Premature Death from Stroke and Socioeconomic Status in Argentina

Muerte prematura por accidente cerebrovascular y condición socioeconómica en Argentina

JAVIER MARIANI [MTSAC, 1], MAURICIO MONSALVO[2], ANABEL FERNÁNDEZ PRIETO[2], ALEJANDRO MACCHIA[1]

ABSTRACT

Background: The association between stroke mortality and socioeconomic status has been scarcely described in Argentina. The evaluation of the temporal trends of early death from stroke and their relationship with socioeconomic status could be useful for public health to identify the most vulnerable groups.

Objectives: The aim of the study was to describe the temporal evolution of stroke mortality and its association with socioeconomic status in Argentina between 2000 and 2011.

Methods: A longitudinal ecological study was performed. Mortality was quantified by age and sex standardized rates and socioeconomic status by quintiles of unmet basic needs. The Argentine departments were the observation units. The association between mortality and socioeconomic status was assessed using a Poisson regression model for panel data.

Results: Stroke mortality progressively increased among quintiles of socioeconomic status (26.2, 28.4, 30.5, 34.5 and 36.9 per 100,000 persons, for quintiles 1 to 5, respectively, in 2000). Mortality in all socioeconomic status groups declined, though differences among them persisted (17.2, 18.5, 20.1, 22.1, and 25.3 per 100,000 persons, for quintiles 1 to 5, respectively, in 2011). The incidence rate ratios were 1.15 (95% CI 1.09 to 1.22; p<0.001), 1.27 (95% CI 1.21 to 1.34; p<0.001), 1.32 (95% CI 1.26 to 1.39; p<0.001) and 1.48 (95% CI 1.41 to 1.56; p<0.001), for quintiles 2 to 5, respectively.

Conclusions: Results suggest an inverse association between socioeconomic status and mortality from stroke. Moreover, the difference in mortality persisted among socioeconomic strata during the study period.

Key words: Stroke/Mortality - Vital Statistics - Social Class - Argentina - Epidemiology

RESUMEN

Introducción: La asociación entre mortalidad por accidente cerebrovascular y el nivel socioeconómico está escasamente descripta en la Argentina. La evaluación de las tendencias temporales de muerte precoz por accidente cerebrovascular y su relación con el nivel socioeconómico podría ser útil desde el punto de vista de la salud pública para la identificación de grupos de mayor vulnerabilidad.

Objetivo: Describir la evolución temporal de la mortalidad por accidente cerebrovascular y su asociación con el nivel socioeconómico en la Argentina entre 2000 y 2011.

Material y métodos: Se realizó un estudio ecológico longitudinal. La mortalidad se cuantificó mediante tasas estandarizadas por edad y sexo y el nivel socioeconómico, mediante quintiles de necesidades básicas insatisfechas. Las unidades de observación fueron los departamentos de la Argentina. La asociación entre mortalidad y nivel socioeconómico se evaluó utilizando un modelo de regresión de Poisson para datos de panel.

Resultados: La mortalidad por accidente cerebrovascular aumentó progresivamente entre los quintiles de nivel socioeconómico (26,2, 28,4, 30,5, 34,5 y 36,9 por 100.000 personas para los quintiles 1 a 5, respectivamente, en el año 2000). La mortalidad en todos los grupos de nivel socioeconómico disminuyó, aunque persistieron diferencias entre ellos (17,2, 18,5, 20,1, 22,1 y 25,3 por 100.000 personas para los quintiles 1 a 5, respectivamente, en el año 2011). Las razones de tasas de incidencias fueron de 1,15 (IC 95% 1,09 a 1,22; p < 0,001), 1,27 (IC 95% 1,21 a 1,34; p < 0,001), 1,32 (IC 95% 1,26 a 1,39; p < 0,001) y de 1,48 (IC 95% 1,41 a 1,56; p < 0,001) para los quintiles 2 a 5, respectivamente.

Conclusiones: Los resultados sugieren una asociación inversa entre el nivel socioeconómico y la mortalidad por accidente cerebrovascular. Además, persistió una diferencia de mortalidad entre los niveles socioeconómicos durante el período de estudio.

Palabras clave: Accidente cerebrovascular/mortalidad - Estadísticas vitales - Clase social - Argentina - Epidemiología

Abbreviations

ACV	Autonomous City of Buenos Aires	**UBN**	Unmet basic needs

[MTSAC] Full Member of the Argentine Society of Cardiology
[1] GESICA Foundation, Buenos Aires, Argentina.
[2] Remediar Program, National Ministry of Health, Argentina.

INTRODUCTION

Stroke is the third leading cause of premature death and disability worldwide (1). Although reductions in mortality are reported for this cause, its incidence tends to increase and as a result of both tendencies, its prevalence also increases, mainly in low- and middle-income countries. This, coupled to the related disabilities, represents a significant burden from the public health point of view. (1, 2)

Epidemiological studies, mainly from developed countries suggest an inverse relationship between socioeconomic status and stroke incidence and mortality. (3-6) In these studies, socioeconomic status was generally assessed by one-dimensional metric techniques (single or combined) usually including education, employment and income, measured according to geographic area levels. (7) Due to the absence of standardized indicators and the different impact that every indicator could have in dissimilar health care contexts, it is not possible to directly extrapolate the effect of health inequity quantification between different contexts. (8)

Assessment of temporal trends of early death from stroke and its relationship with socioeconomic status could be useful in terms of public health for the identification of the most vulnerable groups in which the implementation of preventive measures and treatment is needed, and as a tool to assess the effectiveness of the policies developed. (7)

The purpose of this study was the description of trends of early death from stroke in the Argentine population from 2000 to 2011 and the relationship of mortality (and trends of this relationship) with socioeconomic status.

METHODS

A mixed longitudinal panel design study was performed, including the evaluation of an ecological association and time series, assessing the relationship between death rate from stroke (standardized by age and sex) and socioeconomic status in Argentina. The unit of analysis was the departments.

Mortality

The number of deaths at the level of each of the 512 departments was provided by the Bureau of Vital Statistics and Health Information (DEIS) of the National Ministry of Health. These data are acquired by processing the information provided by death certificates in which the cause of death is obtained from the "underlying cause" according to the recommendations of the World Health Organization. (9) The causes of death are coded according to the International Classification of Diseases, 10th Edition (ICD-10), and codes I60-I69 were selected to identify stroke deaths, which include both ischemic and hemorrhagic stroke. (9)

The denominators for the annual death rate calculations of each department were obtained from the 2000 and 2010 censuses; for the years between censuses, the population was estimated with the cohort component method. (10) The population of each age and sex group was included in these denominators (groups defined as less than 1 year, 1 to 4 years, 5 to 14 years, 15 to 24 years, 25 to 34 years, 35 to 44

years, 45 to 54 years, 55 to 64 years and 65 to 74 years for each sex). Thus, annual death rates were initially calculated as stroke specific for each age and sex group.

Subsequently, annual mortality for each department was calculated by direct standardization, using the 2010 Argentine population as standard population. (11) Rates are expressed per 100,000 persons.

Socioeconomic level

Socioeconomic characterization was performed at the level of a geographical area (department) using for each department the percentage of households with unmet basic needs (UBN). This information comes from integrated sources of the National Institute of Statistics and Censuses (INDEC) and the Economic Commission for Latin America and the Caribbean (CEPAL), and combines complex features that include the following domains: income, level of educational attainment, housing conditions, overcrowding and health conditions. (12)

Each department was assigned the percentage of households with UBN in 2003 and these were then divided into quintiles of UBN nationwide. Thus 5 groups were formed, of which the most advantaged and most disadvantaged departments from the socioeconomic point of view were the first and fifth quintile, respectively.

Statistical analysis

Stroke mortality is expressed as standardized age and sex rates, (11) using the 2010 Argentine population distribution as standard. Standardized rates are described as means with their corresponding 95% confidence intervals (calculated using bootstrap with 100 sampling replications), and time evolution within quintiles of UBN as absolute rate differences and relative rate differences, the latter calculated as:

$$\frac{\text{Rate at the end of the period} - \text{Rate at the beginning of the period}}{\text{Rate at the beginning of the period}} \times 100$$

The association between socioeconomic status and mortality throughout the 12 observation years was evaluated with a conditional multivariate Poisson regression model for panel data. (13) Poisson regression is used when the dependent variable (in this case, stroke mortality), is number of events. (13) The independent variable was UBN (in quintiles) which was modeled as time-invariant. A fixed-effect model was specified after comparing between the fixed-effect and random-effect estimators with the Hausman specification test (p=0.049), indicating that the effects not measured within the observation units contain significant information. (14) Results are expressed as incidence rate ratios, whose interpretation is that of relative risk with their corresponding 95% CI. (15)

To assess the time trend of stroke mortality, Poisson regression models for panel data were also used, repeating the models for each quintile and with year as the only independent variable. These models were also used to evaluate the time trends in population evolution and stroke deaths (both as raw numbers) in each quintile of UBN. A p value <0.05 was considered statistically significant.

All analyses were performed with R version 3.2.3 statistical package for OS x. (16)

Ethical considerations

As the data analyzed are anonymous and public, the approv-

al of an ethics committee was not necessary to perform the present study.

RESULTS

During the study period, 110,332 stroke deaths were recorded, with a progressive reduction over time (from 10,544 in 2000 to 7,527 in 2011) despite the increase in population from 34.4 to 38.6 million in the same period, reducing the standardized age and sex rates from 30.7 per 10,000 persons in 2000 to 19.5 per 10,000 persons in 2011 (Table 1).

Table 2 shows the population and event distribution in each quintile. Since the departments were the analysis unit, the number of people in each quintile was different (thus, in 2000, 22.1% of the population was in the 102 departments of quintile 1 and 6.6% in the 102 departments of quintile 5). The age distribution among quintiles showed higher frequency of lower age persons as the socioeconomic status decreased. Table 2 and Figure 1 show that, despite a significant

increase of the population, the total number of stroke deaths was significantly reduced, and that this absolute decrease was more marked in the most advantaged socioeconomic quintiles.

The standardized rate for stroke death was significantly reduced in all quintiles over the 12 years of study (Table 3 and Figure 2). The relative rate difference between 2000 and 2011 was similar (-34.5% and -32.0% for quintile 1 and 5, respectively), and because the initial rate was higher the lower the socioeconomic status, the absolute reduction was higher as the socioeconomic status was lower (-9.0 and -11.8 per 100,000 persons for quintiles 1 and 5, respectively).

However, over the whole period, the least privileged socioeconomic quintiles showed higher mortality rate (Figure 2). The incidence rate ratios with respect to quintile 1 (considered as the reference category) were 1.15 (95% CI 1.09 to 1.22; p<0.001) for quintile 2, 1.27 (95% CI 1.21 to 1.34; p<0.001) for quintile 3, 1.32 (95% CI 1.26 to 1.39; p<0.001) for quintile 4 and 1.48

Table 1. Population, stroke deaths and adjusted rates per year in Argentina

Year	Population	Stroke deaths	Stroke death rate (95% CI)*
2000	3,4385,208	10,544	31.3 (29.5-33.1)
2001	3,477,8823	10,585	30.9 (29.1-32.6)
2002	35,172,438	10,762	31.8 (29.9-33.6)
2003	35,566,440	10,746	31.5 (29.8-33.2)
2004	35,960,055	10,065	28.2 (26.5-29.9)
2005	36,353,670	8,958	25.6 (24.1-27.2)
2006	36,747,285	8,655	23.8 (22.4-25.3)
2007	37,140,900	8,436	24.6 (23.0-26.1)
2008	37,534,515	8,341	24.3 (22.8-25.9)
2009	37,928,131	7,834	22.5 (21.1-23.9)
2010	38,321,775	7,879	21.3 (20.0-22.5)
2011	38,644,234	7,527	20.6 (19.3-21.9)

*Mean standardized rates of death from stroke in each department.

Table 2. Population and number of stroke deaths in each quintile of unmet basic needs in 2000 and 2011.

	2000					2011				
	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
N departaments	102	103	102	103	102	102	103	102	103	102
Total population, n	7,590,911	10,523,756	10,221,008	3,781,407	2,268,126	7,993,683	11,695,598	12,122,290	4,309,734	2,522,929
Total population, %*	2.1	30.6	29.7	11.0	6.6	20.7	30.3	31.4	11.1	6.5
Age groups, n										
<35	4,192,289	6,450,445	6,641,058	2,607,755	1,626,449	4,306,058	6,977,445	7,568,180	2,822,802	1,728,606
35-54	1,973,271	2,528,014	2,345,629	794,110	431,960	2,126,600	2,863,602	2,882,682	954,853	516,418
55-74	1,425,351	1,545,297	1,234,321	379,542	209,717	1,561,025	1,854,551	1,671,428	532,079	280,293
Age groups, %**										
<35	55.2	61.3	65.0	69.0	71.7	53.9	59.7	62.4	65.5	68.5
35-54	26.0	24.0	22.9	21.0	19.1	26.6	24.5	23.8	22.2	20.4
55-74	18.8	14.7	12.1	10.0	9.2	19.5	15,.8	13.8	12.3	11.1
Stroke deaths	2,465	3,427	2,952	1,059	641	1,383	2,437	2279	895	533

* Average of total population included in each quintile of unmet basic needs.
**Percent distribution of age groups within each quintile.

(95% CI 1.41 to 1.56; p<0.001) for quintile 5. In this context, these incidence rate ratios are interpreted as short relative risks over time. Thus, and consistently with results shown in Figure 2, despite the reduction within UBN quintiles, the relative distance between them persisted without attenuation throughout time.

DISCUSSION

The results of our study suggest that, during the assessment period, mortality from stroke was signifi-

cantly reduced, both at the country level as in each of the quintiles of socioeconomic status. Moreover, the reduction in time within UBN quintiles had fairly similar magnitude, but there was a linear and inverse gradient between UBN quintiles and standardized stroke mortality that remained without attenuation throughout the study period.

Other studies evaluated the association between socioeconomic status and the incidence and mortality from stroke, both between countries as within a
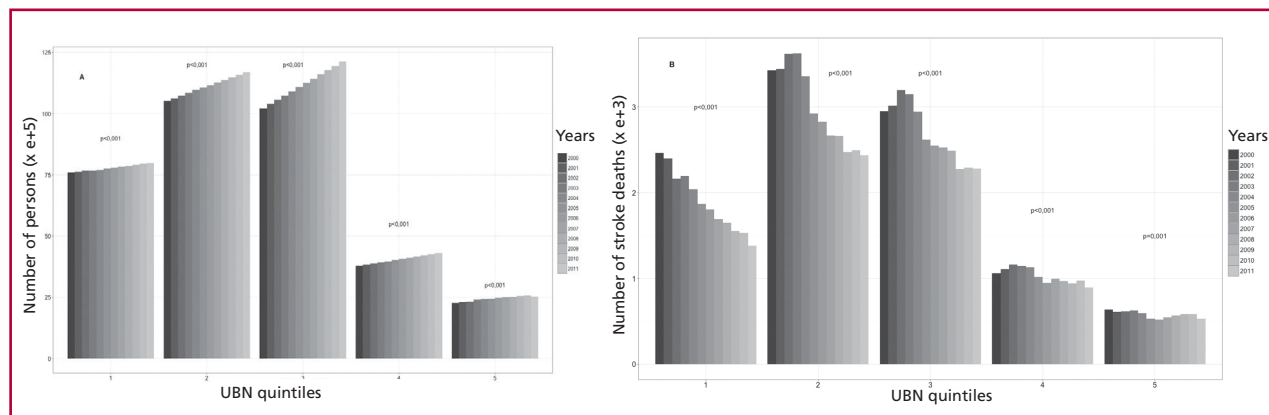

Fig.1. Population (**A**) and stroke death (**B**) temporal evolution in each quintile of unmet basic needs (UBN).

Quintile UBN	Mortality in 2000* Mean (95% CI)	Mortality in 2011* Mean (95% CI)	Relative differance	Absolute difference	p
1	26.2 (23.2-29.9)	17.2 (14.9-19.5)	-34.5	-9.0	<0.001
2	28.4 (25.8-30.8)	18.5 (16.5-20.8)	-34.8	-9.9	<0.001
3	30.5 (27.2-33.7)	20.1 (17.8-22.8)	-34.1	-10.4	<0.001
4	34.5 (30.3-38.8)	22.1 (19.2-24.8)	-36.1	-12.4	<0.001
5	36.9 (31.4-42.6)	25.1 (20.8-29.3)	-32.0	-11.8	0.001

Table 3. Standardized rates of stroke death in 2000 and 2011 per quintile of unmet basic needs and relative and absolute rate differences.

*Standardized age and sex stroke mortality rate per 100,000 persons.
UBN: Unmet basic needs
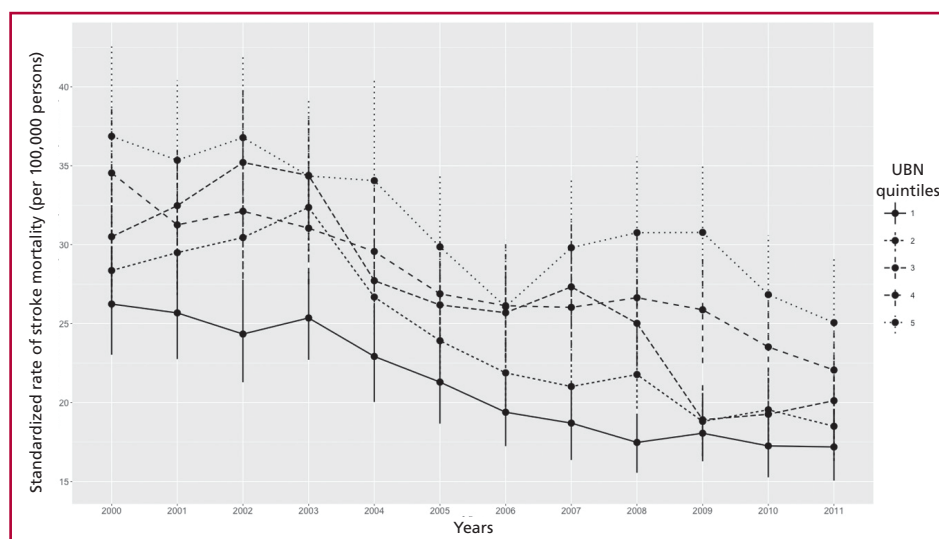
Fig 2. Temporal evolution of mean (with 95% CI) standardized rates of stroke death in each quintile of unmet basic needs (UBN).

country. Data from a global assessment suggest that both the incidence of stroke and mortality from this cause decreased between 1990 and 2013 at the expense of ischemic stroke. (2) However, low-middle-income countries had 43% more mortality from stroke in 1990 (112.9 vs. 160.9 per 100,000 persons), and because mortality reduction was more marked in high-income countries (41.1% vs. 14.9% reduction in high and low-middle income countries, respectively), in 2013, the difference was 100% (67.2 vs. 136.9 per 100,000 persons). (2) In our study, the development of standardized mortality rates among UBN quintiles was parallel, so that, unlike studies among-countries, the difference did not expand but remained similar in relative terms.

Other studies evaluating the relationship between socioeconomic status and mortality from stroke, at national or regional levels, reported an inverse relationship between them. (4-6, 17-18) In addition, the temporal evolution of differences between socioeconomic levels within countries showed findings similar to ours; that is, a reduction in the standardized death rate from stroke in all groups, although there is still a gap between socioeconomic groups. (6) However, since these studies come from high-income countries, where stroke death rates are different from those that occur in Argentina, (1, 19, 20) and given that the measurement of socioeconomic status, frequently performed from data collected for other purposes are not comparable, and some of them are not available in our context to quantify differences in health outcomes between groups, our findings add important information to the local impact of socioeconomic differences and their temporal evolution. (7, 8)

Given the design of our study, it is not possible to determine the mechanisms by which socioeconomic status is associated with increased stroke mortality. Previous studies suggest that part of the increased incidence and severity of stroke in most disadvantaged groups is, at least partially, corrected by adjusting for traditional cardiovascular risk factors. (7, 21, 22) Moreover, in-hospital mortality from stroke has also been associated with socioeconomic status, so that inequity in acute care after the event could also be an additional factor in the differences among the groups. (18, 23) Understanding the mechanisms involved in the association between UBN and stroke mortality in our context is essential to target interventions to eliminate these inequities. (7)

Limitations
Our study has several limitations, mainly due to its design. Since it is an ecological study, the association between stroke death rate and UBN at departmental level should be interpreted in this way, since if the association is transferred to individuals we could incur in ecological fallacy. (24) Furthermore, we did not have available risk factor data, so that the association is not corrected by their distribution and therefore hypotheses on the mechanisms cannot be explored.

Finally, socioeconomic status is evaluated at a point in time (2003) and was considered in the analysis as a time-invariant variable; however, despite this limitation, it consistently identified groups with different mortality occurrence)

CONCLUSIONS
The evaluation of premature death from stroke in all departments of Argentina during 12 years shows a progressive reduction in mortality from this cause over time and an inverse association with socioeconomic status, which remained unchanged throughout the study period.

Conflicts of interest
None declared. (See author´s conflicts of interest forms in the web / Supplementary Material)

REFERENCES

1. GBD 2013 Mortality and Causes of Death Collaborators. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 2015;385:117-71. http://doi.org/f2x6mp

2. Feigin VL, Krishnamurthi RV, Parmar P, Norrving B, Mensah GA, Bennett DA, et al; GBD 2013 Writing Group; GBD 2013 Stroke Panel Experts Group. Update on the Global Burden of Ischemic and Hemorrhagic Stroke in 1990-2013: The GBD 2013 Study. Neuroepidemiology 2015;45:161-76. http://doi.org/bccq

3. Andersen KK, Steding-Jessen M, Dalton SO, Olsen TS. Socioeconomic position and incidence of ischemic stroke in Denmark 2003-2012. A nationwide hospital-based study. J Am Heart Assoc. 2014;3: pii: e000762. http://doi.org/bccr

4. Hunt BR, Deot D, Whitman S. Stroke mortality rates vary in local communities in a metropolitan area: racial and spatial disparities and correlates. Stroke 2014;45:2059-65. http://doi.org/bccs

5. Nordahl H, Osler M, Frederiksen BL, Andersen I, Prescott E, Overvad K, et al. Combined effects of socioeconomic position, smoking, and hypertension on risk of ischemic and hemorrhagic stroke. Stroke 2014;45:2582-7. http://doi.org/bcct

6. Newton JN, Briggs AD, Murray CJ, Dicker D, Foreman KJ, Wang H, et al. Changes in health in England, with analysis by English regions and areas of deprivation, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2015;386:2257-74. http://doi.org/bccv

7. Marshall IJ, Wang Y, Crichton S, McKevitt C, Rudd AG, Wolfe CD. The effects of socioeconomic status on stroke risk and outcomes. Lancet Neurol 2015;14:1206-18. http://doi.org/bcch

8. Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, et al. Socioeconomic status in health research: one size does not fit all. JAMA 2005;294:2879-88. http://doi.org/d29h4k

9. World Health Organization. International Statistical Classification of Diseases, 10th Revision (ICD-10). Geneva: World Health Organization, 1992.

10. Smith SK, Tayman J, Swanson DA. State and Local Population Projections: Methodology and Analysis. 1st ed. Netherlands : Springer, 2002.

11. Anderson RN, Rosenberg HM. Age standardization of death rates: implementation of the year 2000 standard. Natl Vital Stat Rep 1998;47:1-16.

12. Ferres JC, Mancero X. El método de las necesidades básicas insatisfechas (NBI) y sus aplicaciones en América Latina. Disponible en:(http://repositorio.cepal.org/bitstream/handle/11362/4784/S0102117_es.pdf?sequence=1

13. Juárez-Colunga E, Dean CB, Balshaw R. Efficient panel designs for longitudinal recurrent event studies recording panel counts. Biostatistics 2014;15:234-50. http://doi.org/bccj

14. Croissant Y, Millo G. Panel Data Econometrics in R: The plm Package. Journal of Statistical Software 2008;27(2). http://doi.org/bccw

15. Frees, EW. Longitudinal and Panel data: analysis and applica-

tions for the Social Sciences. Cambrige : University Press, 2004. http://doi.org/dr7gwb

16. R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

17. Andersen KK, Dalton SO, Steding-Jessen M, Olsen TS. Socioeconomic position and survival after stroke in Denmark 2003 to 2012: nationwide hospital-based study. Stroke 2014;45:3556-60. http://doi.org/bccx

18. Kapral MK, Fang J, Chan C, Alter DA, Bronskill SE, Hill MD, Manuel DG, et al. Neighborhood income and stroke care and outcomes. Neurology 2012;79:1200-7. http://doi.org/bccz

19. Ma J, Ward EM, Siegel RL, Jemal A. Temporal Trends in Mortality in the United States, 1969-2013. JAMA 2015;314:1731-9. http://doi.org/8v7

20. Rodríguez T, Malvezzi M, Chatenoud L, Bosetti C, Levi F, Negri E, et al. Trends in mortality from coronary heart and cerebrovascular diseases in the Americas: 1970-2000. Heart 2006;92:453-60. http://doi.org/brtjsm

21. Honjo K, Iso H, Nakaya T, Hanibuchi T, Ikeda A, Inoue M, et al; Japan Public Health Center-based Prospective Study Group. Impact of neighborhood socioeconomic conditions on the risk of stroke in Japan. J Epidemiol 2015;25:254-60. http://doi.org/bccf

22. Huang K, Khan N, Kwan A, Fang J, Yun L, Kapral MK. Socioeconomic status and care after stroke: results from the Registry of the Canadian Stroke Network. Stroke 2013;44:477-82. http://doi.org/bcc2

23. Addo J, Bhalla A, Crichton S, Rudd AG, McKevitt C, Wolfe CD. Provision of acute stroke care and associated factors in a multiethnic population: prospective study with the South London Stroke Register. BMJ 2011;342:d744. http://doi.org/frbb42

24. MacRae K. MacRae K. Socioeconomic deprivation and health and the ecological fallacy. BMJ 1994;309:1478-9. http://doi.org/dmsbzv