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A Killer Epidemic in Ahmedabad City, India

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Chikungunya Fever: A Killer Epidemic in Ahmedabad City, India

(An epidemiological study using vital registration data)

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Abstract

Background

The Chikungunya virus is an alphavirus native to tropical Africa and Asia and is transmitted to humans by the bite of infected Aedes mosquitoes. The symptoms of Chikungunya include sudden onset of fever, severe arthralgia, and maculopapular rash. Thirty percent of the population on the French Réunion Island was afflicted with Chikungunya in the past year. They reported 237 deaths. India on the other hand reported 1.39 million cases of Chikungunya but no deaths.

Methods

Mortality data from 2002-2006 was obtained from the Ahmedabad Municipal Corporation (AMC). Actual mortality rate of 2006 was compared to the mortality rate of 2002-05 and its statistical significance tests were carried out.

Findings

Mortality data obtained from the Ahmedabad Municipal Corporation (AMC) suggests that 3112 excess deaths occurred in August-November (epidemic period) compared to the average deaths in the same months during the previous four years. These differences in deaths were found to be highly statistically significant. A peak in excess mortality is seen in the month of September when 1489 additional deaths were recorded. Case fatality rates for Ahmedabad also turn out to be much higher than that of the Reunion Island.

Interpretation

The Chikungunya epidemic was raging when the excess deaths occurred. There were no other adverse events or other epidemics that took place could explain this excess mortality. Government authorities, WHO and other international public health agencies should take these findings of excess mortality seriously and investigate into this occurrence of excess deaths to understand this reemerging disease and prevent future epidemics and mortality.

Key words: Chikungunya, Mortality, India, Epidemic, Infectious Disease.

Chikungunya Fever: A Killer Epidemic in Ahmedabad City, India

Introduction

The Chikungunya virus is an alphavirus belonging to the *togaviridae* family, native to tropical Africa and Asia. It is transmitted to humans by the bite of the infected Aedes mosquito. The first reported Chikungunya outbreak occurred in Tanzania in 1952-53.[1] The word "Chikungunya" is derived from the *Makonde* language, in southeast Tanzania meaning " bent down or become contorted" indicating the classical posture the patient adopts due to severe joint pain. The symptoms of Chikungunya include sudden onset of fever, severe arthralgia, and maculopapular rash. A specific symptom is severe incapacitating arthralgia, often persistent, which could sometimes result in long-lasting disability.[2]

A major epidemic of this disease was reported in March 2005 when 258,000 residents (30% of the population) of the French Réunion Island were estimated (using a sentinel surveillance system) to be affected by clinical Chikungunya fever. Historically, Chikungunya was considered self-limiting and non-fatal; this perception changed when 237 deaths on this island were attributed to Chikungunya by the French Public Health Authorities.[3] This epidemic spread rapidly to other nearby islands in the Indian Ocean. India also had a massive Chikungunya epidemic in 2006. The vector in the reunion Islands was Aedes albopictus while in India the vector was suspected to be Aedes Aegypti. Chikungunya had reemerged in India after 1973 where the attack rate was 37.5%. In this epidemic the attack rate was 45%. [4] More than 1.39 million cases across 10 states were reported by the Government of India during this period.[5] This is most likely an underestimate by a factor of five to ten given the poor disease reporting system in India. Surprisingly, unlike the Réunion Island, no deaths have been reported by the Government of India. The national health ministers of India (cabinet rank and minister of state) have repeatedly affirmed in both houses of the parliament that there have been no deaths directly attributable to Chikungunya.[6] In this paper we look at the comparative number of deaths from 2002 to 2006 reported by the Registrar of Births and Deaths (RBD) of the city of Ahmedabad (A city of 3.8 million located in western India), to determine whether there was any unusual increase in mortality during the Chikungunya

epidemic. Evidence of the sharp rise in mortality in the city during the months of August-November is seen which coincides exactly with the epidemic period in Ahmedabad. We discuss policy implications of this shocking rise in mortality in Ahmedabad during Chikungunya epidemic.

Methods

Data on deaths reported here is compiled by the RBD who registers all births and deaths within the city limits under the Registration of Births and Deaths Act. Deaths are registered in the city in two ways.

i. Deaths that occur in the hospital are reported by the hospital authorities, who then provide a medical certificate of death which is then sent to the RBD officer at the city ward in which the hospital is located.

ii. Deaths that happen at home are reported by the relatives to the local RBD officer in the ward where their home is located.

Both are compiled and sent to the RBD's Central Office and then communicated to the State Level Registrar of Birth and Death. The data on deaths reported here was provided by the Medical Officer of Health of the city as a response to queries by the municipal counselor Mr.Yousuf Saiyed as part of the city budget debate and hence is the most official data from the city.[7] The data obtained includes a month wise total deaths in Ahmedabad city for the years 2002-2006. The data also includes month-wise reported cases of Chikungunya for Ahmedabad city in 2006 provided by the health department.[8]

The average mortality rate for each month for the years 2002-2005 (pre-epidemic years) was calculated using the following formula:

$$\textit{Mortality Rate} = \frac{\textit{Total number of deaths in 2002-05}}{\textit{Average Mid-Year Population for 2002-05}} \times 10{,}000$$

The average month-wise mortality rates for 2002-2005 were then compared to the mortality rate of 2006(epidemic year). Standard statistical significance tests were performed to determine the significance of the increase in monthly mortality rates for 2006 as compared to the average mortality rates for the same month for the previous four years. Twelve pair wise comparisons were done simultaneously (one for each calendar month) between the average mortality rate for 2002-05 and the mortality rate for 2006. Hence a conservative level of significance was chose at $\alpha \leq 0.01$ and the Bonferroni's

method for individual comparison was used where the level of significance was taken as (0.01/12). The corresponding z-value of 3.144 was used as the critical value. The results are summarized in Table 1.

Expected numbers of deaths for the year 2006 were calculated by multiplying the mortality rate of 2002-2005 to the estimated population of 2006. Estimate of additional deaths that occurred in 2006 was made by subtracting the actual deaths from the expected in each month of 2006. The results are summarized in Table 2.

The case fatality rate was calculated for Chikungunya in Ahmedabad using the reported data, the calculated excess mortality and corrected number of cases and deaths using various assumptions which approximate reality. Two assumptions on under reporting of cases (5 times and 10 times) were used. The excess mortality was reduced by 20% for compensating for the fact that severe cases from outside the city limits may come in the city hospitals and died thus inflating the mortality statistics of the city. This rate was then compared with the case fatality reported by French authorities for the epidemic in Reunion Island (See Table 3)

Results

Ahmedabad city reported cases of Chikungunya since April 2006. In the months of August - November 2006 the Chikungunya epidemic hit Ahmedabad hard. There were 60,777 cases of Chikungunya reported by municipal health centers and hospitals in Ahmedabad in year 2006 of these 55,593 (91.5 %) of these cases were in the months of August and September. A total of 154 samples of blood were tested for Chikungunya and 84 (54.5%) were confirmed to be Chikungunya.[8]

Table 1 below presents a month-wise distribution of case of Chikungunya in 2006 and month-wise average mortality rate calculated for 2002-2005 and 2006 per 10,000 population. It is clearly see from table 1 that mortality rate rose significantly months of August to November 2006 as compared to average of 2002-2005 for the same months. These were the exact months where the highest numbers of cases of Chikungunya were reported. There was a shocking 60% increase in the mortality rate of September 2006 compared to the average mortality rate of September 2002-2005. This is statistically highly significant.

Table 1: Month-wise Chikungunya cases and mortality rate of 2002-05 and 2006, Ahmedabad city, India

Months	Reported Cases of Chikungunya 2006	Mortality Rate per 10,000 2002-05	Actual Mortality Rate per 10,000 2006	% increase in mortality rate	z-value
January	0	6.19	6.55	5.84	1.99
February	0	5.56	5.70	2.51	0.81
March	0	5.76	5.98	3.80	1.25
April	434	5.75	5.50	-4.19	-1.39
May	141	6.16	6.43	4.31	1.47
June	31	5.80	5.52	-4.82	-1.61
July	184	5.50	5.81	5.61	1.81
August #	28233	6.08	7.53	23.89*	7.93
September #	27360	6.40	10.21	59.57*	19.61
October #	3555	5.92	7.99	34.96*	11.33
November #	539	6.27	6.91	10.10*	3.46
December	300	6.54	6.50	-0.73	-0.26

*Significant at α=0.01
Months in which Chikungunya epidemic was at its peak.

Table 2: Month-wise actual death registered, expected deaths and excess deaths in Ahmedabad city in 2006 (epidemic year)

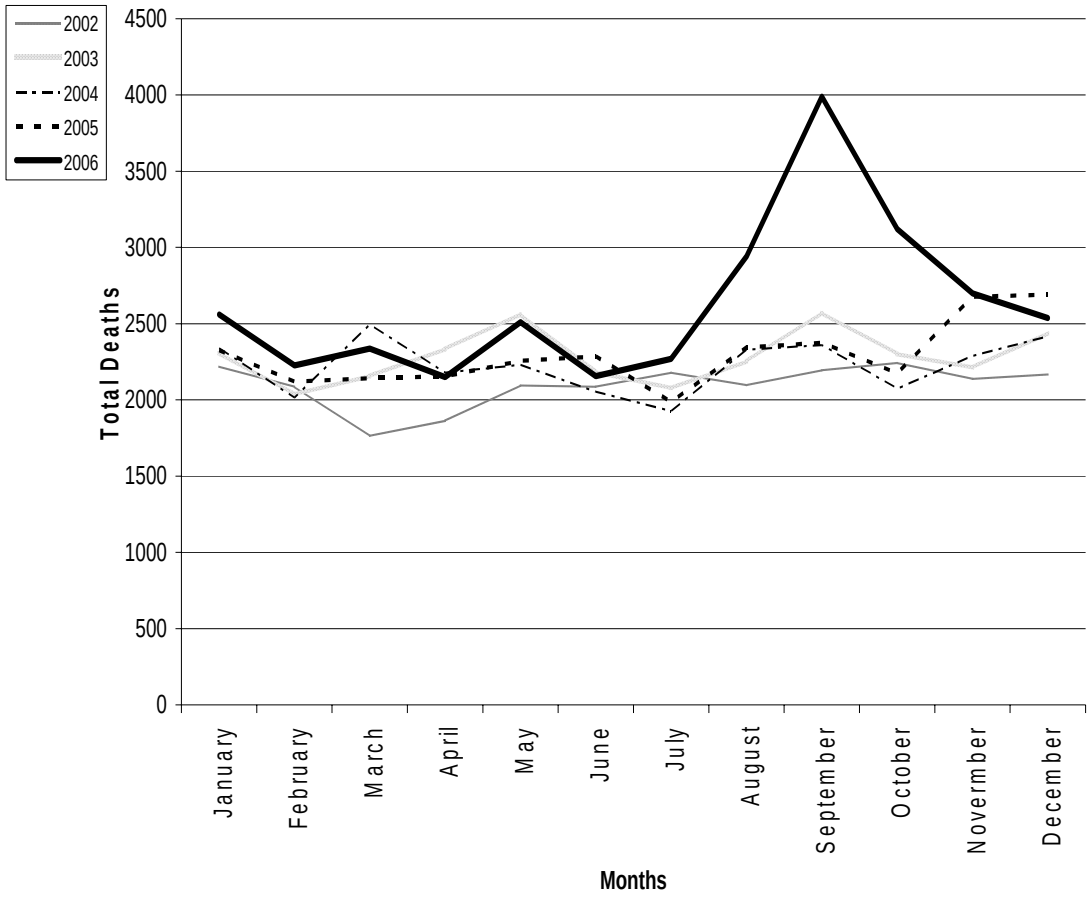
Months	Expected Deaths 2006	Actual Deaths 2006	Excess Deaths
January	2418	2559	141
February	2173	2227	54
March	2251	2337	86
April	2244	2150	-94
May	2406	2510	104
June	2265	2156	-109
July	2149	2270	121
August	2375	2942	567
September	2500	3989	1489
October	2313	3121	808
November	2450	2698	248
December	2556	2537	-19
Total	28100	31496	3396

Note: Expected deaths in 2006 calculated based on average month-specific mortality for 2002-2005

As seen in table 2 in the city of Ahmedabad there were a total of 31,496 deaths registered in 2006 compared to 28,100 expected deaths for the same year based on average mortality for last 4 years. Thus, in 2006 there were a total of 3,396 additional deaths registered in the city as compared to the expected deaths for 2006. The month-wise

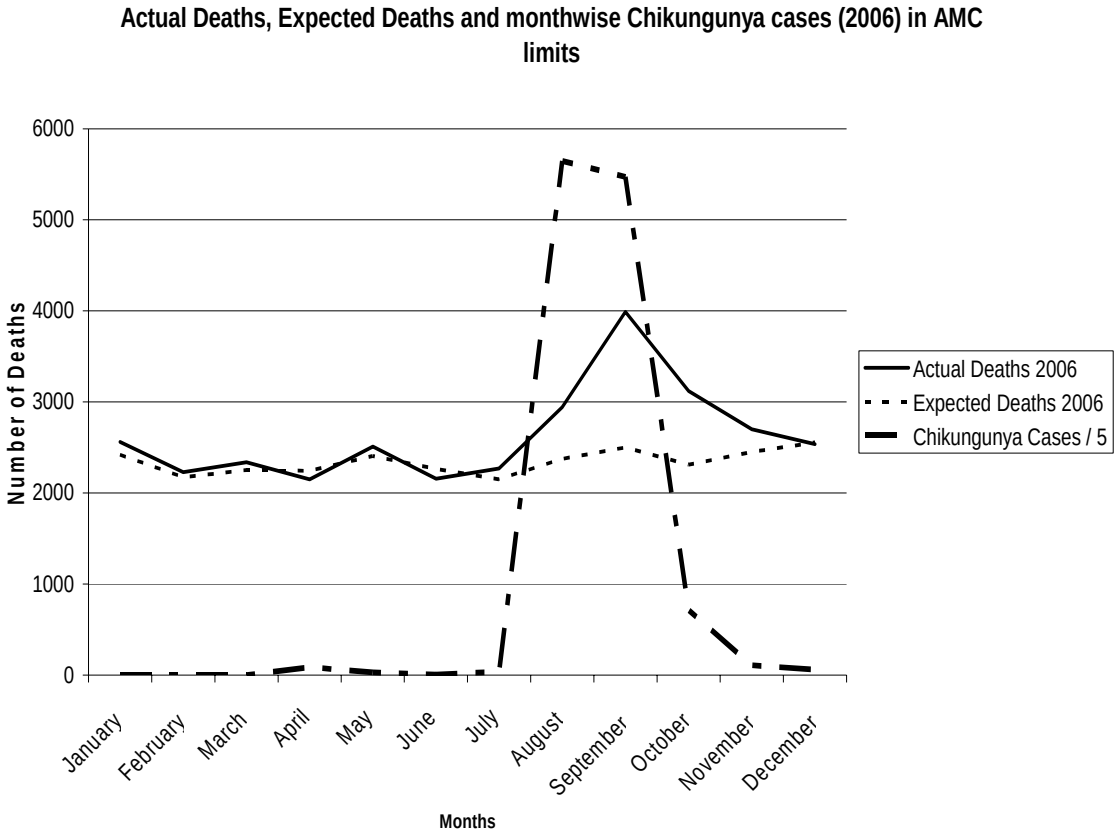
distribution of the actual deaths in 2006 as compared to the expected deaths shows that there was a rapid and clear rise in deaths registered from August 2006 to November 2006. In these five months there were 3,112 additional deaths (91.6% of total additional deaths for 2006) as compared to the expected deaths for the same months for the previous 4 years. The excess mortality peaked in September 2006 when there were about 1,489 additional deaths (43.8% of total additional deaths for 2006) as compared to the expected deaths for September.

Figure 1: Month-wise total deaths reported in Ahmedabad city for the years 2002-2006 showing shocking increase in mortality in 2006



The graph of the total month wise deaths for the year 2002 to 2006 shows a significant peak in deaths registered in September 2006 (Figure 1)

Figure 2: Month-wise Chikungunya Cases (divided by 5) and expected deaths and reported deaths for year 2006 in Ahmedabad city



To see the temporal relationship between the Chikungunya cases and the mortality rise in 2006 as compared to expected mortality all three were plotted on the same graph (see figure 2). It can be clearly seen that there is a peak in the Chikungunya cases in August- September which also coincides with the peak in the actual deaths in 2006. This provides very strong epidemiological evidence that the deaths are due to the Chikungunya epidemic, as there was not other reason in these months in the city which could have lead to such rise in mortality.

Table 3: Reported cases, deaths, excess mortality and case fatality rates of suspected Chikungunya in Reunion Island and Ahmedabad city under various assumptions.

Country / city	Number of Chikungunya Cases reported or (estimated)	Number of Reported Deaths/ (calculated excess mortality)	Case Fatality Rate per 1000 cases
Reunion Island (French Territory)	258,000[1]	237	0.92
Ahmedabad City - reported	60,777	10	0.16
Ahmedabad City - reported	60,777[2]	(3112)[3]	51.20
Ahmedabad City - reported	60,777	(2490)[4]	40.97
Ahmedabad City - Assuming 5 times more cases than reported	(303,885)	(2490)	8.19
Ahmedabad city - Assuming 10 times more cases than reported	(607,777)	(2490)	4.10

Note: The population of Reunion Island about 770,000. Population of Ahmedabad city 3.8 million.

[a] Estimated cases reported in the Reunion Island through a sentinel surveillance system.
[2] Cases reported by the Ahmedabad Municipal Health Officer
[3] Excess deaths from the months of August-November all attributed to Chikungunya
[4]Reducing the number of excess deaths in the months of August-November by 20% to eliminate inflated numbers due to deaths of non-residents.

Table 3 shows case fatality in Ahmedabad under various assumptions as compared to that in Reunion Island. This table shows that data of Municipal Corporation, which has recently and reluctantly reported only 10 deaths due to Chikungunya, gives a very low case fatality of 0.16 per 1000 cases. This is 5.75 times lower than the case fatality reported by French public health authorities in the epidemic in Reunion Island. But if we assume that most of the additional deaths during the peak epidemic (August-November) are due to Chikungunya then the case fatality of Chikungunya in Ahmedabad city works out to be much higher (51.2 per 1000 cases) than reported in Reunion Island, which is a French territory (0.92 per 1000 cases). The more realistic case fatality works out to be about 4.1 – 8.2 per 1000 in Ahmedabad using an assumption of ten times or five times more cases than reported and 20 percent reduction in additional mortality due to immigration of fatal cases in the city from surrounding rural areas (see last row of table 3).

Discussion

The analysis of the data reported by AMC shows that the mortality rate of the city of Ahmedabad increased substantially in 2006 compared to the previous four years. 3396 excess deaths occurred in 2006 compared to the expected deaths. A significant increase in the deaths reported in city of Ahmedabad was in the months of August to November 2006. There was a total of 3112 excess death in these months alone. The reported Chikungunya cases also show a peak in the months of August and September which clearly coincides temporally with the peak in mortality rise in the city. There was no major adverse event or epidemic in the city in 2006 in these months, other than the Chikungunya epidemic. There were heavier rains in July and August 2006 as compared to 2005. The excess deaths peaked in September when the monsoon had ended and increased mortality continued in October and November when there were no rains. Hence additional mortality cannot be explained by the heavier rains in 2006. The rise in mortality is mainly in older population (above 50 years) and not in the younger population where one would expect monsoon related diarrhoeal diseases. Hence, epidemiological evidence shows that the Chikungunya epidemic could be the only explanation responsible for the huge excess in of deaths in Ahmedabad in August to November 2006.

Table 3 shows that under various assumptions the case fatality rate (CFR) is much higher in Ahmedabad as compared to Reunion Island. This was expected because Ahmedabad city is economically much poorer and its health system not as well developed as compared to the French Réunion Island. Our analysis indicates that if one wants to calculate the total deaths in India attributable to Chikungunya, one has to use much higher case fatality rate than in Reunion Island. If the city of Ahmedabad had so much excess mortality (and a higher CFR than Réunion Island), the situation of mortality in other smaller towns and rural areas where the epidemic spread, may be even worse, given the poorer access and quality of health services compared to Ahmedabad which is a major city. With limited reported case data from India and mortality rate from Reunion Island (0.9 per 1000 cases) we had estimated that India would have had any where between about 1200 to 19,000 deaths due to the Chikungunya epidemic depending on the assumptions used – most conservative or realistic.[9] With these high case fatality rates (4.10 or 8.19 per 1000 cases) from Ahmedabad we estimate that total deaths due to Chikungunya in whole of India should be about 26,650-53,235 assuming 6.5 million

cases (five times more than the 1.3 million cases reported by government of India). This shows that the epidemic must have had devastating impact on the communities.

Unfortunately mortality data in Ahmedabad is not routinely analyzed according to the cause of death or by permanent residence status. The number of deaths registered by the Registrar of Birth and Deaths of Ahmedabad city includes deaths at home as well as in hospitals of the city. Given that Ahmedabad has many hospitals, patients coming from surrounding rural areas and dying in the city hospitals could have lead to some excess death reporting in the city during the epidemic. The death reporting system by AMC does not separate the deaths of Ahmedabad residents from non-residents. However this problem is not only in the year 2006 but has also been present in the previous years (2002-2005). The review of deaths registered in rural areas of Ahmedabad districts (outside city limits) show no major decline during the epidemic months of 2006 as compared to the previous years. Hence, the increase in numbers of deaths due to the migration of sick patients cannot explain this major rise in mortality in 2006 even thought this may have contributed to some of the rise.

In spite of this increase in mortality rates in the city the health department of the city recently reported only 10 deaths due to Chikungunya. These are the cases where blood test confirmed Chikungunya. They have not reported any deaths due to "suspected Chikungunya". Thus trying to minimize the adverse publicity due to the epidemic.

An excess in total mortality has also been reported in the Chikungunya epidemic in Reunion Island during February-April 2006.[10] This is very similar to the pattern of mortality rise we have reported in Ahmedabad in this paper. The age distribution of deaths in Ahmedabad shows that most of the excess deaths are in the age group of 50 years and above. This may be due to the fact that this virus proves more deadly in older people who may have some preexisting disease or weak immune and other body defence mechanisms. A similar increase in deaths in the elderly population was seen during the heat wave in France in 2003.[11] This increase in mortality was detected by French authorities immediately and actions were taken to prevent further deaths. On the other hand Indian authorities have not paid much attention to mortality increase during the Chikungunya, hence the possibility of preventing deaths was perhaps lost.

In India the general system of reporting deaths, its compilation and analysis of cause is very poor. It is poorer than what existing 300 years ago in London in the form of 'Bills of Mortality'. Rather than investigating the mortality rise in Ahmedabad, Gujarat or other states the government of India has declared repeatedly in the parliament that "there

are no deaths directly attributable to Chikungunya" in the whole country.[5] The government of India's web site continues to show "zero deaths" in spite of 1.39 million cases of Chikungunya.[4] Recently the Municipal Health Officer of Ahmedabad has reported only 10 deaths out of 60,777 suspected Chikungunya cases.[8] It is surprising that even these 10 deaths have not been reflected on the central government's epidemic information.[5] This shows lack of seriousness about epidemic investigation and death reporting.

No systematic or comprehensive investigation of deaths in relation to this epidemic has been carried out by the authorities before declaring the absence of deaths due to Chikungunya in the parliament. Unfortunately, in spite of repeated requests to the government no such data seem to be collected and published for any other towns or cities of Gujarat state or any state of India where this epidemic was reported. No in-depth investigation has been carried out on mortality & morbidity due to this epidemic nor was any committee/commission appointed to investigate at national or state level. The various national institutes which investigated some epidemics or outbreaks did not study the mortality due to Chikungunya. Even WHO seems to have neglected the mortality related to the epidemic. Further detailed investigation on the cause of excess deaths is urgently needed for dealing with future epidemics of Chikungunya in a better way.

Conclusion

There has been a significant rise in gross mortality in Ahmedabad city during the months of August to November 2006 (when the Chikungunya epidemic was raging in the city) compared to previous months in 2006 and same months of last 4 years. The highest number of Chikungunya cases was also reported in August and September. Thus there is strong epidemiological evidence to believe that the rise in mortality was due to the Chikungunya epidemic and no other cause. This epidemic seems to be responsible for abut 3,112 additional deaths during August-November 2006. Clearly the Chikungunya epidemic in Ahmedabad was deadly with a possible case fatality of 4.1 – 8.2 per 1000 cases. These case fatality applied to total estimated cases in India would lead to an estimated 26,650 to 53,235 death due to this epidemic in India in 2006. The mortality data from Ahmedabad gives further support to the observations of other researchers that this virus may have recently mutated and become much more dangerous than reported previously.[12] The policy implication of our findings is that the National and International Public Health authorities must take the Chikungunya virus very seriously and urgently

investigate the recent epidemics and their mortality in various parts of India and other countries. The morbidity and mortality due to these epidemics must be documented rather than dismissing the disease as a non-fatal one base on past experience. There is a very urgent need to strengthen national and international public health capacities; especially epidemic documentation, mortality analysis, and cause of death reporting which will help detect such epidemics more quickly. If we do not learn from this epidemic much more severe epidemics may occur due to re-emerging infections such as Chikungunya, Dengue, Bird flu or SARS.

What this paper adds:
Chikungunya was considered to be a non-fatal Arbovirus transmitted by the bite of the Aedes mosquito. However 237 deaths in the 2005 Chikungunya epidemic in the Réunion Islands of France changed this perception.

This study provides strong epidemiological evidence that there were 3112 excess deaths during the Chikungunya epidemic months in Ahmedabad which could be due to Chikungunya. Thus, providing evidence that this virus may have mutated and become more virulent. This paper calls for urgent attention to improve public health system in India and developing world.

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