



Heavy rainfall and risk of infectious intestinal diseases in the most populous city in Vietnam



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HIGHLIGHTS

- The association between heavy rainfall and intestinal illness hasn't been well described.
- A positive rainfall – intestinal admission relationship was observed HCMC, Vietnam.
- The relationship pattern of heavy rainfall event–intestinal admissions was provided.
- Heavy rainfall should be considered an indicator in infectious disease prevention.

GRAPHICAL ABSTRACT



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ABSTRACT

The association between heavy rainfall and infectious intestinal diseases (IID) has not been well described and little research has been conducted in developing countries. This study examines the association between heavy rainfall and hospital admissions for IID in Ho Chi Minh City, the most populous city in Vietnam.

An interrupted time-series method was used to examine the effect of each individual heavy rainfall event (HRE) on IID. The percentage changes in post-HRE level and trends of IID were estimated for 30 days following each HRE. Then a random-effect meta-analysis was used to quantify the pooled estimate of effect sizes of all HREs on IID. The pooled estimates were calculated over a 21 day lag period.

The effects of a HRE on IID varied across individual HREs. The pooled estimates indicate that the levels of IID following a HRE increased from 7.3% to 13.5% for lags from 0 to 21 days, however statistically significant increases were only observed for lags from 4 to 6 days (13.5%, 95%CI: 1.4–25.4; 13.3%, 95%CI: 1.5–25.0; and 12.9%, 95%CI: 1.6–24.1 respectively). An average decrease of 0.11% (95%CI: –0.55–0.33) per day was observed for the post-HRE trend.

This finding has important implications for the projected impacts on residents living in this city which is highly vulnerable to increased heavy rainfall associated with climate change. Adaptation and intervention programs should be developed to prevent this additional burden of disease and to protect residents from the adverse impacts of extreme weather events.

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1. Introduction

There is increasing evidence that on-going global climate change, which has been accelerated by anthropogenic greenhouse gas emissions over the last few decades, contributes to more extreme hydrologic events such as heavy rainfall, increased floods and droughts (IPCC, 2013). Such extreme weather events are considered significant health hazards which cause increased morbidity and mortality (Ye et al., 2012; Basu and Ostro, 2008). Heavy rainfall events have been found to be associated with an elevated risk of waterborne diseases in both developed (Curriero et al., 2001; Thomas et al., 2006; Nichols et al., 2009; Chou et al., 2010; Jagai et al., 2015; Wade et al., 2014) and developing countries (Adkins et al., 1987; Dewan et al., 2013; Seidu et al., 2013). However, the relationship between heavy rainfall events and hospital admissions for specific intestinal infectious diseases has not been well described in previous studies. Most studies have focussed on investigating the number of disease outbreaks following heavy rainfall events (Drayna et al., 2010) but have not examined the short-term changes of level and trend in actual number of individual illness cases following heavy rainfall events. Moreover, the link between heavy rainfall and infectious intestinal diseases (IID) such as cholera, typhoid, salmonella and other bacteria has rarely been analysed in developing settings which have a high population density and fewer resources to cope with the potentially growing impacts of climate change related extreme weather events.

Ho Chi Minh City (HCMC) is the most populous city in Vietnam where urban floods have emerged as a serious concern due to the city's rapid growth. Despite the construction and continued expansion of the urban drainage system to address the demands of increased population and infrastructure, this system is often overloaded as water levels in the river, rainfall and the runoff ratio have increased over the past decades (Phi, 2008). Rapid population growth, shortage of investment and aging water and sewage infrastructure have resulted in alarmingly polluted waterways and exposed the inhabitants of HCMC to considerable risk (Ha et al., 2008; Vo, 2007; Wust et al., 2002). The water of the Saigon and Dong Nai rivers is used as the source of drinking water for residents of HCMC, which has limited purification and control over industrial and domestic waste discharge (Hong et al., 2000; Vo, 2007). Vo (2007) estimated that only 40% of waste water from industrial and hospital sources discharged into the Saigon River is treated. Exacerbating this problem is HCMC's highly vulnerability to climate change (Yusuf and Francisco, 2009). Extreme weather events such as heavy rainfall and associated floods have become more frequent in HCMC recently, leading to substantial economic and social losses. For example, research has indicated a linear increasing trend of yearly max 180 mm rainfall events with an overall increasing trend in rainfall of about 0.8 mm per year over the past 50 years (Phi, 2008). The phenomena of heavy rainfall and related inundation may cause negative effects on residents' health, especially intestinal infectious illness due to the possible distribution of infectious agents following heavy rainfall and related floods. However, investigation of the relationship between heavy rainfall and adverse health effects in the context of climate change has seldom been conducted, resulting in a lack of understanding of the potential future impacts associated with increasing extreme rainfall events and hence a lack of evidence for developing appropriate strategies to reduce health risks in this the largest city in Vietnam.

This study examines the association between heavy rainfall events and hospital admissions for intestinal infectious diseases in HCMC, Vietnam.

2. Methods

The study design incorporates interrupted time-series and meta-analysis methods using daily rainfall and hospital admission data.

2.1. Study area

The study was conducted in Ho Chi Minh City (HCMC). HCMC is located in southern Vietnam, about 1730 km from the capital city, Hanoi. HCMC has a total area of 2095.5 km², including 19 urban and 5 suburban districts and a total population of 8,224,400 8.4% of the population of Vietnam and a population density of 3900 persons/km² (HCMC So, 2016). HCMC has a tropical climate with an average annual rainfall of 1800 mm (about 150 rainy days per year). It has two distinct seasons: the rainy season (May–October) and the dry season (December–October). The average temperature is 28 °C, and the average humidity is 78–82% (ADB, 2014). Supplement 1 shows a photo of flooding in HCMC after a heavy rainfall event. In the South-East region, where HCMC is located, infectious and parasitic diseases are leading causes of morbidity with 10.5% of hospital admissions, and of mortality with 13.1% of admissions (HSY, 2013). Of these diseases, Norovirus (NoV) is a leading cause of acute infectious intestinal disease among children <5 years old. It has been estimated that 20.6% of children hospitalized with acute diarrhoea in Ho Chi Minh City tested positive for NoV (Phan et al., 2013). Recent studies have shown that diarrhoeal diseases remain a considerable public health problem in HCMC and these diseases are associated with seasonality and climatic conditions such as flooding, air temperature, and humidity (Thompson et al., 2015a; Thompson et al., 2015b).

HCMC has a total of 72 hospitals that are classified by level (national, city, and district) and speciality (general or multi-faculty, and specialized hospitals e.g. paediatric hospital).

2.2. Data collection

Data on hospital admissions for intestinal diseases (ICD-10 codes: A00–A09) were extracted from hospital admission records from February 2004 to December 2013 in the two largest hospitals in HCMC, Gia Dinh People's Hospital and 115 People's Hospital. These hospitals, which have 1200 and 1600 patient beds respectively, were selected from four big multi-faculty hospitals in HCMC. These hospitals are at the highest level of public multi-faculty hospitals administered by the HCMC Health Department and serve patients from all districts across HCMC with 1000–2000 inpatients daily. These hospitals also serve people outside of the city in case of emergency or for self-funded services.

Data extracted from the hospital admissions were categorized by primary and discharge diagnoses, date of admission, date of discharge, age, sex, and address of individual patients (street and district only). The authors selected A00–A09 codes rather than the symptoms' or non-specific codes for two reasons. First, symptoms are not specific to intestinal diseases only. Second, patients sometime tend to self-treat and don't go to hospitals if they just have symptoms, since in Vietnam people can buy medicine in pharmacies without a doctor's prescription. Thus, we would miss all of these cases if we considered symptoms as the outcome of the study. In this study, the authors included only residents of HCMC and excluded all cases who were not HCMC residents or who were transferred from hospitals located in other cities/provinces. The address described in the hospital records was used for this purpose.

Daily meteorological data were collected from the Southern Regional Hydro-Meteorological Centre (SRHMC) for the February 2004 to December 2013 period. The data were recorded from one hydro-meteorological station located in the central district of HCMC (longitude, 106°39'59.75 East; latitude, 10°47'47.48 North), the Tan Son Hoa Meteorological station, which monitors air temperature, surface temperature, humidity, precipitation, sunlight hours, wind direction and speed, cloud and other climatic conditions. The data are managed by SRHMC as the lead agency for hydro-meteorological information in the South of Vietnam. The data collected for this study, comprised: daily minimum, maximum, and average temperatures (°C) and minimum, maximum and average relative humidity (%), and daily cumulative rainfall (mm).

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