A longitudinal analysis of dengue in Jamaica over the period 2004-2017

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Abstract
Objectives: Dengue fever is caused by the *Aedes aegypti* mosquito that is considered to be a vector borne viral disease. Drastic increase in cases in Jamaica is usually noted to be seen during the raining seasons, which spans from May-September each year. **Method:** Data was obtained from the Surveillance unit at the ministry of Health (MOH) in Jamaica with recordings of dengue reports for the study period (2004-2014). The website for the Statistical Institute (STATIN) was used to obtained data regarding the rainfall activities over the same period. The office of disaster and emergency management (ODPEM) was consulted for appropriate map highlighting Jamaica's flood prone areas. The EBSCO host data base was extensively searched to obtained relevant literature on the incidence of dengue infections worldwide. **Results**: In 2007, Jamaica had 5500 suspected cases of dengue while of that amount only 1550 was confirmed with same. An average of 2139 mm of rainfall was recorded for the same period with temperatures over a period of 1996-2015 showed averages of 28.3^0 C at Norman Manley international airport, $27.6\ ^0$C and 23.7^0C at Sangster International and Worthy park respectively. 2015 showed 100 suspected cases with only 22 patients truly being infected with dengue.
Conclusion. The results show that the dengue infection depends on the seasonal variation of the climate. The rainfall provides places for the mosquitoes to lay eggs and develop to the adult stage. The temperature plays an important role in the life cycle and behavior of the mosquitoes. A very high or very low temperature reduces the risk of the dengue infection. More over continued nationwide knowledge interventions, will continue to greatly aid in the number of confirmed dengue cases to be decreased and hopefully totally eradicated.

Keywords: - Dengue. Jamaica, Rainfall, Vector-borne

1. Introduction

This research is a retrospective analysis of the frequency with which dengue cases are reported in Jamaica from 2004 to 2017. Dengue is a mosquito borne viral illness that mimics the presentation of other flu like illness. Dengue is categorized as the most reported mosquito borne virus. Uncovered water catchment areas are the best place for this mosquito to quickly replicate. Dengue infections are present worldwide and is especially important in developing countries, where sanitation and proper water storage is at its minimum. Mild non-lethal anicteric forms comprise most cases and can be easily confused with flu, leptospirosis, other mild viral illnesses and *P. vivax* malaria [1]. This research is intended to ensure that health officials are always equipped with the knowledge to prevent large outbreaks and reduce the mosquito population. The fewer mosquitoes there are, the fewer chances of outbreaks. Dengue fever affects the body by causing flu like symptoms, aching muscles and high fever, which can also infect ones blood which causes rash, headache and even fatigue.

Problem statement

The large number of dengue cases in Jamaica is of great concern and of such greater preventative and eradication methods must be adhered to in curbing the wide spread of this illness.

Study Context and Conceptual Framework

A holistic analysis of the overall frequency of suspected and confirmed cases will be discussed. The geographical land scape is generally mountainous with plains that serves as water settling regions. Data collection will be validated using reports from individuals, the Ministry of Health, newspapers and journals.

Rationale and Justification

Dengue is considered a major global health crisis with higher cases reported in tropical countries like Jamaica. Preventing frequent outbreaks of dengue must be at the forefront of our minds as the burden placed on the Ministry of Health and other health related entities the sociological and economical cost related to this illness must be mitigated. Addressing factors which directly support the spread of this disease will not only limit the amount of persons becoming affected but lessen the financial burden on the Jamaican economy.

Purpose of Study

The purpose of this study is to highlight the burden dengue outbreak has on Jamaican economy.

2. Literature Review

Dengue fever is amongst the most common mosquito-borne disease in the tropics and the most suspected in patients with fever. With the introduction of chikungunya (2013) and the Zika virus in (2014) it has become more challenging for health workers to diagnose, creating problems for appropriate case management and alleviating fatal events [2]. The global incidence of dengue has grown dramatically in recent decades. Approximately half of the world's population is now at risk. According to the Ministry of Health there were 560 suspected cases of dengue fever across the island of Jamaica (2012) [2].

Mosquitoes transmit the virus by feeding on blood of infected persons. At first, the virus infects and replicates in the mid-gut epithelium of the mosquito and then spreads to other organs until it reaches the salivary glands after 10–14 days where it can be inoculated to another person during subsequent blood meal. On the other hand, mother-to-infant transmission of dengue virus via cord blood or breast milk remains controversial [1, 3, 4].

WHO in their latest estimate states that over 50-100 million dengue infections occur annually. With drastic increases observed over the past 50 years [11]. With increased interventions, dengue still continues to be a public health threat.

It is imperative to note that the age of dengue patients after 2010 was significantly older than that of patients prior to 2010 (mean pooled age: 34.0 vs. 27.2). Possible reasons for this finding may be that younger people now spend more daytime in enclosed air-conditioned environments and are, therefore, less likely to be exposed to mosquitoes [5] and that older people with chronic diseases now visit the doctor more often, causing existing dengue infection to be more likely to be detected [6]. The association between weather and dengue varies across geographical locations and socio-environmental strata [12, 13].

Method

Epidemiological data

A fourteen year empirical data was collected from the Ministry of health surveillance unit in Jamaica. The dengue surveillance system in Jamaica collects data from the four (4) regional health authorities (southern regional health, west regional health, northeast regional health, and south east regional health authority). These bodies' collects surveillance data then send it to the Ministry of Health (MOH) head office for analysis and dissemination. A quarterly bulletin is prepared and posted on the MOH website for ease of access. The dengue cases are diagnosed by public health care professionals at different locations whether clinics, hospitals or private practices around the island. These health centers report the number of suspected and confirmed laboratory dengue cases to the regional medical officer. For the effective control of disease outbreaks, rapid and precise diagnosis of dengue is of paramount importance. The age and gender differences were not captioned for this study however the frequency of the cases were analyzed.

Results

Of the 50 cases that were notified in 2004, 96% of the cases were confirmed (n=48). A similar number of cases were notified in 2005, however a decline of 4 cases was noticed for this year bring the percentage to 88% from 96% confirmed when compared to the previous year. The year 2006

YEAR	Notified	Confirmed
2004	50	48
2005	50	44
2006	56	71
2007	5500	1521
2008	500	428
2009	100	73
2010	3050	440
2011	900	500
2012	5900	817
2013	900	164
2014	900	86
2015	100	22
2016	2200	193
2017	20	12

Table 1.Year date comparison of notified and confirmed dengue cases in Jamaica from 2004-2017- (Source-Ministry of Health surveillance unit)

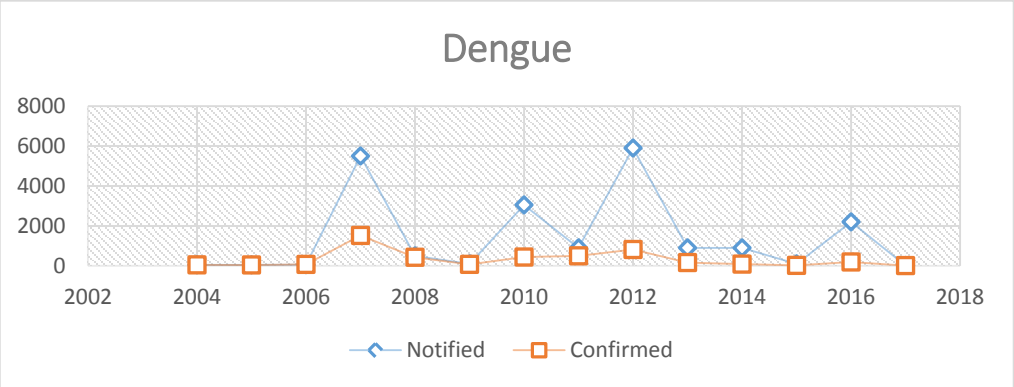


Figure 1-Comparison of suspected and confirmed dengue cases over the test period [9]

Frequency: Annual- Wastes material categories

Categories	2010	2011	2012	2013	2014
Compostables	49			62	55
Plastic	20			12	18
Paper	20			9	17
Cardboard	2			5	2
Textile	3			5	4
Glass	1			3	3
Metal/Tin	2			2	2

Wood/Board	2			1	0
Other	1			0	0
Total	100			100	100

Table 2. Annual waste material in categories from 2010-2014 [8]

Month	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
January	102	81	112	117	80	136	89	189	67	101	73	111	78	112	99	83	70	45	117
February	163	69	39	122	40	40	39	45	35	7	97	37	37	140	62	86	51	55	72
March	90	59	194	126	23	58	43	69	122	12	34	236	114	84	45	70	135	69	58
April	143	54	61	54	76	147	125	153	129	176	131	82	140	120	137	88	201	89	121
May	195	96	88	156	209	310	512	235	256	224	127	264	138	270	269	215	140	212	221
June	139	182	106	155	88	49	198	117	50	234	170	116	156	121	203	313	93	90	47
July	135	95	151	103	105	142	83	116	141	488	142	79	153	59	198	205	90	107	46
August	156	109	146	166	62	86	117	233	158	147	180	304	369	145	191	195	214	193	162
September	188	146	186	274	257	139	595	154	454	168	156	152	210	161	561	184	194	206	183
October	240	201	277	270	222	313	132	215	159	578	196	395	261	176	590	254	237	167	121
November	274	136	205	211	112	247	109	147	76	200	240	294	257	90	135	68	159	148	152
December	37	75	219	51	273	190	116	188	160	77	119	69	47	143	107	78	98	92	181
Annual	1,862	1,303	1,784	1,805	1,547	1,857	2,159	1,861	1,807	2,412	1,665	2,139	1,960	1,621	2,597	1,839	1,682	1,473	1,481

Table 3. *Jamaica's Annual rainfall data Source: Statistical Institute of Jamaica Accessed: May 16, 2016*

Communities in Jamaica that are often implicated with increase dengue cases Table 4

Parish	Number of affected communities	Reference	Population size	Reference	Land area
St Thomas	29	[8]	94,410	[8]	
Kingston & St. Andrew	87	[8]	66,041	[8]	457.2 km^2
St. Catherine	95	[8]	518,345	[8]	1,190.6 km^2
Portland	37	[8]	82,183	[8]	813.9 km^2
St. Mary	21	[8]	114,227	[8]	114,227 km^2
St. Ann	30	[8]	173,232	[8]	173,232 km^2
Westmoreland	54	[8]	144,817	[8]	144,817 km^2
Hanover	18	[8]	69,874	[8]	69,874 km^2
St. James	12	[8]	184,662	[8]	184,662 km^2
Trelawney	32	[8]	75,558	[8]	75,558 km^2
Clarendon	77	[8]	246,322	[8]	246, 322 km^2
St. Elizabeth	97	[8]	150,993	[8]	150,993 km^2
Manchester	36	[8]	190,812	[8]	190,812 km^2
Total	625		2,711,476	[8]	2,711,476 km^2

MEAN MAXIMUM TEMPERATURES 1996-2015 (in degrees celsius) [10] Table 5

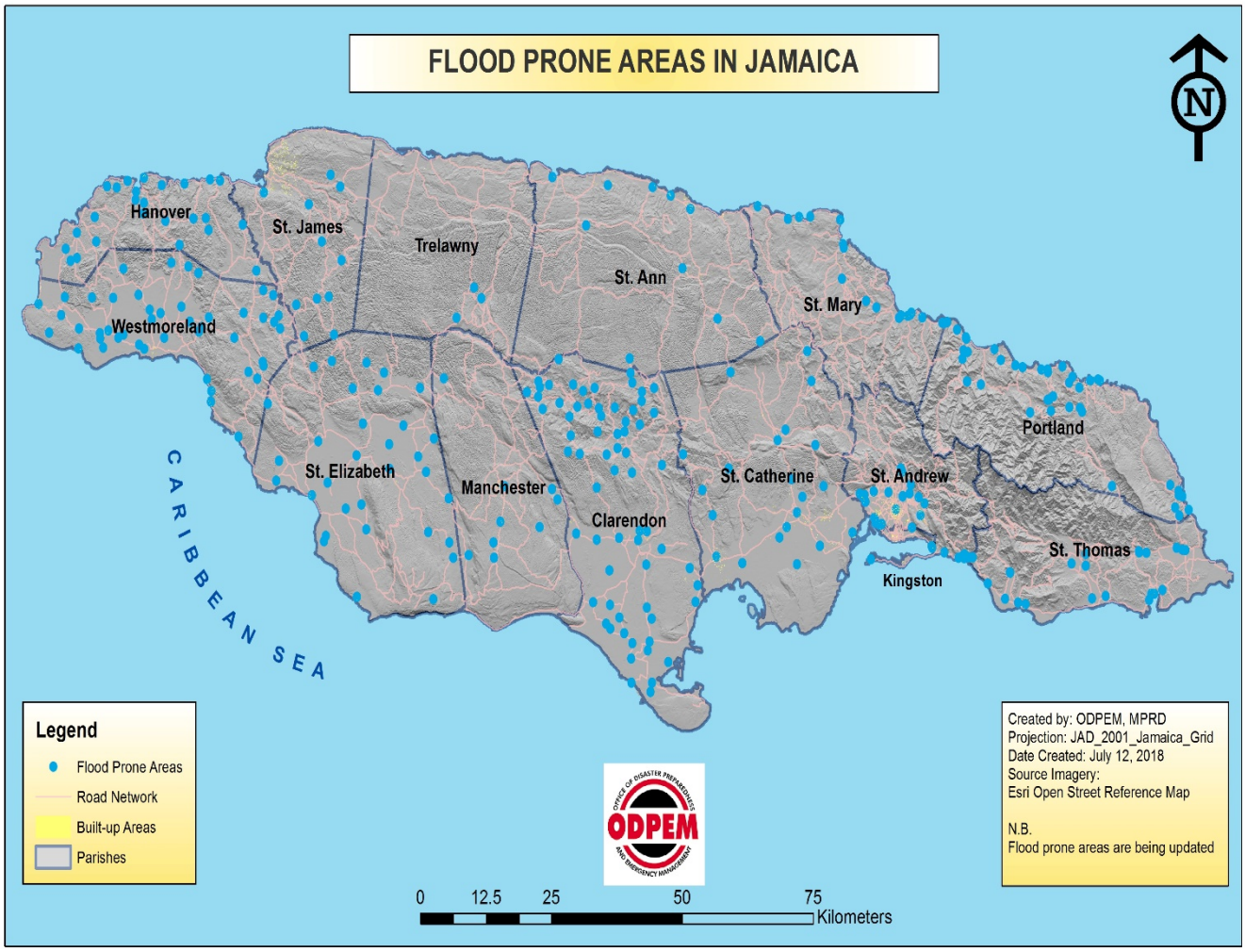
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
Norman Manley Int'l Airport	30.9	30.8	30.9	31.5	31.9	32.6	33.0	32.6	32.8	32.3	31.9	31.3	31.9
Sangster Int'l Airport	29.8	30.0	30.5	31.4	32.1	32.9	33.2	33.4	33.0	32.1	31.2	30.2	31.6
Worthy Park	27.8	28.4	29.2	29.9	30.4	30.8	31.2	31.4	31.1	30.2	29.1	28.3	29.8

MEAN MINIMUM TEMPERATURES 1996-2015 (in degrees celsius) [10] Table 6

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
Norman Manley Int'l Airport	23.0	22.9	23.3	24.2	25.1	25.9	25.9	26.4	25.8	25.3	24.4	23.5	24.7
Sangster Int'l Airport	22.1	21.9	22.4	23.4	24.0	24.6	24.8	24.9	24.5	24.2	23.8	22.8	23.6
Worthy Park	15.8	15.4	15.7	16.9	18.1	18.9	18.9	19.2	19.3	19.1	18.0	16.9	17.7

MEAN TEMPERATURES 1996-2015 (in degrees celsius) [10] Table 7

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
Norman Manley Int'l Airport	25.6	26.9	27.1	27.8	28.5	29.2	29.5	29.5	29.3	28.8	28.2	27.4	28.3
Sangster Int'l Airport	25.9	26.0	26.5	27.4	28.0	28.7	29.0	29.1	28.8	28.2	27.5	26.5	27.6
Worthy Park	21.8	21.9	22.0	23.4	23.5	24.0	25.1	25.3	25.2	24.7	23.6	21.7	23.7



Map 1: Flood prone areas in Jamaica by parishes [18]

Discussion:

In 2004 Jamaica experienced the passage of two hurricanes, Charley and Ivan (category 4) in August and September respectively. The confirmed cases of the vector borne virus was seen to be at its lowest during this period however with rainfall measurements reaching only 1807mm. The rainfall activities for 2005 was higher than the previous year however confirmed cases were less than the previous year only with a margin difference of 4 cases. Rainfall activities were higher in 2005 with measurements of 2412mm due to the passage of hurricanes Dennis, Emily and Wilma. In 2006 the rainfall activities were at its lowest compared to the two previous years. Jamaica was noted to be spared hurricanes attacks for this year. While not having an activity hurricane season the dengue cases continued to slightly increase. There were no distinctions in the reports of the symptoms and sign experienced along with whether the cases were imported or local. Of the 56 previously notified cases, an increase of 15 cases bringing the total for 2006 to 71 confirmed cases. 2007 showed the year with the second highest suspected cases of 5500 of this amount only 1521 were confirmed cases for dengue. 2007 was not spared the attack of hurricane as Jamaica experience the ravaging effects of Hurricane Dean with rainfall activities of 2139mm. 2008 had 428 confirmed cases out of 500 that were suspected and notified. That same year experienced two tropical storms, Nicole and Gustav. Rainfall activity remained somewhat normal with rainfall measuring 1960mm. Rainfall activities for 2009 was lower than the previous year, this was recorded as 1621mm. Notified cases also significantly fell to 100 case with only 73 of the cases confirmed. By 2010 the notified cases fell to 3050 with 440 of these being confirmed. In 2012, a 96% increase in notified cases (n=3050) seen. Only 440 of the 3050 cases were confirmed with dengue. The year that followed (2011) had a notified number of island wide of 900 with 44% being confirmed. 5900 notified cases were reported in 2012 showing the highest suspected report, however 14% (n= 817) were confirmed as having dengue. The years 2013 and 2014 both had notified cases of 900 however different in conformed cases as 2013 confirmed 164 as 2014 confirmed 86. The rainfall activities for both years were 1473mm and 1481mm respectively. A similar decrease as seen in 2009 was noticed in 2015, as only 100 suspected cases were reported with only 22 of the 1000 confirmed as having dengue. A spike was reported in 2016, as 2299 suspected cases were reported. However only 193 of that number was confirmed. 2017 should the lowest over notified and confirmed as. 20 suspected cases were reported with only 12 of that number was seen to be true carriers.

Precipitation is often required to create and maintain breeding sites and consequently has a strong influence on vector distribution. Dengue is endemic in Thailand and Latin American countries, where a positive association between dengue prevalence and rainfall has been reported [14].

Similarly, studies have also been reported that in wetter conditions, compared with drier conditions, mosquitoes expand their spatial range, thereby leading to increased risk of dengue infection [15].

In contrast, dry conditions can also lead to epidemics in urban settings, because vulnerable people with little access to water resources tend to store water in unprotected reservoirs near their households. This water attracts *Ae. aegypti*, which is anthropophilic, thus further increasing the risk of transmission [16,17].

There was a positive relationship seen with the type of landscape, whether low land or mountainous with the prevalence of Dengue as seen on Map 1 and Table 4. Due to the lack of adequate recorded information regarding the waste disposal practices of the nation, conclusive statements cannot be made regarding the categories of waste materials frequently implicated in the different parishes (Table 2). What was observed for the recorded period was that compostable waste was the highest waste materials that were collected, while wood/board were the category with the least frequent.

Conclusion

Dengue is driven by complex interactions among host, vector and virus that are influenced by climatic factors. It is known that with the right conditions, the dengue virus will indeed proliferate. It is clear that with increase in knowledge about this illness and increase interventions, regardless of the increase in rainfall the dengue case will not surpass a certain number.

There are still limitations to this study as many persons who exhibited sign and symptoms of dengue did not report to any medical facility. Additionally, record taking and transfer has always been problem. While plans are afoot to decrease these incidence of none reporting, we had to account for this in the paper.

Author contribution

JBC and AP both contributed to the literature review and the introduction of the paper. JBT contributed to the research design, compilation of documents, analysis of results, first, second and third draft of the manuscript. All others contributed to the final draft.

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Conflict of Interest

The authors declare that there are no conflicts of interest associated with this research.

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