | 2 (8.3)         | 0                        | 2 (3.3) [1-13] |
| 2000-4999               | 2 (5.0) | 1 (1.5) | 0 | 1 (0.7) [0.01-5] | 2 (8.3)         | 0                        | 2 (3.3) [1-13] |
| Above 5000              | 1 (0.7) | 8 (11.9) | 0 | 8 (5.3) [3-10] | 1 (4.2)         | 0                        | 1 (1.7) [0.2-11] |
| **Total medical cost**  | 14 (38.9) | 32 (19.3) | 32 (21.3) [15-29] | 1 (4.2) | 13 (36.1) | 14 (23.3) [14-36] |
| Nil                     | 2 (8.3) | 27 (32.5) | 12 (7.3) [12-24] | 4 (8.3) | 14 (36.1) | 14 (23.3) [14-36] |
| <1000                   | 14 (38.9) | 8 (11.4) | 34 (22.7) [17-30] | 3 (12.5) | 12 (33.3) | 15 (25.0) [15-38] |
| 1000-1999               | 10 (4.2) | 9 (13.4) | 20 (13.3) [9-20] | 1 (4.2) | 4 (11.1) | 5 (8.3) [3-19] |
| 2000-4999               | 6 (16.7) | 23 (34.3) | 40 (26.7) [20-34] | 6 (20.8) | 6 (16.7) | 12 (20.0) [11-32] |
| 5000-9999               | 9 (37.5) | 11 (16.4) | 13 (8.7) [5-14] | 9 (37.5) | 0 | 9 (15.0) [8-27] |
| Above 10000             | 4 (6.7) | 11 (16.4) | 11 (7.3) [4-13] | 4 (16.7) | 0 | 4 (6.7) [2-17] |
| **Transport cost**      | 5 (13.9) | 3 (4.5) | 10 (6.7) [4-12] | 6 (25.0) | 5 (13.9) | 11 (18.3) [10-30] |
| Nil                     | 14 (44.4) | 31 (46.3) | 84 (56.0) [5-64] | 8 (33.3) | 25 (69.4) | 33 (55.0) [42-67] |
| <1000                   | 14 (44.4) | 24 (35.8) | 43 (28.7) [22-36] | 6 (33.3) | 4 (11.1) | 12 (20.0) [11-32] |
| 1000-1999               | 16 (44.4) | 22 (32.8) | 39 (26.0) [19-34] | 5 (20.8) | 6 (16.7) | 11 (18.3) [10-30] |
| 2000-4999               | 7 (19.4) | 12 (17.9) | 20 (13.3) [9-20] | 10 (41.6) | 1 (2.8) | 11 (18.3) [10-30] |
| Above 10000             | 6 (16.7) | 23 (34.3) | 40 (26.7) [20-34] | 6 (25.0) | 0 | 6 (10.0) [4-21] |
| **Hospitalization, yes** | 5 (13.9) | 12 (17.9) | 11 (7.3) [4-13] | 4 (16.7) | 0 | 3 (5.0) |
| Other cost, yes         | 2 (8.3) | 0 | 2 (1.3) | 2 (8.3) | 0 | 2 (0.3) |
| **Special food cost (Md. (IQR))** | 5 (13.9) | 3 (4.5) | 7 (8.4) | 10 (6.7) [4-12] | 6 (25.0) | 5 (13.9) | 6 (10.0) [4-21] |
| Nil                     | 16 (44.4) | 5 (7.5) | 12 (8.0) | 1 (4.2) | 5 (13.9) | 6 (10.0) [4-21] |
| <1000                   | 16 (44.4) | 29 (43.3) | 70 (47.0) [39-55] | 3 (12.5) | 13 (36.1) | 27 (45.0) [33-58] |
| 1000-1999               | 19 (51.3) | 16 (23.8) | 23 (15.3) [10-22] | 6 (25.0) | 2 (5.6) | 8 (13.3) [7-25] |
| 2000-4999               | 8 (21.7) | 8 (11.9) | 12 (6.0) [4-14] | 1 (4.2) | 2 (5.6) | 3 (5.0) [1-15] |
| Above 5000              | 0 | 1 (1.5) | 0 | 1 (0.7) [0.1-5] | 1 (4.2) | 0 | 1 (1.7) [0.2-11] |
| **General food cost (Md. (IQR))** | 5 (13.9) | 3 (4.5) | 3 (2.0) [0.6-6] | 0 | 0 | 0 |
| Nil                     | 17 (70.8) | 62 (92.5) | 140 (93.2) [88-96] | 17 (70.8) | 27 (75.0) | 44 (73.3) [60-83] |
| <1000                   | 17 (70.8) | 4 (6.0) | 1 (1.2) | 5 (3.3) [1-8] | 0 | 4 (11.1) | 4 (6.7) [2-17] |
| 1000-1999               | 5 (13.9) | 0 | 3 (3.6) | 3 (2.0) [0-6-6] | 5 (20.8) | 5 (13.9) | 10 (16.7) [9-29] |
| 2000-4999               | 2 (3.3) | 1 (1.5) | 2 (1.3) | 0 | 2 (3.3) [0-6-6] | 0 |
| Above 5000              | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Contd...
The average (median, and mean ± SD) consultancy cost of dengue patient who took treatment at a private hospital (N = 67) and a government hospital (N = 83) was Rs 0 (p25 to p75: 0 to 305), (3486 ± 12494) and Rs 0 (p25 to p75: 0 to 0), (1.4 ± 11.4) respectively. The minimum to maximum range of consultancy cost for the dengue patient itself was Rs (0–10,000) and Rs (0–85,000) in a government and private hospital respectively [Table 2].

The average (median, and mean ± SD) direct cost due to wage loss days of chikungunya patient who took treatment at a private hospital (N = 24) and a government hospital (N = 36) was Rs 300 (p25 to p75: 200 to 500), (921 ± 2049) and Rs 0 (p25 to p75: 0 to 0), (1.4 ± 11.4) respectively. The minimum to maximum range of consultation cost of chikungunya patient itself was Rs (0–4,83) and Rs (0–10,000) in a government and private hospital respectively [Table 2].

**Diagnosis Cost:** 42.7% of dengue cases and 61.7% of chikungunya cases got the diagnosis done free of cost. 22.7% of dengue and 25.0% in chikungunya cases got the diagnosis done for Rs < 1000. Only a small proportion (3.3% in dengue and 3.3% in chikungunya) spent more than Rs 10,000 on the diagnosis [Table 4].

The average (median, and mean ± SD) diagnosis cost of dengue patient who took treatment at a private hospital (N = 67) and a government hospital (N = 83) was Rs 1,300 (p25 to p75: 550 to 4000), (3541 ± 6528) and Rs 0 (p25 to p75: 0 to 600), (475 ± 962) respectively. The minimum to maximum range of diagnosis cost of dengue patient itself was Rs (0–5,000) and Rs (0–40,000) in a government and private hospital respectively [Table 2].

The average (median, and mean ± SD) indirect cost due to wage loss days of chikungunya patient who took treatment at a private hospital (N = 24) and a government hospital (N = 36) was 900 (p25 to p75: 0 to 2250), (2971 ± 8169) and 0 (p25 to p75: 0 to 50), (197 ± 487). The minimum to maximum range of diagnosis cost of chikungunya patient itself was Rs (0–4,000) and Rs (0–6,000) in a government and private hospital respectively. Table 2.

**Total Medical Cost:** The total medical cost was the sum of consultation cost, diagnosis cost, medicine cost, and hospitalization. Twelve among 150 cases (i.e., 8%) of dengue and 3 among 60 cases (i.e., 5%) of chikungunya required hospitalization [Table 4].

The average (median, and mean ± SD) medicine cost of a dengue patient who took treatment at a private hospital (N = 67) and a government hospital (N = 83) was Rs 300 (p25 to p75: 0 to 1000), (6149 ± 16117) and Rs 400 (p25 to p75: 0 to 1500), (996 ± 1305) respectively. The minimum to maximum range of diagnosis cost of dengue patient itself was Rs (0–5,000) and Rs (0–58,500) in a government and private hospital respectively [Table 2].

**Medicine Cost:** Median medicine cost was estimated to be Rs 1,000 (IQR 200–3000) in dengue and Rs 900 (IQR 100–3000) in chikungunya [Table 2]. Around 21.3% (i.e., 32/150) of dengue cases and 25% (i.e., 15/60) of chikungunya cases did not spend anything on medicine cost, 22.7% of dengue and 25% of chikungunya cases spent Rs <1000 on medicine cost, 26.7% of dengue and 20% of chikungunya cases spent Rs 2,000 to Rs 4,999 on medicine cost. Relatively a lower percentage (dengue: 7.3% and chikungunya: 6.7%) spent more than Rs 10,000 on medicine cost and hospitalization. Twelve among 150 cases (i.e., 8%) of dengue and 3 among 60 cases (i.e., 5%) of chikungunya required hospitalization [Table 4].

The average (median, and mean ± SD) medicine cost of a chikungunya patient who took treatment at a private hospital (N = 67) and a government hospital (N = 83) was Rs 2,500 (p25 to p75: 1000 to 6000), (6149 ± 10074) and Rs 400 (p25 to p75: 0 to 1500), (996 ± 1305) respectively. The minimum to maximum range of diagnosis cost of chikungunya patient itself was Rs (0–5,000) and Rs (0–58,500) in a government and private hospital respectively [Table 2].

**Total Medical Cost:** The total medical cost was the sum of consultation cost, diagnosis cost, medicine cost, and hospitalization. Twelve among 150 cases (i.e., 8%) of dengue and 3 among 60 cases (i.e., 5%) of chikungunya required hospitalization [Table 4].

The average (median, and mean ± SD) medicine cost of a chikungunya patient who took treatment at a private hospital (N = 24) and a government hospital (N = 36) was Rs 5,000 (p25 to p75: 2000 to 7000), (9896 ± 16117) and Rs 500 (p25 to p75: 0 to 1000), (742 ± 1028) respectively. The minimum to maximum range of diagnosis cost of chikungunya patient itself was Rs (0–4,000) and Rs (0–6,000) in a government and private hospital respectively. Table 2.

**Table 4: Contd...**
other medical expenses. On average, dengue cases spent Rs 2,450 (p25 to p75: 400 to 5000) as a total medical expenditure while chikungunya cases spent relatively less money, that is, Rs 1,500 (p25 to p75: 400 to 5200) on medical expenses [Table 2]. A majority of the dengue cases (i.e., 39/150 or 26.0%) spent Rs 2,000 to 4,999 as a total medical expenditure while the majority of chikungunya cases (i.e., 14/60 or 23.3%) spent less than Rs 1,000 as a total medical expense [Table 4].

The average (median, and mean ± SD) total medical cost for a dengue patient who took treatment from a private hospital (N = 67) and a government hospital (N = 83) was Rs 5,000 (p25 to p75: 3000 to 19000), (16595 ± 25363) and Rs 500 (p25 to p75: 0 to 2500), (1493 ± 1917) respectively. The minimum to maximum range of indirect cost due to wage loss days of a dengue patient itself was Rs (0–8,000) and Rs (0–1,30,000) in a government and private hospital, respectively [Table 2].

The average (median, and mean ± SD) total medical cost for a chikungunya patient who took treatment at a private hospital (N = 24) and a government hospital (N = 36) was Rs 58,500 (p25 to p75: 2750 to 9150), (11958 ± 17355) and Rs 500 (p25 to p75: 0 to 1500), (939 ± 1391) respectively. The minimum to maximum range of indirect cost due to wage loss days of a chikungunya patient itself was Rs (0–6,000) and Rs (0–61,000) in a government and private hospital, respectively [Table 2].

**Direct Cost including non-medical expenses**
Along with medical costs, there were some other costs as well, such as transportation cost, special food cost, etc., which were directly involved with the dengue and chikungunya cases [Tables 2 and 4].

**Transportation Cost:** Transportation costs incurred due to dengue and chikungunya were more or less similar. While the average transportation cost in dengue was Rs 600 (p25 to p75: 300 to 1000), the average transportation cost was Rs 500 (p25 to p75: 200 to 1000) in chikungunya [Table 2]. The majority of cases in either of the situations (dengue and chikungunya) spent less than Rs 1,000 on transportation costs [Table 4].

**Special food cost:** The average food cost in both the conditions was observed to be the same, that is, Rs 1,000 (500 to 1500) [Table 2]. 8% in dengue and 10% in chikungunya did not spend any amount on special food but a majority of cases in either condition (dengue and chikungunya) spent Rs 1,000–1,999 on special food [Table 4].

**General food cost:** In dengue infection, general food cost was less than Rs 1,000 (3.3%) followed by Rs 1,000–1,999 (2.0%), and Rs 2,000–4,999 (1.3%). In the case of chikungunya infection, general food cost was Rs 1,000–1,999 (16.7%), followed by less than Rs 1,000 (6.7%), and Rs 2,000–4,999 (3.3%) [Table 4].

**Total non-medical cost:** In dengue infection, non-medical cost was Rs 1,000–1,999 (43.3%) followed by Rs 2,000–4,999 (36.7%), less than Rs 1,000 (10.7%), and more than Rs 5,000 (6.0%). In the case of chikungunya infection, non-medical cost amounted to Rs 2,000–4,999 (36.7%) followed by Rs 1,000–1,999 (33.3%), less than Rs 1,000 (18.3%), and more than Rs 5000 (3.3%) [Table 4].

The average (median, and mean ± SD) total non-medical cost of a dengue patient amounted to Rs 1,575 (p25 to p75: 1300 to 2600), (2243 ± 2288) while a chikungunya patient spent relatively lesser money, that is, Rs 1,500 (p25 to p75: 850 to 2850), (1865 ± 1432) on such expenses [Table 2].

The average (median, and mean ± SD) total non-medical cost of a dengue patient who received treatment at a private hospital (N = 67) and a government hospital (N = 83) was Rs 2,000 (p25 to p75: 1500 to 3000), (2777 ± 2981) and Rs 1,500 (p25 to p75: 1200 to 2000), (1812 ± 1393) respectively [Table 2]. The minimum to maximum range of indirect cost due to wage loss days of a dengue patient itself was Rs (0–10,000) and Rs (0–20000) in a government and private hospital, respectively [Table 2].

The average (median, and mean ± SD) total non-medical cost of a chikungunya patient who received treatment at a private hospital (N = 24) and a government hospital (N = 36) was Rs 2,000 (p25 to p75: 1350 to 3500), (2458 ± 1562) and Rs 1,000 (p25 to p75: 700 to 2050), (1469 ± 1205) respectively. The minimum to maximum range of indirect cost due to wage loss days of a chikungunya patient itself was Rs (0–5,500) and Rs (0–7,400) in a government and private hospital, respectively [Table 2].

**Total cost**
Total cost due to illness included total medical and non-medical costs. The total cost incurred due to dengue and chikungunya was Rs 6,860 (p25 to p75: 3700 to 12525) and Rs 7,000 (2550–14000) respectively [Table 2]. In both the infections, the total cost was in a range of less than Rs 1,000 to more than Rs 40,000 [Table 4]. In dengue infection, the total cost due to illness was more than Rs 40,000 (8.74%) and in Chikungunya infection it was more than Rs 40000 (6.74%) [Table 4].

The average (median, and mean ± SD) total cost of a dengue patient who received treatment at a private hospital (N = 67) and a government hospital (N = 83) was Rs 10,100 (p25 to p75: 600 to 27000), (24396 ± 32123) and Rs 4,100 (p25 to p75: 2700 to7500), (6134 ± 5920) respectively [Table 2]. The minimum to maximum range of indirect cost due to wage loss days of a dengue patient itself was Rs (400–38,500) and Rs (0–49,450) in a government and private hospital, respectively [Table 2].

The average (median, and mean ± SD) total cost of a chikungunya patient who received treatment at a private hospital (N = 24) and a government hospital (N = 36) was Rs 16,000 (p25 to p75: 10400 to 27950), (31492 ± 43877) and Rs 4,050 (p25 to p75: 1500 to 6750), (4783 ± 4757) respectively [Table 2]. The
minimum to maximum range of indirect cost due to wage loss days of a chikungunya patient itself was Rs (0–22,000) and Rs (1,600–2,04,500) in a government and private hospital, respectively [Table 2].

Other information
During the treatment of dengue and chikungunya infection, 11.3% and 13.3% of the families were used to saving money. Family consumption expenditure was reduced by 6.7% and 1.7% in dengue and chikungunya, respectively. Assets were sold by the families, for treatment (5.3% in dengue and 1.7% in chikungunya cases) and day-by-day expenditure (2.0% in dengue and 1.7% in chikungunya cases). Families (34% in dengue and 23.3% in chikungunya cases) had to borrowed money for the treatment. The source of borrowing in dengue infection was family and friends (16%), followed by money lender (8%), and relatives (8%), while in Chikungunya infection, it was the money lender (18.3%) followed by family and friends (8.3%) [Table 5].

Discussion
The present study analyzed the cost of illness among two major vector-borne viral diseases: dengue and chikungunya. The recurrent outbreaks and the increasing number of patients with these viral diseases impose heavy costs on the infected people, their families as well as on the health system. Identifying and unraveling the economic burden of vector-borne viral diseases such as dengue and chikungunya can generate valuable evidence for policy making. Dengue is an important cause of acute febrile illness globally as well as in India, with several outbreaks being reported every year.

The disease is widening its area and its economic burden is growing day by day. In 2018, 101,192 dengue cases, 8,499 chikungunya cases, and 172 deaths due to dengue were reported in India.[46] The state of Gujarat contributed 5.77% of dengue and 11.73% of chikungunya cases to overall cases in the country during the year of 2018. In Gujarat, 7,579 dengue cases, 4 deaths due to dengue, and 997 chikungunya cases were reported in 2018.

Earlier studies on costs of dengue in Surat, 2010,[29] Karnataka, 2016[31] and Haryana, 2014[32] included direct and indirect costs, but only a few factors were included in calculating the direct and indirect costs in those studies. In other studies, conducted in Surat, 2017[33] only direct cost was included and there was no information on non-medical costs such as food and transportation and exact indirect costs such as wage loss to patients and relatives.

In the present study, the economic burden is calculated by the addition of indirect cost (time cost of the ill person and their caretaker) and direct cost (expenses incurred by patients which may be the medical cost or non-medical cost). Medical cost involves doctor consultation fees, medication and diagnostics charges, hospitalization cost and other medical charges such as physiotherapy while non-medical cost includes transportation cost (from home to hospital/clinic/laboratory/testing center), special food cost (supplements), general food for indoor treatment, and lodging of a caretaker.

A majority of the dengue and chikungunya patients were in the age group of 6–20 and 31–80 years, respectively. Our results are consistent with earlier studies that have also reported that the most affected age group due to dengue majorly fall in younger age groups such as 15–24 years,[46] 21–30 years,[31,36] and 17–40[37] years. In the case of chikungunya cases, most of the reported cases were in older age groups such as 46–60 years,[35] 20–30 years,[39] and 47–56 years.[43] Results indicate that dengue mainly affects the younger age groups as compared to chikungunya, which usually affects individuals at a later age.

The total medical cost of dengue and chikungunya patients in the present study was higher than that reported in the earlier study from Surat[31] which was USD 14.8 (IQR 7.3–65.9)/INR (5530 ± 10837). Another study from Surat[31] reported a direct medical cost of USD 439.44/INR 20407 which was similar to our study. In other studies, the average direct cost per household for treatment of dengue reported from Karnataka was INR 9484,[31] Haryana was INR 10022.85,[33] Vietnam was USD 32.7 (INR 2027),[46] Cambodia was USD32 (INR 1887),[33] and Bangkok was USD 102 (INR 6364)[42] which was less than our present study.

The total indirect cost of dengue and chikungunya patients in the present study was higher than that reported in the earlier study from Surat[31] which was USD 146.13/INR 6786. In other studies, the average indirect cost per household for treatment of dengue
reported from Karnataka was INR 1540.65,[31] Haryana was INR 1840,[32] and from Vietnam was USD 28.7/INR 1693[41] which was less than our present study. The total direct and indirect cost of dengue and chikungunya patients was higher than the earlier reported study from Karnataka (INR 11278),[31] Haryana (INR 11563),[32] and Vietnam (USD 61.3/INR 3720).[41]

Duration of illness and duration of wage loss of the patients in case of dengue and chikungunya was 5–15 days and 7–45 days, respectively, in the present study. A previous study from Vellore,[49] India reported a duration of illness of 4 days (IQR 3–7 days) for children and adults in case of dengue infection, which was less than that reported in the present study. Overall, it has been observed that in chikungunya infection, duration of illness and duration of wage loss was more, and days of disabilities were more as compared to dengue infection. The total cost due to illness was high due to the patient's preferred private treatment as compared to the government setup.

The current study demonstrated that both dengue and chikungunya have a substantial financial impact on not only patients but associated families. The study provides insight into the economic costs associated with the two major vector-borne viral diseases. Timely economic evaluation studies need to be done to provide evidence-based policy making decisions. Such studies also help in allocation of limited resources appropriately in urban and rural areas to help alleviate their associated economic burden.

**Conclusion**

In most of the studies, the economic burden of dengue infection has been based on the hospital. The current study was a prospective study and patients were followed up for collection of data. Furthermore, we addressed the total cost including the direct and indirect costs of dengue and chikungunya diagnosis and treatment. The strength of the study is its prospective design, although the study was limited to the Ahmedabad and Kheda districts of Gujarat. This study can be done at a multicenter level countrywide to estimate the actual economic burden of the diseases and make a strong policy to strengthen the vector control program. Patients have to bear high costs from their pockets while suffering from dengue and chikungunya infections. The study provides improved knowledge about the impact of cost and economic burden associated with dengue and chikungunya, which will help policymakers allocate and appropriate the resources for the control of these diseases.

**Ethics committee clearance**

Institutional Ethical Committee approval was obtained vide letter no. ECR/NIMR/EC/2018/35 dated 26 Feb 2018.

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**Conflicts of interest**

There are no conflicts of interest.

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