Assessing Long-Term Climatic Change on Mortality Patterns in Marginal Communities in Gansu China

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Abstract
China has been the fastest growing economy for the past two decades, and is routinely criticized about how this economic prowess comes at the cost of the health and well-being of its populace. Yet, while NGOs and other nations scrutinize how China’s rapid industrialization leads to detrimental environmental degradation for the rest of the world, very little attention has been given to understanding how long-term changes in environmental conditions jeopardizes the lives of vulnerable people living in marginalized areas in China’s poor interior provinces. In this study, we assess how long-term climatic change (drought) impacted mortality for 30 years in communities located in China’s interior province of Gansu. We find that cold temperature, hot temperature, low humidity, high humidity and high diurnal temperature range are related to increased mortality. Expectantly, young and elderly age groups are adversely impacted by long-term climatic changes. However, our results indicate that women’s mortality patterns are much more susceptible to cold and high humidity, suggesting that research is needed to identify mechanisms and biases that compromise women’s well-being in vulnerable communities.

Methods
We combined three meteorological measures of mean temperature (Tm), diurnal temperature range (DTR) and relative humidity (RH) collected daily between Jan 1970 to Dec 31 2009 and death records from Jan 2004 to Dec 31 2009 to highlight how climate change impacted mortality patterns among vulnerable people living in Baiyin (sub-arid), Minqin (arid), and Tianshui (sub-humid) counties in Gansu. Using analytic methods such as distributed lag non-linear model (DLNM) combined with generalized additive model (GAM), a natural cubic spline-natural cubic spline, a double threshold-natural cubic spline, and a high threshold-natural cubic spline to assess non-linear and delayed effects of Tm, DTR and RH, we assess the impact of these factors across non-extreme mortality, age-specific non-extreme mortality (+65 (D65), 65-74 (D45-74), and >75 years (D75)), on gender-specific mortality, and cause-specific mortality (circulatory disease (Dc) and respiratory disease (Dr)).

Research Setting: China -- Gansu Study Sites

China

- Drought is a serious issue in China, with over half of the land mass composed of arid and semi-arid areas.
- 90% of the land in China is located in the northwest, most of this land is arid and semi-arid areas with low levels of precipitation.
- Drought causes extensive problems. About 80% of the loss of grains is attributed to climatic causes, with 50% of this damage due to drought.
- Gansu is in northwest China. It is connected to the “Grain Train” network. Much of Gansu is composed of plains and mountains rising over 1000 meters in intersection. The Badu and Tengger deserts form Gansu’s northern border.
- In recent years, excessive exploration of groundwater, desertification of the ground, water loss and soil erosion, groundwater deterioration and water scarcity, and the increased number of the diseases of deteriorated climatic conditions.
- These climatic changes and the effects of human activities combine to promote severe health problems, including physical, and psychological stress and increased disease burden.

Comparisons of Research Site Characteristics

Geographic Characteristics of Three Study Sites

- Location
- Maximum temperature
- Minimum temperature
- Average diurnal temperature range
- Average precipitation

Comparisons of Health Services and Economic Development in 2007

- Indicators
- Minqin County
- Jingtai County
- Baiyin County
- Tianhuan County

Results

Analytic Data Sources

- Health surveillance data from local CDC (2004-2010)
- Infectious surveillance data from local CDC (2005-2010)
- Health service data from the Health Yellow Book
- Social economic data from the Statistical Year Book
- Climatic data: meteorological reports for Gansu (1970-2009)

Implications

- Based on Attributable Risk (AR) rankings, the top ten illnesses that most impact human health under drought conditions are malignant tumors, injury and poisoning, respiratory infections, diarrhea, infectious diseases, neurological diseases, chronic obstructive pulmonary diseases, bacterial enteritis, HIV/AIDS, and COPD. This means that these five types of illnesses have higher impact on human lives in long duration drought and drought-prone environments.

In comparing disease burden using PYLL, CELE, and PYLLR, our study found that the CELE of circulating system diseases is the greatest. This indicates that the greatest impact on the exposed life (PYLL), is a direct measurement index of burden of disease, which represents the amount of the total caused by diseases. PYLLR is the manifestation of per capita life expectancy loss. However, it can not reflect the association between early death and diseases. CELE is highly related to the association between early death and diseases and where variation is in others to each other, gender and region. In this study, the disease burden of respiratory diseases and diarrheal diseases are the highest.

Conclusion

We conclude with a few policy suggestions for improving human health in drought conditions and drought prone areas. We recommend that studies and policies aimed at understanding and improving human health enhance the development of chronic diseases surveillance systems and cancer surveillance systems, established protocols for registering its health, mortality, and morbidity information. If possible, efforts should be made to expand the scope of registration and maintaining a low-cost surveillance to create an information database that more thoroughly captures morbidity, chronic diseases, and death. These initiatives would also help to identify the responsibilities of medical organizations and personnel, allowing researchers and healthcare professionals assess and improve the quality of life and the health and chronic diseases surveillance.