Current knowledge of stroke risk factors and epidemiology is based mostly on North American or European studies; scarce data have been published from developing countries. Stroke will be a public health problem in South America during the next decades because of an increase in life expectancy and changes in the lifestyle of the population. Because epidemiological and clinical characteristics of stroke vary according to regional factors, we need to know the peculiarities of stroke on this continent.

Here, we review published evidence relevant to epidemiology and subtypes of stroke in South America.

Methods
We used electronic databases to search for community- or hospital-based studies including information on stroke in South America. Community-based studies were included if data were collected through standardized questionnaires and if raw population numbers were available for data confirmation. Age adjustments were described as originally reported. Hospital-based stroke registries were included if the design of the study was adequately described in the methods section and if stroke was diagnosed on the basis of neuroimaging findings.

Results
Only 18 of more than 200 reviewed papers met inclusion criteria (the Figure). Seven provided information on stroke epidemiology; 11 gave data on the pattern of stroke subtypes.

Studies on Stroke Epidemiology
Of the 7 community-based studies meeting inclusion criteria, 3 were designed primarily to assess the prevalence or incidence of stroke; the other 4 were conducted to determine the prevalence or incidence of major neurological diseases (Table 1).

The first study designed to assess stroke epidemiology was performed in Cuzco, a Peruvian city of 210,000 inhabitants located 3380 m above sea level. Twenty-one cases of first-ever stroke were found among 3246 screened individuals >15 years old. This gave a crude prevalence rate of 6.2 per
1000 population. Six of these 21 stroke cases occurred in the year before the study, giving a crude annual incidence rate of 1.83 per 1000. Age, alcohol consumption, polycythemia, and high income levels were positively associated with stroke prevalence. The authors noted the importance of environmental factors and lifestyle as contributors to stroke occurrence.

In a Colombian study conducted in the city of Sabaneta, 76 of 13 588 screened people (from 17 659 inhabitants) had a stroke. This gave a crude stroke prevalence rate of 5.6 per 1000. The annual incidence rate of stroke was 0.89 per 1000. This low incidence rate could be related to the implementation of campaigns directed at teaching the community about the hazards of stroke risk factors. Another prevalence study was conducted in rural areas of Santa Cruz (Bolivia). Of 9955 screened inhabitants, 16 had a stroke. This gave a crude prevalence of stroke of 1.74 per 1000. The prevalence was

**TABLE 1. Community-Based Studies on Stroke Prevalence and Incidence in South America**

<table>
<thead>
<tr>
<th>Study</th>
<th>Data Collection</th>
<th>Ethnic Group,*</th>
<th>Population Studied, n</th>
<th>Crude Prevalence Rates†</th>
<th>Age-Adjusted Prevalence Rates†</th>
<th>Incidence Rates†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cuzco, Peru¹</td>
<td>1988</td>
<td>Quechuas 97</td>
<td>3246</td>
<td>6.2</td>
<td>5.74‡</td>
<td>1.83</td>
</tr>
<tr>
<td>Sabaneta, Colombia²</td>
<td>1992–1993</td>
<td>...</td>
<td>13 588</td>
<td>5.6</td>
<td>...</td>
<td>0.89</td>
</tr>
<tr>
<td>Santa Cruz, Bolivia³</td>
<td>1994</td>
<td>Mestizos 70, Guaranes 30</td>
<td>9955</td>
<td>1.74</td>
<td>3.22‡</td>
<td>...</td>
</tr>
<tr>
<td>Quiroga, Ecuador⁴</td>
<td>1982</td>
<td>Quechuas</td>
<td>1113</td>
<td>3.6</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Colombia⁵</td>
<td>Rural areas</td>
<td>...</td>
<td>7746</td>
<td>4.1</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>Urban centers</td>
<td>...</td>
<td>8286</td>
<td>9.6</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>...</td>
<td>16 032</td>
<td>6.51</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Aratoca, Colombia⁶</td>
<td>1995–1996</td>
<td>...</td>
<td>544</td>
<td>4.7</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Chávez, Bolivia⁷</td>
<td>1995–1996</td>
<td>Chiquitanos</td>
<td>1514</td>
<td>...</td>
<td>0.35</td>
<td>...</td>
</tr>
</tbody>
</table>

*Quechuas, refers to interbreeding of the white descendants of the Hispanic population with the Amerindian population; Mestizos, descendants of intermarriage between Spaniards and natives; Guaranes, Indians; and Chiquitanos, native tribe from the southern Amazon region in Bolivia.

†Per 1000 population.

‡All ratios and rates were adjusted for age to the World Health Organization population according to the original descriptions.
2-fold higher in men than in women. It was suggested that this low prevalence rate could be related to a high number of stroke fatalities.

In a study designed to assess the epidemiology of neurological diseases in the Andean village of Quiroga (Ecuador), 4 of 1113 screened people had a stroke, yielding a crude prevalence rate of 3.6 per 1000.4 In a Colombian study screening 16 032 people from 7 different rural and urban communities, the crude stroke prevalence rate was 6.5 per 1000, which was higher in people living in urban areas (9.6 per 1000) compared with that found in those living in rural areas (4.1 per 1000).5 In another Colombian study conducted in the rural area of Aratoca, 10 of 544 screened people (from 6664 inhabitants) had a stroke; this gave a crude prevalence rate of 4.7 per 1000.6 In a Bolivian study on the incidence of neurological diseases among a small Amazonian tribe, 2 of 1514 individuals followed up over 1 year had a stroke, yielding an annual incidence rate of 0.35 per 1000.7

Studies on Stroke Subtypes

Of the 11 hospital-based stroke registries meeting inclusion criteria, 6 evaluated patients with both ischemic and hemorrhagic strokes,8–11 4 included patients with ischemic stroke,14–17 and 1 evaluated patients with intracranial hemorrhages.18 Eight of the 11 studies included adult patients of all ages,8–12,14,15,17 and the other 3 were restricted to young adults.13,16,18

In Guayaquil, 500 Ecuadorian mestizos with stroke were evaluated.8 The authors found 37.4% of strokes were intracranial hemorrhages and 62.6% were cerebral infarctions. Hypertensive arteriolopathy was the cause of 64% of the hemorrhages and 43% of the infarctions. Lacunar infarctions were seen in 39% of patients with ischemic stroke. This was the first study to suggest that stroke patterns in South America are different from those seen in developed countries. Subsequent studies confirmed that intracranial hemorrhages are more prevalent (Table 2) and that the pattern of ischemic strokes is different in South America than in developed countries (Table 3).

In Joinville (Brazil), 73.4% of 429 stroke patients had a cerebral infarction, 25.9% had an intracranial hemorrhage, and 0.7% had unclassified stroke.9 Arterial hypertension was the most common risk factor for ischemic and hemorrhagic strokes. Similar figures were observed in a stroke registry from Santiago (Chile) that included 450 patients.10 Of them, 51% had ischemic strokes, 34% had cerebral hemorrhages, 12% had subarachnoid hemorrhages, and 3% had transient ischemic attacks. Arterial hypertension was observed in 64% of these patients and was the most common cause of both infarctions and hemorrhages.

Another study conducted in Buenos Aires (Argentina) identified differences in risk factors and stroke subtypes between Argentinian natives and whites.11 The authors found a high frequency of hemorrhagic strokes and small-vessel disease in both ethnic groups. Hemorrhages were significantly higher in Argentinian natives than in whites (34% versus 27%), and whites had a nonsignificantly higher tendency of penetrating artery disease than natives (35% versus

### Table 2. Proportion of Ischemic and Hemorrhagic Stroke Subtypes in South American Hospital-Based Stroke Registries

<table>
<thead>
<tr>
<th>Stroke Registry</th>
<th>Strokes, n</th>
<th>Ethnic Group</th>
<th>Cerebral Infarction, %</th>
<th>Intracranial Hemorrhage, %</th>
<th>Other,* %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guayaquil, Ecuador9</td>
<td>500</td>
<td>Mestizos†</td>
<td>62.6</td>
<td>37.4</td>
<td>...</td>
</tr>
<tr>
<td>Joinville, Brazil9</td>
<td>429</td>
<td>...</td>
<td>73.4</td>
<td>25.9</td>
<td>0.7</td>
</tr>
<tr>
<td>Santiago, Chile15</td>
<td>450</td>
<td>...</td>
<td>51</td>
<td>46</td>
<td>3</td>
</tr>
<tr>
<td>Buenos Aires, Argentina11</td>
<td>361</td>
<td>Whites</td>
<td>73</td>
<td>27</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Natives</td>
<td>66</td>
<td>34</td>
<td>...</td>
</tr>
</tbody>
</table>

*Includes patients with transient ischemic attacks, intracranial venous thrombosis, and unclassified strokes.
†Mestizos = a racial admixture between Spaniards and Ecuadorian natives.

### Table 3. Proportion of Ischemic Stroke Subtypes in South American Hospital-Based Stroke Registries

<table>
<thead>
<tr>
<th>Stroke Registry</th>
<th>Mean Age, y</th>
<th>Large-Artery Disease, %</th>
<th>Cerebral Embolism, %</th>
<th>Small-Artery Disease, %</th>
<th>Other Causes, %</th>
<th>Unknown, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guayaquil8 (n=313)</td>
<td>58</td>
<td>7.4</td>
<td>14</td>
<td>43.1</td>
<td>6</td>
<td>29.5</td>
</tr>
<tr>
<td>Santiago10 (n=233)</td>
<td>64</td>
<td>33.5</td>
<td>32.6</td>
<td>14.1</td>
<td>5.2</td>
<td>14.6</td>
</tr>
<tr>
<td>Buenos Aires12 (n=250)</td>
<td>62</td>
<td>12</td>
<td>21</td>
<td>42</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Whites (n=123)</td>
<td>11</td>
<td>20</td>
<td>48</td>
<td>5</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Natives (n=126)</td>
<td>13</td>
<td>22</td>
<td>36</td>
<td>8</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Bogota14 (n=119)</td>
<td>66</td>
<td>19</td>
<td>18</td>
<td>19</td>
<td>12</td>
<td>32</td>
</tr>
<tr>
<td>Santiago15 (n=110)</td>
<td>67</td>
<td>7</td>
<td>14</td>
<td>43</td>
<td>6</td>
<td>29</td>
</tr>
</tbody>
</table>

Denominators of ischemic stroke are in parentheses.
24%). The same authors compared the frequency of stroke subtypes among whites living in Buenos Aires and Boston and found that the former had a higher frequency of hemorrhagic strokes (27% versus 15%) and small-vessel disease (35% versus 21%).

Among 119 patients with cerebral infarction studied in Bogota (Colombia), only 19% had large-vessel atherosclerosis as the cause of stroke. In Santiago, 2 study of 110 patients with ischemic stroke suggested that the prevalence of extracranial carotid artery atherosclerosis is low among Chilean patients with cerebral infarctions. Another study from Guayaquil showed that 60% of Ecuadorian mestizos with cerebral infarctions related to large-artery atherosclerosis had intracranial lesions, located mostly in the middle cerebral artery stem.

Stroke subtypes in young adults have also been evaluated in some studies. In a series from Sao Paolo (Brazil) that included 106 patients 15 to 40 years of age with cerebral infarction, cardioembolism was the most common pathogenetic mechanism of stroke in the subgroup of patients 30 to 40 years of age, whereas other defined causes of stroke were mostly seen among patients <29 years of age. Lacunar infarctions were more common in patients >30 years of age. There was a predominance of women among patients <29 years of age and of men in patients 30 to 40 years of age. The authors concluded that the pathogenesis of ischemic stroke in young adults varies according to age and sex. In a series of 151 young adults (15 to 44 years of age) with intracranial hemorrhage from Guayaquil, hypertensive arteriopathy was the leading cause of bleeding (39.7% of cases). In Curitiba (Brazil), another series of 164 young adults with stroke (86% ischemic) also showed that arterial hypertension was the most common risk factor for the occurrence of both ischemic and hemorrhagic strokes.

Discussion
Valuable information can be extracted from the scarce publications of stroke in South America. Stroke prevalence is lower than that in developed countries, probably because of some unknown protective ethnic factors or differences in dietary habits or lifestyles. This hypothesis is supported by the finding that stroke prevalence is even lower in rural than in urban areas. It has also been suggested that low prevalence rates are related to an increased mortality in patients during the acute disease. However, 4 of the 6 community-based studies on stroke prevalence in South America have been conducted in Colombia and Ecuador, where stroke mortality is low. The other 2 studies came from Peru and Bolivia, where no information on adjusted stroke mortality rates is available.

Stroke incidence is more difficult to assess than prevalence when resources that allow prospective follow-up of a community are limited. The 3 studies on stroke incidence in South America yielded rates ranging from 0.35 to 1.83 per 1000 population, which are lower than that of developed countries. However, those geographically restricted studies may not reflect the situation of the entire continent.

Another conclusion that can be drawn from South American studies is the consistently reported high percentage of patients with intracranial hemorrhages among stroke sufferers, which is 2 to 3 times higher than that seen in people living in developed countries. Several factors may explain such differences, including a higher prevalence of uncontrolled arterial hypertension, dietary habits, widespread abuse of over-the-counter medications that predispose to bleeding, and alcohol abuse. Among patients with ischemic strokes, stroke registries suggest that intracranial atherosclerotic lesions and penetrating small-vessel disease are more common in South America than in developed countries.

An unsolved puzzle is the contribution of racial-ethnic factors to the particular expression of stroke patterns. The South American population is heterogeneous and includes native Indians, immigrants of all races, and a number of racial admixtures. Therefore, it is difficult to group the patients according to race or ethnic group even after considering skin color or last names. Likewise, lifestyles, dietary habits, and environmental conditions are not uniform in South America, and results from a given study may not extrapolate to the entire region. It is important to describe ethnic subgroups to better understand stroke differences among different populations. The term “Hispanic,” used in US stroke studies to refer to people coming from Latin America, should be banned from South American studies attempting to evaluate the role of race-ethnicity in the pattern of disease expression. A more specific classification using terms such as whites, blacks, mestizos, mulattos, and natives may be of more value in this setting.

In summary, much has to be learned about stroke in South America. Large-scale, multicentric community- and hospital-based studies with standardized designs that make them comparable to each other are urgently needed to increase our knowledge of the epidemiology and patterns of stroke subtypes in South America.

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