

Geographic Variation in Morbidity and Mortality of Cerebrovascular Diseases in Korea during 2011-2015

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Background: Little is known about within-country variation in morbidity and mortality of cerebrovascular diseases (CVDs). Geographic differences in CVD morbidity and mortality have yet to be properly examined. This study examined geographic variation in morbidity and mortality of CVD, neighborhood factors for CVD morbidity and mortality, and the association between CVD morbidity and mortality across the 245 local districts in Korea during 2011-2015. *Methods:* District-level health care utilization and mortality data were obtained to estimate age-standardized CVD morbidity and mortality. The bivariate Pearson correlation was used to examine the linear relationship between district-level CVD morbidity and mortality Z-scores. Simple linear regression and multivariate analyses were conducted to investigate the associations of area characteristics with CVD morbidity, mortality, and discrepancies between morbidity and mortality. *Results:* Substantial variation was found in CVD morbidity and mortality across the country, with 1074.9 excess CVD inpatients and 73.8 excess CVD deaths per 100,000 between the districts with the lowest and highest CVD morbidity and mortality, respectively. Higher rates of CVD admissions and deaths were clustered in the noncapital regions. A moderate geographic correlation between CVD morbidity and mortality was found (Pearson correlation coefficient = .62 for both genders). Neighborhood level indicators for socioeconomic disadvantages, undersupply of health care resources, and unhealthy behaviors were positively associated with CVD morbidity and mortality and the relative standing of CVD mortality vis-à-vis morbidity. *Conclusions:* Policy actions targeting life-course socioeconomic conditions, equitable

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distribution of health care resources, and behavioral risk factors may help reduce geographic differences in CVD morbidity and mortality in Korea. **Key Words:** CVD morbidity—CVD mortality—geographic variation—neighborhood socioeconomic status—health care resource—behavioral risk factors—South Korea. © 2017 National Stroke Association. Published by Elsevier Inc. All rights reserved.

Introduction

Cerebrovascular disease (CVD) is the second leading cause of death in the world and in South Korea (hereafter “Korea”).¹ The substantial reductions in CVD incidence and mortality from 1990 to 2013 in the developed world, however, represent a quantum leap in CVD prevention, treatment, and management and reflect improved access to quality health care services. The mortality rates from both ischemic and hemorrhagic stroke in developed countries have been almost halved over the past 24 years, from 112.9 per 100,000 in 1990 to 67.2 per 100,000 in 2013.² Likewise, in Korea, the proportional contribution of deaths due to stroke among all-cause deaths has decreased from 14.2% in 1995 to 10.4% in 2010.³ Nevertheless, more than 90% of stroke-related disability-adjusted life years have been found to be attributable to modifiable risk factors, implying that substantial room still remains for improvement.⁴ In Korea, meanwhile, the increase in the absolute number of people who have had a stroke caused the economic burden of stroke to grow by 4.4% between 2005 and 2010.⁵ Rapid population aging will potentially further accelerate the social and economic burden of CVD in the future.

Despite its clinical importance and policy relevance, little is known about within-country variation in CVD morbidity and mortality, and the key causes of regional disparities have yet to be fully identified.⁶ Better knowledge of the geographic variation in CVD in Korea may lead to better understanding of the etiology of the diseases and improvements in the quality, equity, and efficiency of the allocation of health care resources across the country. Ecological studies may have policy implications for the development of effective strategies to prevent higher incidence and deaths from CVD at the community level, thereby shifting our attention from an individual-level approach to community-level differences in neighborhood material and social deprivation levels, the distribution of available health care resources, and neighborhood factors related to unhealthy behaviors to reduce regional disparities in the burden of CVD.⁷

Furthermore, little is known about geographical correlation between CVD morbidity and mortality. No previous studies examined discrepancies between CVD mortality and morbidity at the level of local districts and identified community factors explaining such discrepancies. Standardizing raw scores by transforming them into Z-scores allows us to compare scores from different distributions—in this case, morbidity and mortality

distributions across geographical regions in a country. By comparing a local district’s relative standing in the magnitude of morbidity and mortality, we can determine how their morbidity and mortality compare with one another. In terms of relative standing, we can explore for each local district whether the relative level of CVD mortality is greater than that of CVD morbidity. The causes of the differential association between the morbidity and mortality of CVD across the country have yet to be discussed. It remains unclear how the geographical distribution of health care resources and medical services affects the relative levels of CVD morbidity and mortality.

Aims

To address this important gap in research, we examined the geographic variation in CVD morbidity and mortality and the association between CVD morbidity and mortality across the 245 local districts of Korea during 2011–2015. In this study, we further identified potential community-related factors affecting district-level CVD morbidity and mortality and the discrepancy between CVD morbidity and mortality.

Methods

This study was approved by the National Health Insurance Service (NHIS) of Korea and obtained ethics approval from the Seoul National University Hospital Institutional Review Board (IRB No. E-1605-006-758).

Unit of Analysis

This study used the municipal-level divisions of Korea as the geographic unit of analysis, which consisted of 263 local districts according to the 2015 governmental administrative classification. However, in light of the changes in administrative units from 2011 to 2015 and the multiple sources of data used in this study, we reclassified the geographic units into 245 local districts to maintain consistency over the study period and across different data sources.

Data Sources

In this study, we used the National Health Information Database from the National Health Insurance Service, mortality data from Statistics Korea, the Korean Community Health Survey, and the 2010 Korean census data. These data sources are further described in [Appendix S1](#).

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