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ORIGINAL RESEARCH

Incidences of Waterborne and Foodborne Diseases After Meteorologic Disasters in South Korea

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Abstract

BACKGROUND Climate change could increase the number of regions affected by meteorologic disasters. Meteorologic disasters can increase the risk of infectious disease outbreaks, including waterborne and foodborne diseases. Although many outbreaks of waterborne diseases after single disasters have been analyzed, there have not been sufficient studies reporting comprehensive analyses of cases occurring during long-term surveillance after multiple disasters, which could provide evidence of whether meteorologic disasters cause infectious disease outbreaks.

OBJECTIVES This study aimed to assess the nationwide short-term changes in waterborne and foodborne disease incidences after a meteorologic disaster.

METHODS We analyzed cases after all 65 floods and typhoons between 2001 and 2009 using the Korean National Emergency Management Agency's reports. Based on these data, we compared the weekly incidences of *Vibrio vulnificus* septicemia (VVS), shigellosis, typhoid fever, and paratyphoid fever before, during, and after the disasters, using multivariate Poisson regression models. We also analyzed the interactions between disaster characteristics and the relative risk of each disease.

FINDINGS Compared with predisaster incidences, the incidences of VVS and shigellosis were 2.49-fold (95% confidence interval, 1.47-4.22) and 3.10-fold (95% confidence interval, 1.21-7.92) higher, respectively, the second week after the disaster. The incidences of VVS and shigellosis peaked the second week postdisaster and subsequently decreased. The risks of typhoid and paratyphoid fever did not significantly increase throughout the 4 weeks postdisaster. The daily average precipitation interacted with VVS and shigellosis incidences, whereas disaster type only interacted with VVS incidence patterns.

CONCLUSIONS The incidences of VVS and shigellosis were associated with meteorologic disasters, and disaster characteristics were associated with the disease incidence patterns postdisaster. These findings provide important comprehensive evidence to develop and support policies for managing and protecting public health after meteorologic disasters.

KEY WORDS waterborne diseases, foodborne diseases, communicable diseases, disasters, Republic of Korea

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INTRODUCTION

The Intergovernmental Panel on Climate Change's Fifth Assessment Report projected that climate change could increase the number of regions with heavy precipitation and risk of flooding on a regional scale.[1] Increased urbanization and subsequent reduction in vegetation, agricultural lands, and low-lying areas can also increase meteorologic disaster severity.[2,3] The potential magnitude and extent of the effects of meteorologic disasters on various economic sectors suggest that governments should establish ways to proactively combat the negative impact, including preventive measures or a monitoring system. To that end, a quantitative assessment of the effects on the national incidences of infectious diseases may help predict the effects of future climate change–induced meteorologic disasters. Furthermore, possible effects of climate change on human health may influence the public's perception of these issues and greenhouse gas reduction policies. However, very few studies have quantitatively assessed the effects of meteorologic disasters on public health.[4-6]

Meteorologic disasters can directly cause death or injury, and they can also increase infectious disease outbreaks by weakening a community's health delivery capabilities and changing the hygienic environment.[7-10] There have been numerous reported instances of changes in infectious disease prevalence after meteorologic disasters, such as after the 2004 Bangladesh flood, when >350,000 patients experienced diarrhea after being infected with *Escherichia coli*, *Shigella*, or *Vibrio cholerae*.[11] The number of patients with diarrhea also increased after the December 2004 tsunami in Thailand.[12] Furthermore, a cholera outbreak was observed in Haiti after the 2010 earthquake; this outbreak was enhanced by water contamination that was related to heavy rainfall.[13] Similar effects have also been observed in developed countries, such as increases in *Vibrio vulnificus* septicemia (VVS) cases and norovirus infections after Hurricane Katrina (in the United States), in addition to the increased incidence of gastrointestinal illness after a flood in Massachusetts.[14-16]

Thus, it is clear that meteorologic disasters may significantly affect infectious disease outbreaks in specific regions, although nationwide effects of meteorologic disasters cannot be easily quantified using the data in those reports. Infectious disease incidence can be linked to regional sanitation and health response capabilities.[17] which further complicates analysis at a national level. Although specific meteorologic disasters in isolated regions may provide general evidence of the need for coordinated responses, they provide insufficient data for designing national response strategies and determining the appropriate resource investment. Therefore, national, long-term, and comprehensive assessments of numerous meteorologic disasters and their effects on national health are needed to develop national climate change policies and health response measures.

Among the available nationwide studies, Curriero et al[18] analyzed American meteorologic disasters from 1948-1994 and reported that disasters were related to infectious disease outbreaks. Thomas et al[19] also analyzed meteorologic disasters over a 27-year period in Canada, using the same method, and reported that disasters may be a risk factor for infectious disease outbreaks. In addition, Ni et al[6] analyzed floods that occurred in 3 Chinese cities between 2004 and 2009 and found that the number of patients with diarrhea increased by 66% after each flood. Although these studies could inform public policy, their findings were limited in terms of the specific regional characteristics or specific disease. Because various waterborne infectious diseases (eg, cholera, VVS, shigellosis, typhoid fever, and paratyphoid fever) that are related to meteorologic disasters have different transmission methods and latency periods, it is necessary to individually analyze each disease.[9]

When formulating policies to prevent infectious diseases and making appropriate quarantine arrangements for exposed patients, it is not sufficient to examine individual meteorologic disasters and their related epidemics. In addition, because each individual meteorologic disaster is associated with varied regional conditions, such as the affected population, urbanization, natural environment, or public health capacity, analysis of individual disasters does not provide enough evidence to support changes in public policy. Public policy should be informed by knowledge of how infectious disease incidence increases after a disaster and what conditions can influence this incidence. Therefore, a comprehensive long-term analysis of various infectious diseases, their specific incidences, regional effects, and other related factors is urgently needed. By identifying the infectious diseases that are associated with meteorologic disasters within administrative regional units, it would then be possible to compile information regarding the factors that can increase or decrease their incidences. Thus, we