

EXCESS MORTALITY AS AN EPIDEMIC INTELLIGENCE TOOL IN CHIKUNGUNYA MAPPING

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Introduction

Mortality is an important public health indicator [1]. Mortality data is accurately recorded, readily accessible, and includes precise temporal and geographical variables. During epidemic outbreaks, excess mortality can inform on the virulence of an infection. Moreover, in the absence of outbreak prevalence data, mortality can additionally inform on the spatio-temporal progression of the disease.

The mosquito-borne viral disease chikungunya has affected more than 1 million people worldwide in epidemic outbreaks since 2005 which seem to have originated in the Kenyan coastal towns of Lamu and Mombasa in 2004 [2]. The disease reached the south-west Indian Ocean island of Mauritius (size of 1,865 km² and population of 1.2 million) in April/May 2005 with an outbreak localized in its capital city Port Louis and affecting about 3,600 people. A second more severe outbreak affected the island from the beginning of February 2006, peaking in the last week of February and beginning of March, and fading out in April. Official figures indicate that approximately 11,000 inhabitants of Mauritius were affected by chikungunya during the second outbreak. No local cases of chikungunya have been registered in Mauritius since August 2006 although the infection continues its worldwide spread with recent outbreaks in the Ravenna province of northern Italy [3,4] and in Singapore.

Chikungunya may cause severe morbidity and has only recently been noted to be associated with excess mortality. The excess mortality in the neighbouring island of Reunion (size of 2,512 km², population of 775,000), where about 260,000 inhabitants were affected at about the same time as the epidemic was prevailing in Mauritius, has been estimated at about 250 [5]. An excess mortality has also been reported in Mauritius during the months of March (approximately one month after the beginning of the epidemic), April and May 2006 [6,7] and this has been estimated at a total of about 750 [7]. The island of Mauritius is divided into nine geographical districts: Port Louis in the north-west, Pamplemousses and Rivière du Rempart in the north, Flacq, Grand Port, and Savanne respectively in the east, south-east and south, the central districts of Plaines Wilhems and Moka, and Black River in the west. In this paper we report a district-wide analysis of mortality in the island during the 2006 epidemic outbreak.

Methods

Monthly mortality data and the mid-year population for each of the nine districts for the period from January 2000 to December 2006 were obtained from the Mauritius Central Statistics Office and the monthly Crude Death Rates (CDRs) were computed. The

predicted mortality for a month of 2006 was the product of the average CDR for the month in the period 2000-2005 and the 2006 mid-year population divided by 1,000 [7]. The excess mortality was the difference between the observed mortality and the predicted mortality. A t-distribution was used to calculate the p-values for the difference between the observed and predicted CDRs.

Besides the chikungunya epidemic there was no other identified phenomenon which could have caused excess mortality during the months of February to May 2006 in Mauritius. Based on the excess mortality, we have developed a chikungunya case calculator (CCC) as follows:

1. Divide the affected country into homogenous sub-regions of known populations.
2. Calculate the excess mortality over the epidemic period for each of the sub-regions.
3. Identify one of the sub-regions as a baseline region.
4. Assume the level of chikungunya infection (percentage of inhabitants infected) in the baseline region to be Z%.
5. Calculate the case-fatality per 1,000 (CF) for this level of infection as:

$$1000 \times \frac{\text{excess mortality of baseline region}}{(Z/100) \times \text{population of baseline region}}$$

6. Calculate the number of infected people in a sub-region as:

$$1000 \times \frac{\text{excess mortality of sub - region}}{\text{case - fatality per 1000 of baseline region}}$$

7. Calculate the percentage of infection for the sub-region as:

$$100 \times \frac{\text{number of infected people in sub - region}}{\text{population of sub - region}}$$

8. Repeat 6. and 7. for the other sub-regions.
9. Repeat steps 4-8 for different levels of chikungunya infection Z to construct a chikungunya case table.

Using the districts of the island of Mauritius as the sub-regions and the district of Pamplemousses as the baseline sub-region, the CCC was used to construct a chikungunya case table for the island of Mauritius. In the computations, the excess mortality for each district was the sum of the respective excess mortalities for the months of March, April and May 2006 except for the districts of Pamplemousses, Rivière du Rempart and Flacq where the month of February 2006 was also included in the sum. Also, the case-fatality (CF) was assumed constant over the epidemic period in the whole island for each level of infection Z.

FIGURE 1

Monthly excess mortality per 1,000 population for the nine districts of the island of Mauritius for the months of February to May 2006

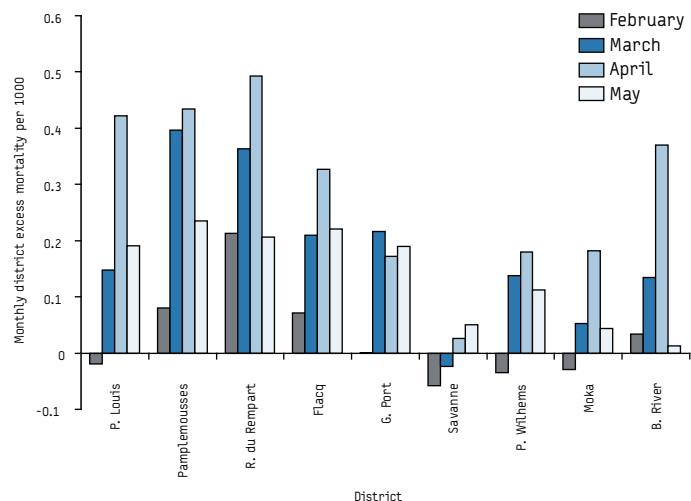
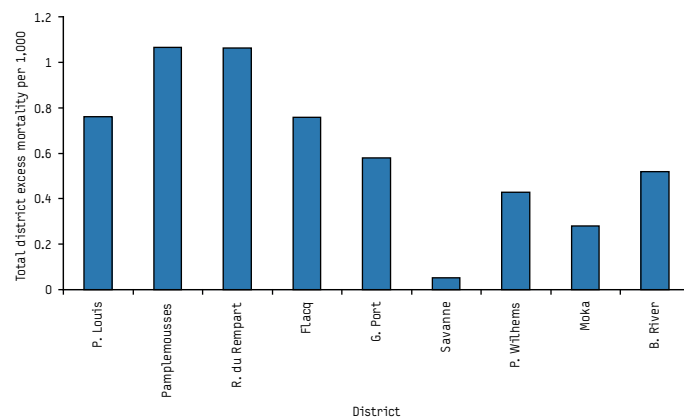


FIGURE 2

Total excess mortality per 1,000 population for the nine districts of the island of Mauritius in the period March – May 2006



TABLE

Chikungunya case calculator (CCC) - reference table to estimate the proportion of population affected by 2006 chikungunya outbreak in Mauritius

Z (%)	CF	Percentage of inhabitants infected								
		P. Louis	R. du Rempart	Flacq	G. Port	Savanne	P. Wilhems	Moka	B. Rivier	Total
2	57.3	1.3	2.2	1.4	1.0	0.1	0.7	0.5	0.9	1.1
5	22.9	3.3	5.6	3.6	2.5	0.2	1.9	1.2	2.3	2.8
10	11.5	6.6	11.1	7.2	5.0	0.5	3.7	2.4	4.5	5.7
20	5.7	13.3	22.3	14.5	10.1	0.9	7.5	4.9	9.0	11.3
30	3.8	19.9	33.4	21.7	15.1	1.4	11.2	7.3	13.6	17.0
40	2.9	26.6	44.5	28.9	20.2	1.9	15.0	9.7	18.1	22.7
50	2.3	33.2	55.7	36.1	25.2	2.3	18.7	12.2	22.6	28.3
54	2.1	35.9	60.1	39.0	27.2	2.5	20.2	13.1	24.4	30.6
60	1.9	39.8	66.8	43.4	30.3	2.8	22.5	14.6	27.1	34.0
70	1.6	46.5	77.9	50.6	35.3	3.3	26.2	17.0	31.6	39.6
80	1.4	53.1	89.0	57.8	40.4	3.7	30.0	19.5	36.1	45.3
90	1.3	59.8	100.2	65.1	45.4	4.2	33.7	21.9	40.7	51.0
100	1.1	66.4	111.3	72.3	50.4	4.7	37.4	24.3	45.2	56.6

Z % = level of infection in the baseline region (district of Pamplémousses)
 CF = case-fatality per 1,000 in the baseline region (district of Pamplémousses)

Results

Figure 1 shows the computed excess mortality per 1,000 by district for the months of February to May 2006. The total excess mortality for the months of March to May 2006 was 746. The most affected districts were the northern districts of Pamplémousses and Rivière du Rempart as shown in Figure 2.

In February, March, April and May 2006, monthly CDRs for the island of Mauritius were higher than the 2000-2005 monthly respective means by 3.5%, 33.0%, 50.9%, and 27.1% ($p < 0.01$ for March, April and May). However, CDRs increased by 16.8%, 45.8%, and 16.1% in the districts of Pamplémousses, Rivière du Rempart, and Flacq as early as February 2006 ($p < 0.01$ for Rivière du Rempart).

Discussion and conclusion

A recent field study in a locality in Pamplemousses district indicated that about 50% of the inhabitants of this locality may have been affected by chikungunya during the 2006 epidemic [8]. Assuming this figure to be representative of the entire district, the CCC gives a case-fatality of 2.3 per 1000 for the district. The associated levels of infectivity would then be as given in the table, for example 25.2% for Grand Port and 28.3% for Mauritius. However, these figures should be interpreted with caution since serological studies are needed to confirm the actual levels of infection. When resources are limited, the CCC can be a useful epidemic intelligence tool [9] which enables to extrapolate the results of the serological studies in a baseline sub-region to the other sub-regions. The tool can be used either in real-time during an outbreak if excess mortality data are available in real-time or at the end of an outbreak. In this way regions which have not attained herd-immunity levels would be identified. These could then be targeted and public health measures reinforced.

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