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Rainfall Variability and its Impact on Reported OPD Cases of *Salmonella typhi* Infections in Sunyani, Ghana

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ABSTRACT

Typhoid fever, otherwise known as enteric fever is a disease, prevalent in the world over and continues to be a major public health concern in most developing countries of the world, especially Africa. The aim of the study was to investigate the effect of climatic variability on typhoid fever prevalence in Sunyani, Ghana. Data for the study were collected from the Out-Patient Department (OPD) of the Sunyani Municipal Hospital from January 2008 to December 2011. This was augmented with data collected from the GEONETCast Centre from the University of Energy and Natural Resources, Sunyani-Ghana over the same period. Both records were retrieved between January and June, 2013. Analysis of the results from the data collected showed that, in the year 2008, the rainfall pattern declined from August (76 mm) to November (38 mm). Within this period, the number of typhoid reported cases increased marginally from 8-14. Surprisingly, although there were no appreciable increase in the pattern of rainfall from November to December, the number of reported cases at the hospital shot up exponentially from 14-114 cases. The number of reported cases of laboratory confirmed *Salmonella typhi* infection patients who reported at the OPD section of the Municipal Hospital increased from 30 in March to 105 in August. This was accompanied with a rainfall pattern increase over the period from 15-110 mm. Results from this study has shown that, periods of extended rainfall patterns have also not helped to reduce the prevalence of *Salmonella typhi* infection. In addition, it was also realized that, extended periods of rainfall recorded between January 2008 and December, 2011 has increased the prevalence of the disease in Sunyani Metropolis. Results from this study have shown that, extended periods of rainfall recorded between January 2008 and December, 2011 has increased the prevalence of the disease in Sunyani Metropolis.

Key words: *Salmonella*, typhoid fever, rainfall, pattern, GEONETCast, municipal

INTRODUCTION

Typhoid fever, otherwise known as enteric fever is a disease, prevalent in the world over and continues to be a major public health concern in most developing countries of the world, especially Africa (Mizel and Bates, 2010). It is caused by *Salmonella typhi* which is a rod-shaped gram-negative facultative anaerobe bacterium belonging to the Enterobacteriaceae family (Liang *et al*., 2013). *Salmonella* infections are usually acquired by ingestion faecally contaminated

food or water (Vega *et al*., 2013). Once ingested, the organisms quickly multiply in the small intestine usually over a period of between 1-3 weeks depending on the immune status of the individual. This the etiological agent of the disease do by breeching the intestinal wall and spread further to other organ systems as well as tissues (Rajashekar *et al*., 2013). Research has shown that, *Salmonella typhi* organisms usually interacts with non-phagocytic and phagocytic cells (Song *et al*., 2013). As a result, the primary site of invasion of *Salmonella* strains is thought to be the M cells in the Peyer's patches. Starting in the late 1990s, *Salmonella flagella* was highlighted in host early innate immunity against probably because, the flagella of these *Salmonella typhi* organisms of infected patients were identified by several independent groups as the mediator that causes intestinal epithelial or macrophage inflammation following infection (Jesudasan and John, 1990). Ciacci-Woolwine *et al*. (1998) subsequently reported that, *Salmonella enterica serovar*, flagella induced cytokine to be released from human monocytes and impaired antigen presentation by human macrophages.

Climate variation for some time now has been a long-term shift in the statistics of the weather (including its averages). For example, it could show up as a change in climate's normal expected average values for temperature and precipitation for a given place and time of year, from probably 5 years to the next few decades (Mathur *et al*., 2012). It has been reported that, among most of the climatic elements, rainfall happens to be the first index, ever thought of by both public health experts and climatic analyzers. This has become necessary because one of the most important single factor which could determine the prevalence of many infectious tropical diseases is rainfall (Crump *et al*., 2004). Of all of the natural conditions, rainfall is the only parameter, regarded as one of the fundamental variables in climatic analysis with the potential to negatively affect infectious disease prevalence in most tropical region of the world (Khan *et al*., 2012). But the fact still remains that rainfall patterns in given geographical area could to a larger extent be affected by seasonal variation of the local weather conditions.

Despite these considerable, research activity based on rainfall variability and disease have not been fully investigated. It is therefore an open secret that, for some years now, the actual impacts of climate change on public health are still far from clear (Petit *et al*., 1999). In effect, the possible role rainfall variations with respect to reported cases of typhoid fever in Ghana, is yet to be fully explored. In part, this uncertainty reflects difficulties in predicting the local effects of global changes in climate and disease prevalence in Africa. Even if we were certain about future local climates, there is still uncertainty over what impact these climates would have on health (Harish and Menezes, 2011). The focus of this pilot study reported in this study was to investigate the potential impacts of rainfall pattern variability on reported laboratory confirmed cases of typhoid fever infections at the Sunyani Municipal Hospital, Ghana.

MATERIALS AND METHODS

Study area and population

Climate and vegetation: The climatic zone of Sunyani West District falls within the Wet Semi-Equatorial region and therefore has two rainy seasons in a year. The major rains begin in April and end in July and the minor rainy season is from September to October. Average annual rainfall is about 170 cm. The dry season often lasts for 5 months (between November and mid-March) each year. The abundance of rainfall offers the district a comparative advantage in agricultural production and forestry. This map is shown in Fig. 1.

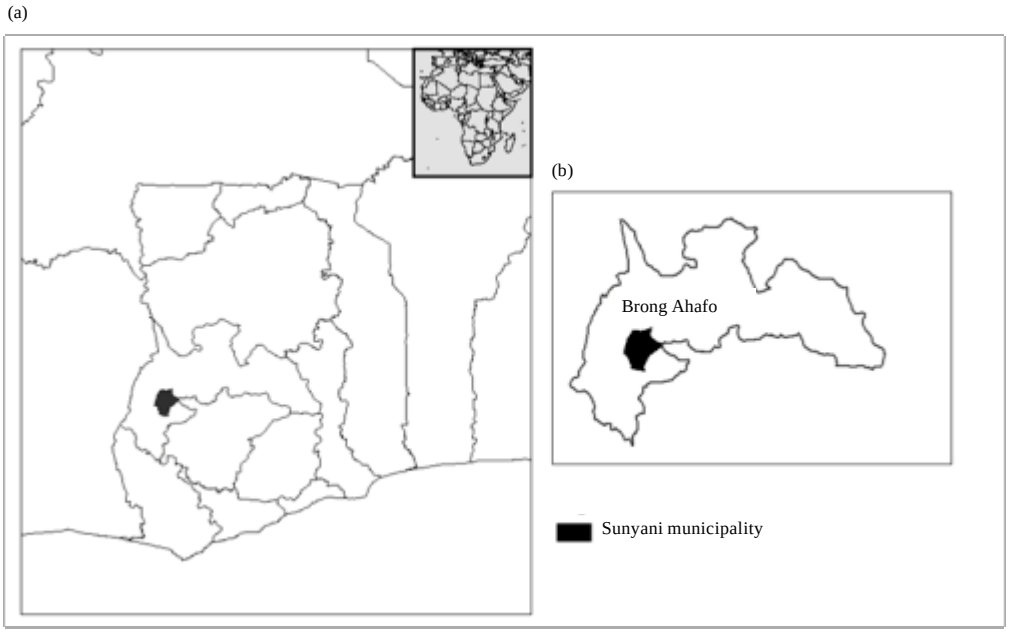

Fig. 1(a-b): (a) Map of Ghana and (b) Brong Ahafo Region showing Sunyani municipality

Vegetation: The district falls within the moist-semi deciduous forest vegetation zone. The forest reserves in the district are Tain 1, Tain 11 and Yaya forest reserves. The forest zones contain timber, wild life, herbs and other valuable resources. Timber species found in the district are Odum, Mahogany, Wawa, Oframo, Teak, Kyenkyen, Sapele, Amire, Asanfra and Onyina. Some crops that are cultivated in the district include cassava, plantain, cashew nut, palm oil, cocoyam maize, etc. However, in recent times, the forest is being depleted trough human activities such as agricultural activities, bush fires, indiscriminate felling of trees and settlement expansion. As a result of these activities, the Sahara desert is fast approaching this region.

Data collection: The study employed a combination of desk studies, checklist and data collected from the Out-Patient Department (OPD) of the Sunyani Municipal Hospital, Brong Ahafo Region, Ghana. This was coupled with data collected from the GEONETCast Centre from the University of Energy and Natural Resources, Sunyani.

With the help of the Sunyani Municipal Hospital Administrator, records of laboratory confirmed cases of typhoid fever, recorded at the OPD section of the hospital between January 1, 2008 and December 31, 2011 were retrieved and recorded. These were supported by an in-depth interview by selected Clinicians and Public Health personnel at the hospital over the period. Within the same period, rainfall data recorded at the GEONETCast Centre from January 1, 2008 to December 31, 2011 for the Sunyani Municipality at the University of Energy and Natural Resources were also mined from the main storage server and stored.

Data analysis: Data of reported laboratory confirmed cases of typhoid fever from the OPD section of the Sunyani Municipal Hospital and rainfall recorded from the GEONETCast over the period were overlaid in a bar chart and the results were interpreted.

RESULTS AND DISCUSSION

The Fig. 2 shows laboratory confirmed cases of typhoid fever reported with monthly rainfall patterns in the Sunyani municipality, in the year 2008. Results of the study has shown, that rainfall patterns did not directly relate to reported cases of typhoid fever over the period. Analysis of the results from the data collected showed that, within the month of January and March, there were no appreciable rainfall figures within the Sunyani Municipality for the year under review (Fig. 2). However, in April that same year, total rainfall recorded was approximately 25 mm with 25 cases *Salmonella typhi* cases recorded. With the rains peaking from June to August (13-76 mm), the number of typhoid cases rather declined from 34-8 as shown in Fig. 2.

Within the same year i.e., 2008, the rainfall pattern declined from August (76 mm) to November (38 mm) (Fig. 2). Within this period, the number of typhoid fever reported cases increased marginally from 8-14. Surprisingly, although there were no appreciable increase in the pattern of rainfall from November to December, the number of reported cases at the hospital shot up exponentially from 14-114 cases. This was compared with the average monthly rainfall patterns in the Sunyani Metropolis over a period of 5 years. This was an attempt to access whether climatic variation could possibly have an impact on reported cases of the disease in the Metropolis. Based on the above results, the lack of adequate correlation between monthly rainfall patterns and reported cases of typhoid fever did not come as surprise. Research has shown that, typhoid fever infections in recent times has occurred in populations where sustainable environmental sanitation practices has not been properly implemented (Bhattacharya *et al*., 2011).

Information gathered during an in-depth interview with some officials of the Sunyani Municipal Hospital (Clinicians and Public Health personnel) during the study revealed that, a lot of sound sanitation practices were put in place in 2008. During the year under consideration, the

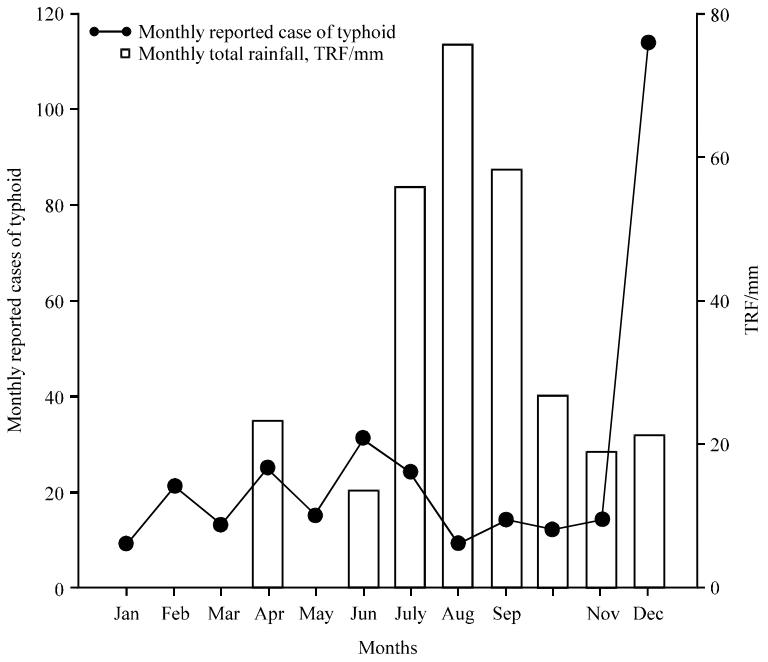

Fig. 2: Reported cases of typhoid fever infections variations with rainfall patterns in Sunyani municipality from January to December 2008

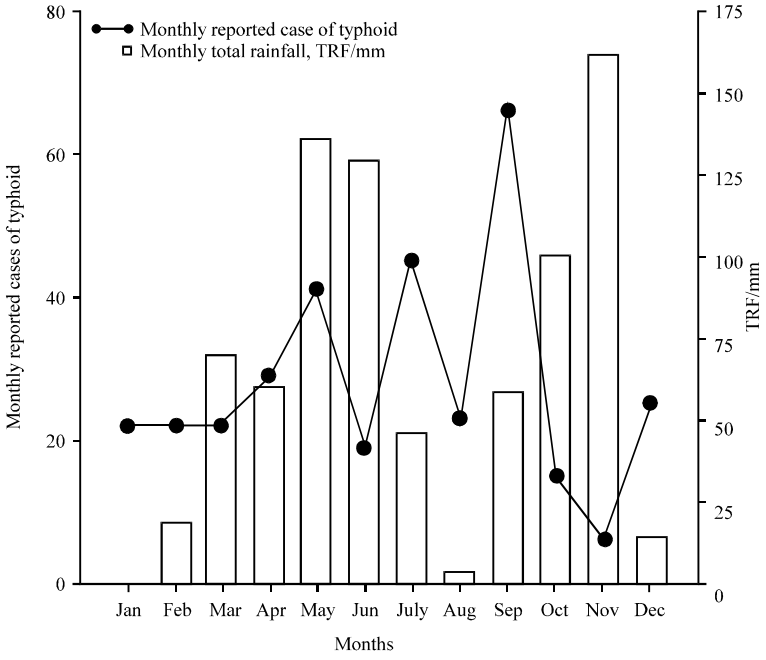

Fig. 3: Reported cases of typhoid fever infections variations with rainfall patterns in Sunyani municipality from January to December 2009

city Authorities in Sunyani, the Brong Ahafo Regional Capital of Ghana succeeded in managing its liquid and solid waste effectively and this could have resulted in low reported laboratory confirmed cases of *Salmonella typhi* infection. This was consistent with this present study.

The study further showed that during first 3 months, in the year 2009, the number of reported cases of *Salmonella typhi* infections (22) plateaued for 3 months after which the number increased to 42 in May. Within the same period, the rainfall pattern increased from 25 mm in February to 140 mm in May the same year as shown in Fig. 3. The similarity in the trend of typhoid fever and rainfall pattern could be attributed to an upward surge in the spread of diseases caused by ingestion of faecally contaminated water (Verma *et al*., 2010).

An increase in typhoid fever infection has often occurred during certain periods of continues rainfall in most tropical regions of the world, especially West Africa. This rise in *Salmonella typhi* infection cases, can be alarming especially in children and this could be attributed to climate variation's influence on seasonal rainfall patterns. As a result, this phenomenon can reduce the flow of the some rivers in the tropical world limiting the availability of fresh water (Jimenez *et al*., 1989). The study has also shown that as the rainfall pattern decreased in September from 140-15 mm to November, the rate of reported cases of laboratory confirmed *Salmonella typhi* cases also increased to August from 2-75 as shown in Fig. 3.

This development was expected and did not come as a surprise because it is a well-known fact that, 3-5% of patients who have recovered from typhoid fever infections could still habour the bacilli in their system many weeks after treatment with antibiotics without showing symptoms (Sharan *et al*., 2011). It is possible these people were still shedding the bacteria into food and drinking water sources and as a result, inhabitants were ingesting faecally contaminated materials without knowing. This assertion was in line with this present study.

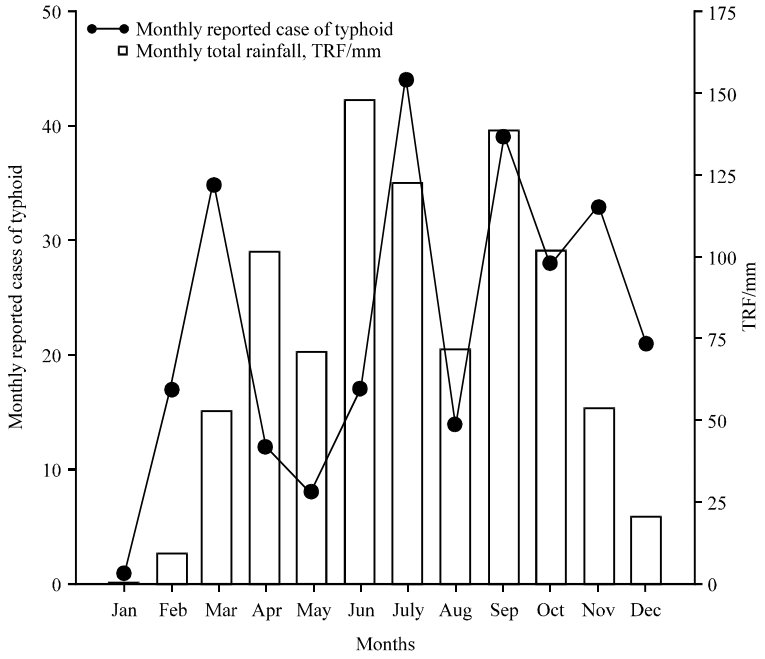

Fig. 4: Reported cases of typhoid fever infections variations with rainfall patterns in Sunyani municipality from January to December 2010

In the year 2010, reported cases of laboratory confirmed typhoid fever patients who visited the OPD section of the Hospital rose in January from 1-35 as shown in Fig. 4. This was accompanied with a corresponding increase in rainfall pattern recorded from the GEONETCast Centre at the University of Energy and Natural Resources, Sunyani, Ghana from 5-115 mm as shown in Fig. 4. The same was seen with the year in question from May to July. This development was also not surprising. It has been established earlier that short-term variations in climatic conditions particularly rainfall patterns and extreme weather events could exert direct negative effects on human health outcomes especially with some water borne diseases including typhoid fever and cholera (Menezes *et al*., 2012).

Changes in these climatic conditions and variability could also affect human health via indirect pathways. This can occur through changes in biological and ecological processes that influenced some infectious disease transmission including typhoid and cholera. For centuries, it has been known that climatic conditions can affect epidemic infections. This knowledge has been in the open well before the basic notion of infectious agents were understood late in the nineteenth century (Hunter, 2003). This was consistent with the present study.

The development from the previous year during the study did not change much during year 2011. The number of reported cases of laboratory confirmed *Salmonella typhi* infection patients who reported at the OPD section of the Municipal Hospital increased from 30 in March to 105 in August (Fig. 5). The rainfall pattern also increased over the period from 15-110 mm. Infectious disease transmission should be viewed within an ecological framework which has always been influenced by rainfall patterns change (Ongeng *et al*., 2011).

Infectious agents involved in diseases recorded in recent times are known to obtain the necessary nutrients and energy required for proliferation and development by parasitization of

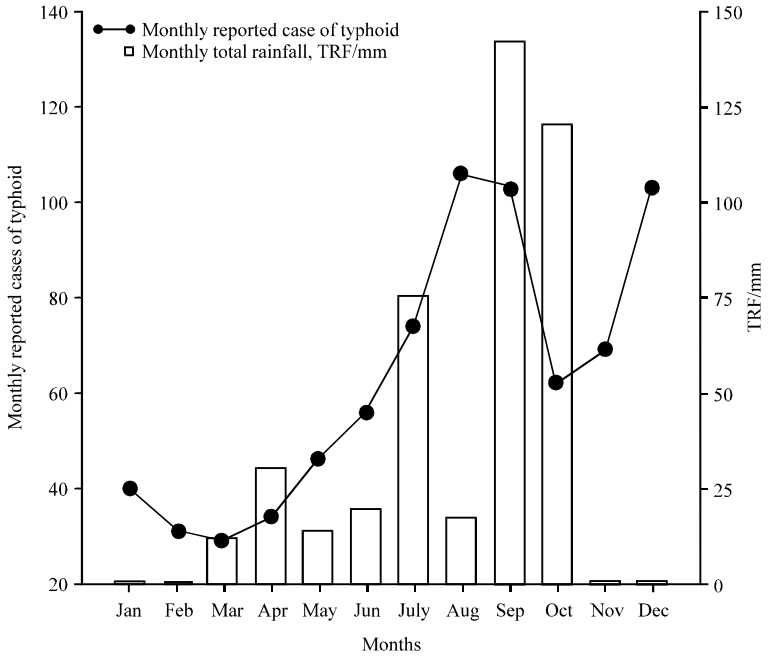

Fig. 5: Reported cases of typhoid fever infections variations with rainfall patterns in Sunyani Municipality from January to December 2011

higher organisms. This research has shown that the bacteria thrive very well with periods of increased precipitation (Song *et al*., 2013). It is an undeniable fact that, most of such infections are benign and some are even beneficial to both host and microbes alike. However, only a minority of infections that adversely affect the host's biology are termed "infectious disease" (Cummings *et al*., 2009). But the rise in rainfall patterns have always contributed to a rise in diseases in the tropical regions of the world which include typhoid fever and this was in line with this present study.

CONCLUSION

It is an open secret among public health experts that enteric fever, otherwise known as Typhoid fever has been and still is a major public health problem in many developing countries worldwide. This disease has been aggravated by improper sanitation, lack of adequate public health education and reduced vaccination. This has contributed to an increase prevalence in *Salmonella typhi* infection. Periods of extended rainfall patterns have also not helped to reduce the prevalence of *Typhoid typhi* infection in most tropical regions of the world, especially Ghana. Results from this study has shown that, extended periods of rainfall recorded between January 2008 and December, 2011 has increased the prevalence of the disease in Sunyani Metropolis.

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