Quantifying the Impact of Floods on Bacillary Dysentery in Dalian City, China, From 2004 to 2010

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ABSTRACT

Objective: Studies quantifying relationships between floods and diarrheal diseases have mainly been conducted in low-latitude regions. It's therefore increasingly important to examine these relationships in midlatitude regions, where they may have significant public health implications. This study aimed to examine the association between floods and bacillary dysentery in the city of Dalian, China.

Methods: A generalized additive mixed model was applied to examine the association between floods and bacillary dysentery. The relative risk (RR) of flood impact on bacillary dysentery was estimated.

Results: A total of 18,976 cases of bacillary dysentery were reported in Dalian during the study period. Two weeks' lagged effect was detected from the impact of floods on bacillary dysentery. The RR of flood impact on bacillary dysentery was 1.17 (95% CI: 1.03-1.33).

Conclusions: Floods have significantly increased the risk of bacillary dysentery in Dalian. More studies should focus on the association between floods and infectious diseases in different regions. Our findings have significant implications for managing the negative health impact of floods in the midlatitude region of China. (*Disaster Med Public Health Preparedness*. 2017;11:190-195)

Key Words: floods, bacillary dysentery, generalized additive mixed model, relative risk

Floods have been recognized as the most frequent and devastating type of natural disaster worldwide, and are responsible for almost half of the victims of all natural disasters.[1] Because of rising sea levels and frequent extreme precipitation events, flooding events are expected to increase in frequency and intensity. Floods are also recognized as the most serious natural disasters in China; they cause considerable economic losses and serious damages to towns and farms, affecting people's lives and productivity.[2] Dalian, an important city with abundant precipitation and numerous rivers in northern China, encountered several floods between 2004 and 2010 because of water and soil losses, riverbed elevation, and damage to water conservancy facilities in the area.[3,4] The characteristics of floods and their significant health impacts on human beings have been examined over the last decade. It has been argued that floods will increase the global burden of diseases and will place continuous stresses on public health service system.[5] For instance, exacerbation of diarrheal diseases following floods has been observed in some African countries, Bangladesh, and Indonesia.[6-8] Bacillary dysentery, as a type of diarrheal diseases, remains a major public health problem worldwide, especially in developing countries.[9] Public infrastructures including water supply systems and sewerage-disposal systems can be adversely affected during flooding. Contaminants can be washed into water sources, deteriorating water quality and increasing the transmission of enteric pathogens.[10] Therefore, the possibility of bacillary dysentery (a waterborne disease) transmission could be increased when flooding occurs. China has made rapid socioeconomic progress over the past decade. However, bacillary dysentery, which has a high relapse rate, still seriously threatens the health of people in general.[11] The annual average incidence of bacillary dysentery was 28.79 per 100,000, ranking it fourth among notified infectious diseases from 2002 to 2010 in China.[12] In Dalian, the annual average incidence of bacillary dysentery was 25.96-69.54 per 100,000, ranking it second among notified diseases from 2006 to 2010.[13]

The health impacts of floods on human being are complex and far-reaching. Quantitative studies have been conducted to explore relationships between floods and diarrheal diseases, cholera, typhoid, and paratyphoid fever.[7,8,14-16] However, these studies have been conducted mainly in the low-latitude areas with higher annual average temperature. According to the Fifth Assessment Report of the United Nations Intergovernmental Panel on Climate Change, extreme precipitation events and major flooding are increasing in frequency and becoming greater in magnitude.[17] Therefore, it's necessary to quantify the risk of infectious diseases caused by floods in midlatitude regions, which will have significant public health implications. Some researchers have analyzed monthly data to assess the effects of floods on dysentery in China.[18,19] However, monthly data have limitations, such that they are not able to reflect the effects of floods on dysentery accurately. Drawing on a 7-year (from 2004 to 2010) record of weekly bacillary dysentery cases and flood data in Dalian, our study aimed to explore the association between floods and bacillary dysentery in the midlatitude region in China.

METHODS

Background Information

The study was conducted in Dalian, a coastal city in the southern part of northeastern China. Figure 1 shows the geographic position of Dalian. It's located between latitude 38°43′ and 40°10′N and longitude 120°58′ and 123°31′E. This geographic location of the city is characterized by a warm, temperate, continental monsoon climate with an annual average temperature of 10.4°C and an annual average rainfall of 687.7 mm.[20] The area of Dalian covers 13,399.8 square kilometers. In 2010, the population of Dalian was 6.69 million.

Data Collection

Surveillance Data

Weekly disease surveillance data on bacillary dysentery from January 2004 to December 2010 for Dalian were obtained from the National Notified Disease Surveillance System.[21] In our study, all bacillary dysentery cases were diagnosed according to diagnostic criteria and principles of management for bacillary dysentery (GB 16002-1995) issued by the Ministry of Health of China.[22] Only the cases confirmed by clinical laboratory tests, including microscopic examination and biochemical identification, were included in our study. In China, a direct network reporting system for infectious diseases was established in 2004. The local health authority must report statutory category A, B, and C notified infectious diseases through the system within 2, 24, and 24 hours respectively.[23] Bacillary dysentery is a statutory category B notified infectious disease in China. According to the National Communicable Disease Control Act, physicians in hospitals are required to report every case of bacillary dysentery to the local Center for Disease Control and Prevention. Then, the local health authorities must report these cases to their upper level authorities within 24 hours. Therefore, it is believed that the degree of compliance in disease notification over the study period was consistent.

Data on Floods

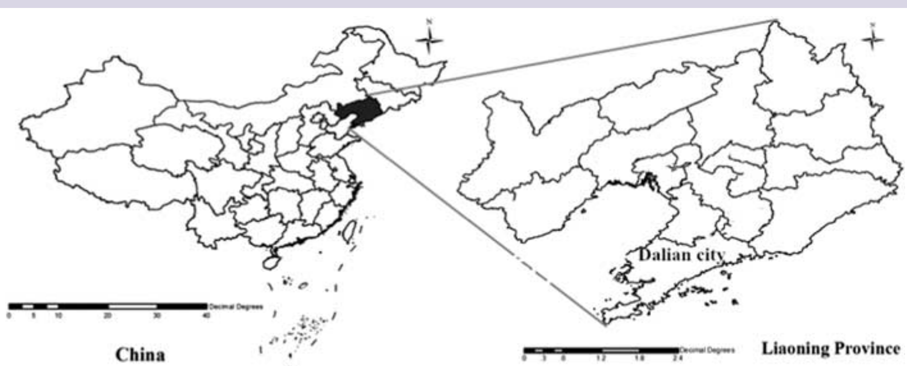
According to the *Yearbooks of Meteorological Disasters in China*, the definition of flooding is a natural disaster resulting from the rivers overflowing because of short-term heavy precipitation, which leads to farmland and cities submerged, casualties, and economic losses.[3] The yearbooks record detail information of floods, including dates, affected cities, and economic losses. According to the yearbooks, there were 9 flood events recorded in Dalian from 2004 to 2010.[3]

Meteorological and Demographic Data

Weekly meteorological data from January 2004 to December 2010 were collected from the China Meteorological Data Sharing Service System (http://cdc.cma.gov.cn/).[24] The meteorological variables in this study included weekly average temperature, weekly average relative humidity, weekly cumulative sunshine duration, and weekly average air pressure. Demographic data for Dalian were obtained from

FIGURE 1

Location of Study Area in Liaoning Province, China.



The study area covers Dalian, a coastal city in the southern part of Northeast China. It's located between latitude 38°43′ and 40°10′N and longitude 120°58′ and 123°31′E. It has a warm, temperate, continental monsoon climate with average annual temperature of 10.4°C and average annual rainfall of 687.7 mm. There are 7 cities and counties, with a total land area of 13,399.8 square kilometers and a population of about 6.69 million in Dalian.

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the Center for Public Health Science Data in China (http://www.phsciencedata.cn/).[25]

Statistical Analysis

Firstly, a descriptive analysis was performed to describe the distribution of weekly bacillary dysentery morbidity and meteorological factors from 2004 to 2010 in Dalian. Spearman's correlation was utilized to examine the association between floods, climatic variables, and the weekly morbidity of bacillary dysentery with various lagged values. According to the reproducing of pathogen and the incubation period of bacillary dysentery, a time lag of 0-4 weeks was considered in this study. The lagged value with the maximum correlation coefficient for each variable was included in the subsequent regression analysis.

The generalized additive model (GAM) is a flexible and effective technique for conducting nonlinear regression analysis in time-series studies with a Poisson regression.[26] It allows Poisson regression to be fit as a sum of nonparametric smooth functions of predictor variables. The GAM has been widely applied to study relationships between air pollution, heat waves, and mortality, because it allows nonparametric adjustment for nonlinear confounding effects such as seasonality, trends, and weather variables.[27-29] In our study, the Poisson regression, using a generalized additive mixed model (GAMM), was applied to analyze the relationship between floods and bacillary dysentery with adjustment for the multiple lag effects of weather variables. The GAMM is an extension of the GAM. The GAMM allowed the parametric and nonparametric functions to be analyzed together in the model. Therefore, there are better strengths in applying the GAMM compared with the GAM. The values and confidence interval of relative risks (RRs) of floods on bacillary dysentery were evaluated with the natural logarithms of corresponding parameters in the GAMM. The regression model was described as follows:

$$\text{Log}\,(\text{E}[\text{Y}_t]) = \beta_0 + \beta_1\,(\text{floods}) + \text{S}_1\,(\text{temperature})$$
$$+ \text{S}_2\,(\text{humidity}) + \text{S}_3\,(\text{sunshine duration})$$
$$+ \text{S}_4\,(\text{air pressure}) + \text{S}_5\,(\text{t}) + \sin\,(2\pi\text{t}/52)$$

Y_t denoted the weekly number of bacillary dysentery at time t, which represented the specific week. Floods were a categorical variable including nonflood and flood weeks endowed by 0 and 1 respectively. S_1 (temperature), S_2 (humidity), S_3 (sunshine duration), and S_4 (air pressure) were smooth functions of weekly average temperature, weekly average relative humidity, weekly cumulative sunshine duration, and weekly average air pressure, respectively, which were designed to control the effects of meteorological factors. The smooth spline of specific week was projected as $S_5(t)$ to avoid the influence of secular trend. The proposed model included a triangular function, $\sin(2\pi t/52)$, to control the effects of seasonality on bacillary dysentery.[30] We adjusted the multiple lag effects of meteorological variables, secular trend, and seasonality, and then analyzed the association between floods and bacillary dysentery. The statistical analyses were performed by using SPSS18.0 (SPSS Inc, Chicago, IL) and R3.1.1 (MathSoft Inc, Vienna, Austria).

RESULTS

Descriptive Analysis for Bacillary Dysentery and Meteorological Factors

A total of 18,976 cases of bacillary dysentery were notified in the study area during the study period. Weekly numbers of bacillary dysentery cases varied from 7 to 211, with an average weekly morbidity of 0.87 per 100,000 from 2004 to 2010. Table 1 shows the weekly bacillary dysentery morbidity and meteorological factors of Dalian during the study period.

Spearman's Correlation Analysis

Table 2 shows the results of Spearman's correlation test performed to determine the relationship between the weekly morbidity of bacillary dysentery and explanatory variables during the study periods.

The results indicated that floods ($r = 0.182$, $P < 0.05$), weekly average temperature ($r = 0.790$, $P < 0.05$), weekly average relative humidity ($r = 0.603$, $P < 0.05$), and weekly cumulative sunshine duration ($r = 0.118$, $P < 0.05$) were positively correlated to the weekly morbidity of bacillary dysentery, with 2, 3, 1, and 4 weeks lagged respectively. The weekly average air pressure ($r = -0.724$, $P < 0.05$) was negatively

TABLE 1

Description of Weekly Bacillary Dysentery Morbidity and Meteorological Variables From 2004 to 2010 in Dalian

Variables	Mean ± SD	Min	P_{25}	Median	P_{75}	Max
Weekly morbidity of bacillary dysentery, 1 * 10^5	0.87 ± 0.64	0.12	0.41	0.66	1.13	3.56
WAT, °C	11.51 ± 10.10	−10.54	2.08	12.86	21.11	27.36
WARH, %	66.92 ± 14.30	32.57	55.64	66.00	78.25	97.14
WCSD, h	48.42 ± 13.97	10.70	38.63	48.55	56.88	86.60
WAAP, hPa	1005.57 ± 8.13	989.20	998.83	1006.15	1012.28	1026.10

Abbreviations: SD, standard deviation; Min, minimum; P_{25}, 25th percentile; P_{75}, 75th percentile; WAT, weekly average temperature; WARH, weekly average relative humidity; WCSD, weekly cumulative sunshine duration; WAAP, weekly average air pressure.

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TABLE 2

Correlations Between the Weekly Morbidity of Bacillary Dysentery and Meteorological Variables in Dalian From 2004 to 2010

Variables	Lag, wk	*r*	*P*
Floods	0	0.140	<0.05
	1	0.160	<0.05
	2	0.182	<0.05
	3	0.153	<0.05
	4	0.173	<0.05
WAT	0	0.765	<0.05
	1	0.783	<0.05
	2	0.788	<0.05
	3	0.790	<0.05
	4	0.781	<0.05
WARH	0	0.599	<0.05
	1	0.603	<0.05
	2	0.520	<0.05
	3	0.580	<0.05
	4	0.593	<0.05
WCSD	0	–0.056	0.285
	1	–0.024	0.652
	2	0.010	0.847
	3	0.049	0.354
	4	0.118	<0.05
WAAP	0	–0.547	<0.05
	1	–0.608	<0.05
	2	–0.645	<0.05
	3	–0.690	<0.05
	4	–0.724	<0.05

Abbreviations: WAT, weekly average temperature; WARH, weekly average relative humidity; WCSD, weekly cumulative sunshine duration; WAAP, weekly average air pressure.

TABLE 3

Parameter Coefficients From the Generalized Additive Mixed Model for Bacillary Dysentery Disease[a]

Variables	Coefficients	Standard Error	*P*	RR (95% CI)
Intercept	–11.845	0.01546	<0.01	—
Floods	0.15751	0.06333	0.01336	1.17 (1.03-1.33)
Sin(2πt/52)	–0.10767	0.03677	0.00364	—

Abbreviations: RR, relative risk; CI, confidence interval.
[a]Adjusted R^2 of the model was 0.859.

correlated with the weekly morbidity of bacillary dysentery with 4 weeks lagged. The lagged effects of all these climatic variables were included in the subsequent regression analysis.

Regression Analysis

The parameters of the models and RRs of floods on the risk of bacillary dysentery are presented in Table 3. After controlling for meteorological factors, secular trend, and seasonality, the results indicated that floods were significantly associated with the morbidity of bacillary dysentery (coefficients: 0.157). Floods were significantly associated with an increased risk of bacillary dysentery in Dalian (RR = 1.17, 95% CI: 1.04-1.33).

DISCUSSION

Our study, for the first time, has quantified the association between floods and bacillary dysentery in Dalian, China, drawing on longitudinal data from 2004 to 2010. The results confirmed that floods play an important role in bacillary dysentery epidemics and may bring an increase of more than 17% in bacillary dysentery cases following flooding in Dalian. Although the study is based on only 1 city in China, the real health impact of bacillary dysentery due to floods will be larger than the estimate in this study, given the much larger population at risk in the midlatitude region. Quantifying the effect of floods on bacillary dysentery has significant implications for policy making and strategy developing in bacillary dysentery control after flooding in the midlatitude region.

The multiple environmental consequences of floods can directly affect the health of people in general. During the initial stage of floods, heavy precipitation may cause changes in the environment and lead to rapid reproduction and fast growing of pathogens.[7] Excessive or heavy rainfall could mobilize the pathogens and transport them into rivers, coastal waters, and wells.[31] Therefore, floods would probably adversely affect local water quality. In addition, water treatment plants may be overwhelmed during heavy rainfall. Cross-contamination between sewage and drinking-water pipes and sewage overflowing or bypassing into local waterways probably happens.[32] Waterborne outbreaks of diarrheal diseases after floods can be caused by the contamination of water due to the disruption of purification and sewage disposal systems.[33] Therefore, there is a potential for increased fecal-oral transmission of bacillary dysentery due to the lack of clean water and sanitation. A study conducted in India found that the chlorine level of water was associated with prevalence of viral hepatitis in flood-affected areas.[34] Contaminated water could be indirectly ingested by people in different ways during the flood period. For example, contaminated water could be added directly as an ingredient during cooking. It has also been reported that refugees used contaminated water to clean plates and fruits directly, increasing the transmission of pathogens.[18]

The risk of infectious diseases after natural disasters such as floods is often event specific. It also depends on a number of factors, including the type of disaster, the impact of the disaster on water and sanitation systems, the availability of shelter, the congregating of displaced persons, and the availability of health care services.[31] Inappropriate emergency preparedness combined with backward surveillance programs for the detection of disease may increase the risk of infectious disease after flood. Some potential risks for the transmission of communicable diseases are usually ignored by people during the flood period. In most cases, disinfection is usually

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restricted to drinking water and domestic uses such as bathing are not in consideration. However, exposure to floodwater, such as swimming in contaminated surface waters, could be an important risk factor for contracting infectious diseases.[18] Furthermore, subsequent impacts, including power shortage, heavy population displacement, and subsequent fecal-oral spread of gastrointestinal pathogens, caused by flooding may also contribute to the occurrence and spread of diarrheal diseases.[35] The flood-displaced people usually were forced to stay in temporary shelters without adequate basic sanitation facilities. The sanitation situation could be exacerbated by overcrowding, which might increase the transmission of bacillary dysentery.

CONCLUSIONS

In conclusion, this study has quantified the effects of floods on bacillary dysentery, showing that floods could significantly increase the risk of bacillary dysentery epidemic. Our findings have significant implications for developing strategies to prevent bacillary dysentery transmission, and to reduce negative health impact of floods in the midlatitude region of China.

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REFERENCES

1. EM-DAT. Disaster profiles. The OFDA/CRED International Disaster Database [database online]. http://www.emdat.be/database. Published 2011. Accessed September 20, 2011.
2. Wang JH, Jiang D, Chen CY. The study of flood law in China [in Chinese]. *J Catastrophol*. 1999;14:36-40.
3. China Meteorological Administration. *The Yearbook of Meteorological Disasters in China* [in Chinese]. Beijing, China: China Meteorological Press; 2004-2010.
4. Zhang SF, Jiang Y, Dong RM. Analysis on waterlog and causes of waterlog in Liaoning Province [in Chinese]. *Liaoning Agric Sci*. 2006;1:16-18.
5. Alderman K, Turner LR, Tong S. Floods and human health: a systematic review. *Environ Int*. 2012;47:37-47.
6. Abaya SW, Mandere N, Ewald G. Floods and health in Gambella region, Ethiopia: a qualitative assessment of the strengths and weaknesses of coping mechanisms. *Glob Health Action*. 2009;2. http://dx.doi.org/10.3402/gha.v2i0.2019.
7. Schwartz BS, Harris JB, Khan AI, et al. Diarrheal epidemics in Dhaka, Bangladesh, during three consecutive floods: 1988, 1998, and 2004. *Am J Trop Med Hyg*. 2006;74:1067-1073.
8. Vollaard AM, Ali S, van Asten HA, et al. Risk factors for typhoid and paratyphoid fever in Jakarta, Indonesia. *JAMA*. 2004;291:2607-2615.
9. Kosek M, Bern C, Guerrant RL. The global burden of diarrhoeal disease, as estimated from studies published between 1992 and 2000. *Bull World Health Organ*. 2003;81:197-204.
10. Parker DJ, Thompson PM. Floods in Africa: vulnerability, impacts and mitigation. *Floods*. London: Routledge; 2000:188-203.
11. Wang XY, Tao FB, Xiao DL, et al. Trend and disease burden of bacillary dysentery in China (1991-2000). *Bull World Health Organ*. 2006;84:561-568.
12. Gao FH, Feng JQ, Jiang LF, et al. Analysis of legal infectious diseases epidemic situation from 2002 to 2010 in mainland China [in Chinese]. *Mod Prev Med*. 2013;40:756-761.
13. Zhou YH, Lin Q. Epidemic analysis of shigellosis in Dalian city in Liaoning province, 2006-2010 [in Chinese]. *Dis Surveill*. 2011;26:618-619.
14. Waring SC, Reynolds KM, D'Souza G, et al. Rapid assessment of household needs in the Houston area after Tropical Storm Allison. *Disaster Manag Response*. 2002;3-9.
15. Korthuis PT, Jones TR, Lesmana M, et al. An outbreak of El Tor cholera associated with a tribal funeral in Irian Jaya, Indonesia. *Southeast Asian J Trop Med Public Health*. 1998;29:550-554.
16. Heller L, Colosimo EA, Antunes CM. Environmental sanitation conditions and health impact: a case-control study. *Rev Soc Bras Med Trop*. 2003;36:41-50.
17. Taylor J, Lai KM, Davies M, et al. Flood management: prediction of microbial contamination in large-scale floods in urban environments. *Environ Int*. 2011;37:1019-1029.
18. Ni W, Ding GY, Li YF, et al. Impacts of floods on dysentery in Xinxiang city, China, during 2004–2010: a time-series Poisson analysis. *Glob Health Action*. 2014;7:23904.
19. Ni W, Ding GY, Li YF, et al. Effects of the floods on bacillary dysentery in north central region of Henan Province, China from 2004 to 2009. *J Infect*. 2014;69:430-439.
20. Cui LF. *Climate Change of Dalian City in Recent 50 Years and Assessment of Adaptation* [in Chinese]. Dalian, China: Liaoning Normal University; 2012.
21. National Notified Disease Surveillance System. The statutory infectious diseases report database [in Chinese]. http://www.phsciencedata.cn/Share/index.jsp. Published 2011. Accessed October 10, 2014.
22. State Bureau of Technical Supervision of China. Ministry of Health of the People's Republic of China. Diagnostic criteria and principles of management of bacillary and amebic bacillary dysentery [in Chinese]. Beijing, China; Standards Press of China; 1995. GB 16002-1995.
23. Ministry of Health of the People's Republic of China. Emergency events and regulation of the notifiable disease surveillance system [in Chinese]. http://www.moh.gov.cn/mohzcfgs/pgz/200901/38689.shtml. Published 2006. Accessed October 11, 2014.
24. China Meteorological Data Sharing Service System. Chinese surface climate data set of daily data [in Chinese]. http://cdc.cma.gov.cn/. Published 2011. Accessed January 10, 2014.
25. Center for Public Health Science Data in China. Population database of network reporting system for infectious diseases [in Chinese]. (http://www.phsciencedata.cn/. Published 2011. Accessed June 10, 2014.

26. Wood SN. Stable and efficient multiple smoothing parameter estimation for generalized additive models. *J Am Stat Assoc*. 2004;99: 673-686.
27. Schwartz J. Air pollution and hospital admissions for the elderly in Birmingham, Alabama. *Am J Epidemiol*. 1994;139:589-598.
28. Hertel S, Le Tertre A, Jockel KH, et al. Quantification of the heat wave effect on cause-specific mortality in Essen, Germany. *Eur J Epidemiol*. 2009;24:407-414.
29. Sarnat JA, Schwartz J, Suh HH. Fine particulate air pollution and mortality in 20 U.S. cities. *N Engl J Med*. 2001;344:1253-1254.
30. Singh RB, Hales S, de Wet N, et al. The influence of climate variation and change on diarrheal disease in the Pacific Islands. *Environ Health Perspect*. 2001;109:155-159.
31. Ivers LC, Ryan ET. Infectious diseases of severe weather related and flood-related natural disasters. *Curr Opin Infect Dis*. 2006;19: 408-414.
32. Semenza JC, Nichols G. Cryptosporidiosis surveillance and water-borne outbreaks in Europe. *Euro Surveill*. 2007;12:13-14.
33. Baqir M, Sobani ZA, Bhamani A, et al. Infectious diseases in the aftermath of monsoon flooding in Pakistan. *Asian Pac J Trop Biomed*. 2012;2:76-79.
34. Shaikh MG, Majumdar VS. Chlorination level of water and prevalence of viral hepatitis in flood affected areas of Vadodara, India. *Clin Chem Lab Med*. 2011;49:S541.
35. Kunii O, Nakamura S, Abdur R, et al. The impact on health and risk factors of the diarrhoea epidemics in the 1998 Bangladesh floods. *Public Health*. 2002;116:68-74.