

## Epidemiology for public health practice: The application of spatial epidemiology

Longjian Liu, Garvita Nagar, Ousmane Diarra, Stephanie Shosanya, Geeta Sharma, David Afesumeh, Akshatha Krishna

**Specialty type:** Health care sciences and services

**Provenance and peer review:** Invited article; Externally peer reviewed.

**Peer-review model:** Single blind

**Peer-review report's scientific quality classification**

Grade A (Excellent): A, A  
Grade B (Very good): B  
Grade C (Good): C, C  
Grade D (Fair): D  
Grade E (Poor): 0

**P-Reviewer:** Aslam MS, Malaysia; Fakhradiyev I, Kazakhstan; Harsini PA, Iran; Kadriyan H, Indonesia; Mohammadi A; Welter J, Switzerland

**Received:** February 12, 2022

**Peer-review started:** February 12, 2022

**First decision:** April 17, 2022

**Revised:** May 5, 2022

**Accepted:** June 22, 2022

**Article in press:** June 22, 2022

**Published online:** July 15, 2022



**Longjian Liu, Garvita Nagar, Ousmane Diarra, Stephanie Shosanya, Geeta Sharma, David Afesumeh, Akshatha Krishna,** Epidemiology and Biostatistics, Drexel University Dornsife School of Public Health, Philadelphia, PA 19104, United States

**Corresponding author:** Longjian Liu, MD, MSc, PhD, Doctor, Epidemiology and Biostatistics, Drexel University Dornsife School of Public Health, 3215 Market ST, Philadelphia, PA 19104, United States. [ll85@drexel.edu](mailto:ll85@drexel.edu)

### Abstract

Spatial epidemiology is the description and analysis of geographic patterns and variations in disease risk factors, morbidity and mortality with respect to their distributions associated with demographic, socioeconomic, environmental, health behavior, and genetic risk factors, and time-varying changes. In the Letter to Editor, we had a brief description of the practice for the mortality and the space-time patterns of John Snow's map of cholera epidemic in London, United Kingdom in 1854. This map is one of the earliest public health practices of developing and applying spatial epidemiology. In the early history, spatial epidemiology was predominantly applied in infectious disease and risk factor studies. However, since the recent decades, noncommunicable diseases have become the leading cause of death in both developing and developed countries, spatial epidemiology has been used in the study of noncommunicable disease. In the Letter, we addressed two examples that applied spatial epidemiology to cluster and identify stroke belt and diabetes belt across the states and counties in the United States. Similar to any other epidemiological study design and analysis approaches, spatial epidemiology has its limitations. We should keep in mind when applying spatial epidemiology in research and in public health practice.

**Key Words:** Diabetes mellitus; Spatial epidemiology; Diabetes belt; Public health practice

©The Author(s) 2022. Published by Baishideng Publishing Group Inc. All rights reserved.

**Core Tip:** This is a Letter to the Editor on the article published in *World Journal of Diabetes* 2021; 12: 1042, entitled: Spatial epidemiology of diabetes: Methods and Insights. Spatial epidemiology is a new sub-field of epidemiology. We read with great interest this paper, and would like to further address the application of spatial epidemiology for public health practice.

**Citation:** Liu L, Nagar G, Diarra O, Shosanya S, Sharma G, Afesumeh D, Krishna A. Epidemiology for public health practice: The application of spatial epidemiology. *World J Diabetes* 2022; 13(7): 584-586

**URL:** <https://www.wjgnet.com/1948-9358/full/v13/i7/584.htm>

**DOI:** <https://dx.doi.org/10.4239/wjd.v13.i7.584>

## TO THE EDITOR

Dear Editor, we read with great interest the recently published review paper, entitled “Spatial epidemiology of diabetes: Methods and Insights” by Cuadros *et al*[1], in *World Journal of Diabetes* 2021. The investigators reviewed spatial methods used to understand the spatial structure of the disease and identify the potential geographical drivers of the spatial distribution of diabetes mellitus. Their report serves as a good review on the concepts and methods of spatial epidemiology. In this letter we aimed to briefly address few examples of the historical public health practice in the United Kingdom and the application of spatial epidemiology in the recent decades in the United States, and to address the potential limitations when applying this technique in research and in public health practice.

The method used in “*analysis of geographic variation in disease*” could be tracked back to more than 150 years ago, for example, the renowned study of cholera epidemic in London, United Kingdom In 1854. John Snow, a physician, used mapping approach to trace the source of the Broad Street cholera outbreak (or Golden Square outbreak) in central London[1]. In the United States, an example is that a “stroke belt” or “stroke alley” was identified in early 1980s using spatial analysis approach and to define a 11-state region, where the states had age-adjusted stroke mortality rates more than 10% above the national average[2,3]. In 2011, a study by Barker *et al*[4] identified a geographically coherent region of the United States, where the prevalence of diagnosed diabetes mellitus is especially high. This area is also known as the “diabetes belt”. The “diabetes belt” consisted of 644 counties in 15 mostly southern states. A further analysis indicated that the prevalence of obesity and sedentary lifestyle (two modifiable risk factors for diabetes) was significantly higher in the diabetes belt than in the rest of the United States[5].

However, it should be noted that similar to the other analytical techniques, spatial epidemiology also has potential limitations[5,6]. First, the basic analysis approach of spatial epidemiology is based on ecological analysis design. Exposures and responses are measured only for aggregates rather than individuals. Therefore, findings from the analysis are subject to have ecological fallacy[5-8]. For example, results from an ecological analysis suggested that there was a significant correlation between increased state-level stroke prevalence and state-level stroke mortality. However, of the study states, several states that had higher state-level stroke prevalence rates did not have high stroke mortality rates, which led to a relatively weaker association than results from analyses using individual-level data[2]. Second, most spatial epidemiological studies apply age-adjusted rates to examine and map the variations in disease rates across geographic areas, such as neighborhoods, communities, districts, counties, states and countries at a global level. However, the calculation of age-adjusted rate is based on the proportion of age distributions across the geographics defined areas. If the proportions of age distributions vary widely between the comparison areas or regions, a simple weighted age-adjusted rate may be meaningless and may lead to an inappropriate comparison[5]. Third, data from disease registries, such as a small regional cancer registry, disease surveillance, or data from hospital electronic health records in a specific township is susceptible to information bias as a result of limited sources. Fourth, data protection and confidentiality should be kept in mind, specifically if mapping disease across small areas, such as small neighborhoods. It is likely that the number of persons at risk (*i.e.*, denominators) and the number of cases (*i.e.*, numerators) are too small to be used[8,9]. In the situation, a combined sample should be considered[10]. Lastly, confounding effects on the study association between exposures and outcomes should be considered and controlled appropriately in spatial epidemiological study.

In conclusion, the application of spatial epidemiology plays a pivotal role in advancing our understanding of the geographic distributions of specific disease and disease risk factors, which significantly contributes to disease control and prevention at population and community levels. However, the limitations of the study design and analysis approaches should be kept in mind when applying it in research and in public health practice.

---

## FOOTNOTES

**Author contributions:** Liu L drafted the Letter; Nagar G, Diarra O, Shosanya S, Sharma G, Afesumeh D, and Krishna A critically reviewed the Letter.

**Conflict-of-interest statement:** The authors have no conflict of interest to disclose.

**Open-Access:** This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <https://creativecommons.org/licenses/by-nc/4.0/>

**Country/Territory of origin:** United States

**ORCID number:** Longjian Liu 0000-0001-7956-7111; Garvita Nagar 0000-0002-3572-9024; Ousmane Diarra 0000-0002-0643-2598; Stephanie Shosanya 0000-0002-9089-8592; Geeta Sharma 0000-0003-2856-5663; David Afesumeh 0000-0002-5519-5939; Akshatha Krishna 0000-0002-6063-0747.

**S-Editor:** Chang KL

**L-Editor:** A

**P-Editor:** Chang KL

---

## REFERENCES

- 1 **Cuadros DF**, Li J, Musuka G, Awad SF. Spatial epidemiology of diabetes: Methods and insights. *World J Diabetes* 2021; **12**: 1042-1056 [PMID: 34326953 DOI: 10.4239/wjd.v12.i7.1042]
- 2 **Bingham P**, Verlander NQ, Cheal MJ. John Snow, William Farr and the 1849 outbreak of cholera that affected London: a reworking of the data highlights the importance of the water supply. *Public Health* 2004; **118**: 387-394 [PMID: 15313591 DOI: 10.1016/j.puhe.2004.05.007]
- 3 **Liao Y**, Greenlund KJ, Croft JB, Keenan NL, Giles WH. Factors explaining excess stroke prevalence in the US Stroke Belt. *Stroke* 2009; **40**: 3336-3341 [PMID: 19679841 DOI: 10.1161/STROKEAHA.109.561688]
- 4 **Barker LE**, Kirtland KA, Gregg EW, Geiss LS, Thompson TJ. Geographic distribution of diagnosed diabetes in the U.S.: a diabetes belt. *Am J Prev Med* 2011; **40**: 434-439 [PMID: 21406277 DOI: 10.1016/j.amepre.2010.12.019]
- 5 **Lanska DJ**, Kuller LH. The geography of stroke mortality in the United States and the concept of a stroke belt. *Stroke* 1995; **26**: 1145-1149 [PMID: 7604404 DOI: 10.1161/01.str.26.7.1145]
- 6 **Elliott P**, Wartenberg D. Spatial epidemiology: current approaches and future challenges. *Environ Health Perspect* 2004; **112**: 998-1006 [PMID: 15198920 DOI: 10.1289/ehp.6735]
- 7 **Beale L**, Abellan JJ, Hodgson S, Jarup L. Methodologic issues and approaches to spatial epidemiology. *Environ Health Perspect* 2008; **116**: 1105-1110 [PMID: 18709139 DOI: 10.1289/ehp.10816]
- 8 **Szklo M**. Epidemiology: Beyond the Basics. *Am J Epidemiol* 2001; **153**: 821-822 [DOI: 10.1093/aje/153.8.821]
- 9 **Liu L**, Wang F, Gracely EJ, Moore K, Melly S, Zhang F, Sato PY, Eisen HJ. Burden of Uncontrolled Hyperglycemia and Its Association with Patients Characteristics and Socioeconomic Status in Philadelphia, USA. *Health Equity* 2020; **4**: 525-532 [PMID: 34095699 DOI: 10.1089/heq.2020.0076]
- 10 **Liu L**, Núñez AE. Multilevel and urban health modeling of risk factors for diabetes mellitus: a new insight into public health and preventive medicine. *Adv Prev Med* 2014; **2014**: 246049 [PMID: 25431678 DOI: 10.1155/2014/246049]



Published by **Baishideng Publishing Group Inc**  
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA  
**Telephone:** +1-925-3991568  
**E-mail:** [bpgoffice@wjgnet.com](mailto:bpgoffice@wjgnet.com)  
**Help Desk:** <https://www.f6publishing.com/helpdesk>  
<https://www.wjgnet.com>

