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*Stroke*. 2012;43:1186-1191; originally published online February 23, 2012;

doi: 10.1161/STROKEAHA.111.639732

*Stroke* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

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Print ISSN: 0039-2499. Online ISSN: 1524-4628

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## Socioeconomic Status and Stroke An Updated Review

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**Background and Purpose**—Rates of stroke incidence and mortality vary across populations with important differences between socioeconomic groups worldwide. Knowledge of existing disparities in stroke risk is important for effective stroke prevention and management strategies. This review updates the evidence for associations between socioeconomic status and stroke.

**Summary of Review**—Studies were identified with electronic searches of MEDLINE and EMBASE databases (January 2006 to July 2011) and reference lists from identified studies were searched manually. Articles reporting the association between any measure of socioeconomic status and stroke were included.

**Conclusions**—The impact of stroke as measured by disability-adjusted life-years lost and mortality rates is >3-fold higher in low-income compared with high- and middle-income countries. The number of stroke deaths is projected to increase by >30% in the next 20 years with the majority occurring in low-income countries. Higher incidence of stroke, stroke risk factors, and rates of stroke mortality are generally observed in low compared with high socioeconomic groups within and between populations worldwide. There is less available evidence of an association between socioeconomic status and stroke recurrence or temporal trends in inequalities. Those with a lower socioeconomic status have more severe deficits and are less likely to receive evidence-based stroke services, although the results are inconsistent. Poorer people within a population and poorer countries globally are most affected in terms of incidence and poor outcomes of stroke. Innovative prevention strategies targeting people in low socioeconomic groups are required along with effective measures to promote access to effective stroke interventions worldwide. (*Stroke*. 2012;43:1186-1191.)

**Key Words:** public health ■ social class ■ socioeconomic position ■ stroke

Stroke accounts for nearly 10% of all deaths worldwide. It was ranked as the seventh leading cause of disability-adjusted life-years lost in 2002 and is projected to become the sixth by 2030.<sup>1,2</sup> It is estimated that in 2005 there were 16 million first-ever strokes and 5.7 million stroke deaths worldwide with 87% of them occurring in low- and middle-income (LMIC) countries.<sup>3</sup> The number of first-ever strokes worldwide is projected to increase to 18 million in 2015 and 23 million in 2030 in the absence of population-wide interventions.<sup>3</sup> Stroke will remain the second leading cause of death worldwide by 2030.<sup>1</sup> The projected increase in stroke mortality is expected to be faster in LMIC compared with high-income countries (HIC) as a result of increasing prevalence of risk factors and differences in availability of primary prevention and acute care programs.<sup>3</sup>

The importance of socioeconomic factors as predictors of stroke incidence, mortality, and impact has been discussed previously.<sup>2,4</sup> A 2006 review of socioeconomic status (SES)

and stroke found a generally consistent pattern of higher stroke incidence and mortality in lower socioeconomic groups but conflicting evidence in relation to service provision and trends in outcome between socioeconomic groups.<sup>5</sup> There is evidence of widening socioeconomic inequalities in income and cardiovascular disease risk factors in different populations in recent years, but the effects of these changes on previously reported socioeconomic disparities in stroke remain unknown.<sup>6,7</sup> Knowledge of existing disparities in stroke risk is important for effective stroke prevention and management.

This article presents an updated overview of associations between SES and stroke. It first provides an overview of the global impact of stroke in terms of mortality and disability-adjusted life-years and differences between countries and income groups. Next, it examines the socioeconomic differences in stroke incidence, distribution of stroke risk factors, case severity, mortality, and access to stroke services.

Received September 23, 2011; final revision received November 25, 2011; accepted November 30, 2011.

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Stroke is available at <http://stroke.ahajournals.org>

DOI: 10.1161/STROKEAHA.111.639732

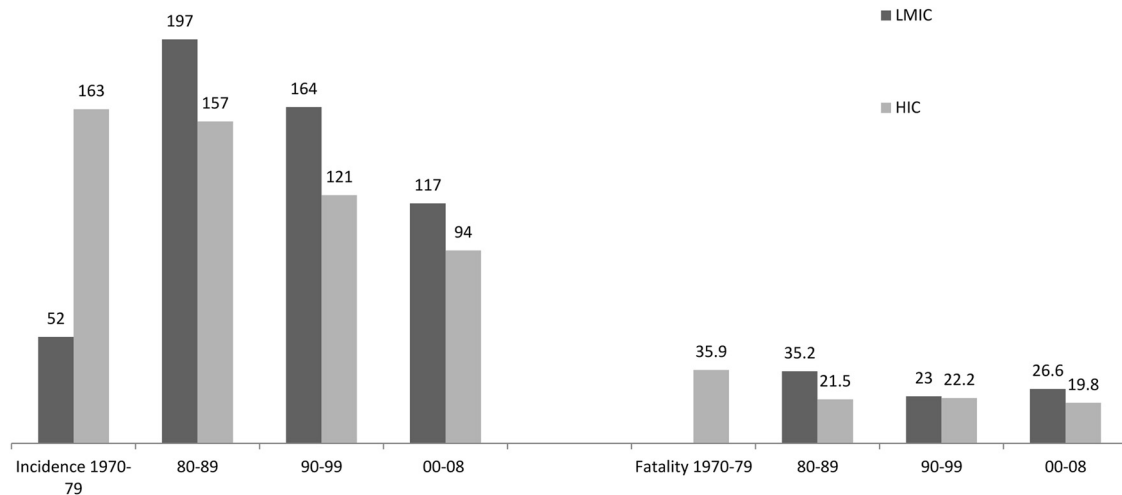


Figure. Variation in Incidence (cases/100 000 person-years) and early case fatality (%).<sup>9</sup>

**Methods**

Relevant articles published in English between January 2006 and July 2011 and reporting the association between any measure of SES and stroke were identified from electronic searches of MEDLINE and EMBASE databases. Additionally, reference lists from identified studies were searched manually for further relevant publications. Search terms and strategies used included stroke, cerebrovascular accident/disorder, cerebral hemorrhage, subarachnoid hemorrhage, socioeconomic factors, social class, income, poverty, deprivation, manual and nonmanual occupation, recurrence, care, and inequality. A total of 530 titles and abstracts were screened for inclusion. All articles finally included in this review were evaluated for relevance and methodology.

**Results**

**Worldwide Impact**

Demographic and epidemiological shifts resulting in population aging and changes in the distribution of cardiovascular risk factors have resulted in stroke becoming a major health problem in LMIC.<sup>3,8</sup> Data from the World Health Organization indicate an increased incidence and mortality of stroke in low socioeconomic groups in different populations and a disproportionately increased impact on LMIC compared with HIC.<sup>2,3</sup> A systematic review of population-based studies showed that although there was a 42% decrease in stroke incidence in HIC over 4 decades, a >100% increase in stroke incidence occurred in LMIC over the same period (Figure).<sup>9</sup> Data from a systematic review of published studies from sub-Saharan Africa suggest that although the absolute prevalence of stroke and number of stroke deaths remain low as a result of the younger population structure, the prevalence of disabling stroke as well as age-adjusted stroke mortality is similar to that reported in developed countries and hospital-based case-fatality is even higher.<sup>10</sup> Stroke mortality rates decreased over 2 decades in China due to rapid economic development with a faster decline occurring in economically better-off urban areas compared with disadvantaged rural areas with less developed healthcare services.<sup>11</sup> Mortality rates and disability-adjusted life-years lost have been reported to be up to 3.5-fold higher (Figure) in low-income compared with middle- and high-income countries.<sup>2,3,9</sup> The number of deaths from stroke is projected to increase from 6.5 million in

2015 to 7.8 million in 2030 with a faster increase projected for LMIC compared with HIC.<sup>3</sup> Differences in risk factor distribution, availability of primary stroke prevention programs, and provision of acute care have been considered as possible explanations for the differences in stroke incidence and mortality between HIC and LMIC.<sup>2,3,8</sup>

**Incidence**

An increased incidence of stroke has been reported among those of lower SES as shown in the Table.<sup>12–20</sup> A meta-analysis of 17 studies published between 1980 and 2008 demonstrated an increased incidence of stroke in those of lower SES (pooled hazard ratio, 1.67 [1.46–1.91]).<sup>21</sup> The associations between lower SES and the incidence of stroke have generally been demonstrated across stroke subtypes, although some studies have demonstrated nonsignificant or weaker associations with hemorrhagic stroke.<sup>12–14</sup> Higher rates of both ischemic and hemorrhagic strokes were found in men and women from lower SES (using area-based deprivation index) in a study conducted in Italy.<sup>12</sup> The inverse association between ischemic stroke and annual income observed in a study conducted in Sweden was however not significant with hemorrhagic stroke.<sup>14</sup>

**Stroke Recurrence**

Few studies have investigated the association between SES and stroke recurrence with conflicting findings.<sup>14,22</sup> A study conducted in Italy reported a tendency toward an increased risk of a recurrent stroke in men of lower SES compared with those of higher SES after an ischemic stroke.<sup>12</sup> An increased risk of stroke recurrence occurred with a decrease in annual income in women but not in men in Sweden.<sup>14</sup> There was however no association between SES and stroke recurrence 1, 5, and 10 years after first-ever stroke in a UK study.<sup>22</sup>

**Mortality**

An inverse association has been reported between SES and stroke mortality in studies conducted within and across countries. The risk of death after stroke was higher in unemployed patients compared with employed patients in a Danish study.<sup>23</sup> Lower SES was associated with an increased

**Table. Studies on SES and Stroke Incidence**

Study	Year of Data Collection and Type of Study	Age of Participants, Y	Sample Size	Measures of SES	Findings
Heeley, <sup>15</sup> Australia and New Zealand, 2011	Three population-based studies 1995–2003		3077 patients with stroke	Area-level socioeconomic deprivation	Higher rates of stroke in people from more deprived areas (RR, 1.70; 95% CI, 1.47–1.95)
Grimaud, France, 2011 <sup>17</sup>	Stroke Register 1995–2003	≥40	62 299 residents; 1433 strokes	Area-level socioeconomic indicators	Low SES (large neighborhood inequality) increased stroke incidence in women (IRR, 1.34; <i>P</i> =0.003) and in 40- to 59-yr-old men (IRR, 1.56; <i>P</i> =0.01)
Cesaroni, Italy, 2009 <sup>12</sup>	Hospital data 2001–2004; 1-y follow-up	35–84	10 033 strokes	A small-area composite index	Higher rates of ischemic (RR, 1.76; 95% CI, 1.59–1.95 in men and 1.72; CI, 1.55–1.91 in women) and hemorrhagic (RR, 1.50; 95% CI, 1.26–1.80 in men and 1.37; 95% CI, 1.15–1.63 in women) strokes in low SES than in higher SES groups
McFadden, UK, 2009 <sup>18</sup>	Participants recruited between 1993–1997 and followed up to 2007	39–79	22 488 in cohort; 683 strokes	Social class: current or last employment or partner's employment; educational status	Higher incidence in social Class V compared with Class I (HR, 2.62; 95% CI, 1.63–4.22)
Li, Sweden, 2008 <sup>14</sup>	Citizens living in the city of Malmo in 1990 with 10 y follow-up	40–65 y at baseline	69 625 citizens; 1648 strokes	Annual income and occupational status: job titles and work tasks	Incidence increased in those in lowest income quartile compared with highest (RR, 1.75; 95% CI, 1.36–2.25 in women and 1.29; 1.06–1.58 in men)
Avendano, US, 2008 <sup>16</sup>	National sample of US adults enrolled in 1992, 1993, and 1998 and followed up through 2004	50+	19 445 with 1542 stroke events	Household wealth, income, education	Between age 50 and 64 y, those in the lowest 10% of wealth had the highest stroke risk (HR, 3.1; CI, 2.1–4.4); the association was not significant after age 65 y
Kuper, Sweden, 2007 <sup>13</sup>	Random selection of women residing in Uppsala region in 1991 and 1992 followed up until 2002	30–50 at baseline	47 942 cohort; 200 strokes	Education	Risk of stroke inversely associated with years of education completed (comparing lowest with highest education, HR, 2.1; 95% CI, 1.4–2.9)
Thrift, Australia, 2006 <sup>19</sup>	1997–1999 population-based stroke register with follow-up	Mean age 74.6	1421 patients with stroke	Index of relative socioeconomic disadvantage and area-based measure	Fatal and nonfatal stroke incidence increased with increasing levels of socioeconomic disadvantage
Avendano, US, 2006 <sup>20</sup>	Prospective cohort in 1982 and followed up to 1991 and in 1994	65+	2812 with 270 incident strokes	Education and income	Lower SES associated with higher stroke incidence at ages 65–74 y (HR, for education 2.07; CI, 1.04–4.13); beyond age 75 y, stroke rates were higher among highest education (HR, 0.42; CI, 0.22–0.79)

SES indicates socioeconomic status; RR, relative risk; HR, hazard ratio; IRR, interrater reliability.

3-year mortality rate after a first-ever stroke in China.<sup>24</sup> Graded inverse associations between income and stroke mortality were reported among public servants in South Korea.<sup>25</sup> Decreasing income was associated with an increased 28-day and 1-year case-fatality in men but not women in Sweden.<sup>14</sup> In a study using World Health Organization data from 35 countries in Europe and Central Asia, stroke mortality rates generally decreased sharply between 1990 and 2006 in countries with the highest economic standard of living, at the same time as increasing substantially in countries with lower economic standards of living over the same period.<sup>26</sup> No evidence of socioeconomic disparities was however reported in 30-day or 1-year mortality after a first stroke in an Italian study or in 12-month case-fatality in a pooled analysis of studies from Australia and New Zealand using area-level SES.<sup>12,15</sup>

### Ethnic Differences

Ethnic differences have been reported in the incidence and mortality of stroke. It has been suggested that socioeconomic factors, reflected by income and education, may explain some of the excess ethnic differences in incidence and mortality.<sup>20,27</sup> In a US national longitudinal study, adjustment for both childhood and adult social conditions explained nearly all the association between ethnicity and stroke incidence.<sup>28</sup> A study reported that 14% to 64% of the increased stroke mortality in black men was explained by socioeconomic factors but with no significant association in black women.<sup>27</sup> Studies on mortality differences between blacks and whites have however been inconsistent with some studies reporting an increased mortality and others demonstrating a survival advantage in blacks.<sup>27,29,30</sup> Similarly, whereas some studies have reported black patients as receiving fewer evidence-based processes after stroke compared with Hispanic or white patients, others have shown blacks to have better access to evidence-based interventions after stroke.<sup>29,31</sup> Given the contradictory evidence, it remains unclear whether or not the effect of ethnicity on stroke is independent of SES.

### Risk Factors

Higher rates of stroke risk factors have been reported among people of lower SES.<sup>12,13,32</sup> Classic vascular risk factors partly explain the increased risk of stroke among lower socioeconomic groups.<sup>15,20,21</sup> A study of patients with stroke and transient ischemic attack found a higher proportion of smokers in the lowest SES quartile.<sup>33</sup> The US National Health and Nutrition Examination Surveys conducted at different times between 1971 and 2002 showed a decline in the prevalence of high blood pressure and cholesterol in all socioeconomic groups but with widening socioeconomic disparities observed in smoking.<sup>6</sup> A widening of the disparities in the prevalence of stroke risk factors among different socioeconomic groups may partly explain any widening in the socioeconomic disparities in mortality from cardiovascular disease.<sup>34</sup> Despite the identification of effective interventions and strategies for preventing stroke and its recurrence through modification and treatment of risk factors, uptake remains considerably low in some populations worldwide.<sup>3,35</sup>

### Stroke Severity

The association between SES and stroke severity has been investigated in a number of studies with some evidence of an association between lower SES and increased severity.<sup>33,36</sup> A study that used insurance status as a proxy for SES found a better outcome up to 3 months after stroke (modified Rankin Scale) and milder stroke severity in the acute phase among patients of higher SES in an acute stroke population.<sup>37</sup> Studies have demonstrated an association between lower SES and the risk of having more severe deficits after stroke assessed by the modified National Institutes of Health Stroke Scale.<sup>5,33,36</sup> A study conducted in Austria found that patients with a higher education were less likely to have comorbidities and to have had a previous stroke or other cardiovascular disease.<sup>36</sup> A higher level of education was associated with better motor and functional recovery during the inpatient rehabilitation period after stroke in an European multicenter study.<sup>38</sup>

### Receipt of Stroke Services

SES has been associated with inequalities in the delivery of care across the stroke pathway. Differences in receipt of evidence-based care occur not only between HIC and LMIC, but also within countries with universal access to health care.<sup>39</sup> Patients of higher SES were more likely to receive postacute stroke rehabilitation in a US cohort study.<sup>40</sup> Using routinely collected data from English public hospitals, patients with stroke from more deprived areas were less likely to receive a brain scan on the same day of admission.<sup>39</sup> Regarding secondary stroke prevention, patients with lower income and those without medical insurance were less likely to receive antithrombotic therapy after stroke in China.<sup>41</sup> Patients with a higher level of education were more likely to undergo echocardiography and have speech therapy during admission compared with patients with no basic education in Austria.<sup>36</sup> Low-income patients were less likely to receive 7 specific processes of care (including stroke unit care, scan, antiplatelets or anticoagulation, assessment by a physiotherapist or occupational therapy) after stroke compared with high-income patients in a Danish nationwide study.<sup>23</sup> There were however no socioeconomic differences in the administration of thrombolysis, frequency of physiotherapy or occupational therapy, or the rate of prescribing secondary prevention drugs in Austria.<sup>36</sup> Equal access to stroke unit care and an apparent equity in thrombolysis provision among all socioeconomic groups was reported in patients from 3 Scottish hospitals with universal access to care.<sup>33</sup>

### Discussion

This review updates evidence related to associations between SES and stroke. It demonstrates a generally increased impact of stroke among lower socioeconomic groups in different populations with a 30% higher incidence,<sup>21</sup> more severe deficits in the acute phase, and higher case-fatality. There is less available evidence of an association between SES and stroke recurrence or temporal trends in inequalities. Those with a lower SES are less likely to receive evidence-based stroke services, but the evidence is inconsistent and requires more research. Socioeconomic disparities in stroke risk were not completely explained by the differences in stroke risk

factors or access to care.<sup>2,21</sup> Differences in SES along the entire life course may possibly explain socioeconomic differences in stroke risk in adulthood with evidence of an increased risk for developing stroke among those who experience worse socioeconomic conditions in childhood independent of their adult life circumstances.<sup>42</sup>

A previous review on SES and stroke suggested the need for more prospective population-based studies to confirm the inverse association identified between SES and stroke incidence, mortality, and other outcomes.<sup>5</sup> This current review identified more articles using prospective population-based methods published on SES and stroke over the past 5 years. This suggests a growing interest in gathering appropriate research evidence to support implementation of interventions that will address socioeconomic disparities in stroke risk. Most studies were however from HIC with limited evidence from LMIC, emphasizing the need for more rigorous data from such populations.<sup>2,10</sup> Few studies were identified on SES and stroke recurrence or temporal trends in inequalities, making it difficult to assess whether patterns of associations are changing over time. The varying methods used in the different studies in this review and the different measures of SES used limit comparisons across studies. Nevertheless, the findings indicate that poorer people within a population and poorer countries globally are most affected in terms of incidence and poor outcomes after stroke. Innovative prevention strategies targeting people in low socioeconomic groups are required along with effective measures to promote access to effective stroke interventions in lower socioeconomic groups.

### Sources of Funding

This study was funded by Guy's and St Thomas' Hospital Charity, The Stroke Association, Department of Health HQIP grant, UK, National Institute for Health Research Programme Grant (RP-PG-0407-10184). The authors (C.D.A.W.) acknowledge financial support from the Department of Health through the National Institute for Health Research (NIHR) Biomedical Research Centre award to Guy's & St Thomas' NHS Foundation Trust in partnership with King's College London. Charles DA Wolfe is an NIHR Senior Investigator.

### Disclosures

None.

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