Population Group Differences in Trends in Stroke Mortality in Israel

S. Koton, MOccH, RN; N.M. Bornstein, MD; M.S. Green, MD, PhD

Background and Purpose—In Israel, stroke is the third most common cause of death. In 1997 stroke accounted for 2905 deaths (8.1% of total), 1390 of them among men (7.5% of total; crude mortality rate of 48.3/100 000) and 1515 among women (8.6% of total; crude rate of 51.7/100 000). This report presents trends on stroke mortality by population group and estimates of morbidity in Israel.

Methods—Data on stroke mortality in Israel during 1969–1997 were obtained from the Israel Central Bureau of Statistics. Age-specific and age-adjusted mortality rates were calculated for the 2 main population groups. Data on morbidity were obtained form the 1996/1997 National Health Survey. Hospitalization rates due to stroke are based on the national hospitalization data.

Results—A monotonic decrease in stroke mortality is evident in Jews during 1969–1997 in both sexes. Age-adjusted mortality rates declined by 62.5% for Jewish men and by 73.4% for Jewish women during 1969–1997. Among Arabs, there was a general decreasing trend in the mortality for both sexes during 1973–1997. The main difference in population group mortality trends was found in the group aged ≥75 years: a statistically significant decrease in mortality rates for Jews is evident, while no decrease is apparent for Arabs. On the basis of available data for 1990, an estimated 13,000 patients with stroke were hospitalized during 1997.

Conclusions—During the last 25 years, age-adjusted stroke mortality in Israel has declined substantially, but the decline has been much greater among Jews than Arabs. The group aged ≥75 years shows the greatest difference in trends between Jews and Arabs. This finding may be explained by differences in risk factor distribution and case fatality rates. (Stroke. 2001;32:1984-1988.)

Key Words: epidemiology ■ ethnic groups ■ mortality ■ stroke, acute

In Israel, as in the United States and most European countries, stroke is the third most common cause of death. In 1997, stroke was the underlying cause in 7.5% of deaths among men and 8.6% of deaths among women.1 Community-based studies conducted during the 1980s in several Western countries report that 61% to 81% of first strokes represent infarctions, 8% to 16% intracerebral hemorrhages, and 4% to 8% subarachnoid hemorrhages.2–5 A similar distribution of stroke types has been reported in Israel according to the hospital-based Tel Aviv Stroke Registry data.6

No national data on the incidence of stroke are available in Israel. In a few local studies, the incidence of stroke was reported in defined population groups. Epstein et al7 reported in 1984 an annual crude incidence rate of 827/100 000 among men and 677/100 000 among women for the Jewish population aged ≥45 years in northern Israel. The highest incidence rate was found among Jews of Asian origin.7 The annual incidence of stroke in young adults (17 to 49 years) in 1992–1993 has been reported to be 10.4/100 000 (13.0/100 000 among men and 7.7/100 000 among women).8 Incidence rates among men were found to be higher than among women in all age groups except the group aged 20 to 24 years.8 This report presents trends in stroke mortality by population group and estimates of morbidity in Israel during a 25-year period.

Methods

Data on stroke mortality in Israel during 1969–1997 were obtained from the Israel Central Bureau of Statistics. Data on the population size until 1971 are based on the Census of May 22, 1961. For 1972–1982, population estimates are based on the Census of Population and Housing of May 20, 1972. For 1983–1994, estimates are based on the Census of June 4, 1983. As of 1995, data on population are based on the Census of November 4, 1995. The population includes permanent residents (Israeli citizens and permanent residents without Israeli citizenship) as well as potential immigrants staying in Israel or in Jewish localities in Judea, Samaria, and the Gaza area. Also included is an estimate of tourists and temporary residents residing in Israel for >1 year. All population estimates since 1967 include the East Jerusalem population. The Druze and Moslem population of the Golan is included in population estimates from 1982 to the present.9 The proportion of population coverage in the 1995 census was evaluated as 99.3%. The accepted proportion of coverage in developed countries is 98%; thus, the quality of coverage in the 1995 census is very high.10 In Israel, data on causes of death are obtained from death notifications and coded at the Central Bureau of Statistics.11 The underlying causes of death were coded according to the International Classification of Diseases, Eighth Revision, Clinical Modification during 1969–1978. The International Classification of Diseases, Ninth Revision, Clinical Modification was first used in Israel in 1979 and was still in use during 1997. The detailed codes for stroke according to both International Classification of Diseases revisions are 430 to 438. Age-specific and age-adjusted mortality rates were calculated for the 2 main popula-

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tion groups: Jews and non-Jews. Data for non-Jews include mainly Arabs-Moslems (72.5%), Christians (10.5%), Druze (8.1%), and members of other religions who constitute only a very small minority. These are termed the “Arabs” group. The 1997 average population in Israel was 5 828 900, of them 4 658 800 Jews and 1 170 100 Arabs. The sex distribution for the same year was 2 875 400 men and 2 953 500 women.10 Mortality rates for Arabs were calculated for 1973–1997. The available data on rates in 1969–1972 for the Arab population were not included because a high percentage of deaths were not medically certified. Comparisons between age-adjusted mortality rates in Israel and in the United States and European countries are presented. International data were collected from the Heath for All 1997 database12 and from the National Center for Health Statistics in the United States.13

Data on morbidity were collated from local studies because there is no national registry of stroke. Self-reported lifetime prevalence of stroke is based on preliminary data from the 1996/1997 National Health Interview Survey. Hospitalization rates due to stroke are based on the national hospitalization data. The specified causes for hospitalization were coded according to the International Classification of Diseases, Ninth Revision, Clinical Modification.

Statistical Methods
Age-adjusted and age-specific mortality rates per 100 000 are presented. Rate ratios with 95% CIs were calculated for the comparison between rates in the different population groups. Age adjustment was conducted by the direct method. The standard population used in comparisons over time for Jews and Arabs is the Israel 1983 population. The standard European and the 1940 US populations were used for the international comparisons. Linear regression was used to evaluate trends in age-specific mortality rates, with log-mortality rates used as the dependent variable. Analyses were performed with the SAS program, version 6.12.

Results
Mortality by Age, Sex, and Population Group
In 1997, stroke accounted for 2905 deaths, of them 2630 (90.5%) among Jews and 1515 (52.2%) among women.1 The crude mortality rate in 1997 was 48.3/100 000 for men and 51.7/100 000 for women. Rates increased significantly with age. Age-adjusted mortality rates were 29.7% higher among Arab men than among Jewish men. Among women, rates for Arabs were 76.5% higher than for Jews. Among Jews, age-adjusted mortality rates were 22.5% lower for women than for men. Among Arabs, rates were 5.4% higher for women than for men.

Age-Adjusted Mortality Trends
During the last 25 years there has been a decline in age-adjusted mortality rates in all population groups in Israel. During 1973–1990, mortality rates declined by 53% among men and by 60% among women. Rates stabilized during 1990–1995 and declined since 1995. Trends in age-adjusted mortality by sex are shown in Figure 1. Since 1980, rates have been consistently higher for Arabs, and the gap in mortality rates between Jews and Arabs has been increasing.

Age-Specific Mortality Rates
Age-specific mortality rates for 1997 are shown in Table 1. The highest age-specific mortality rates in 1997 were in Arab women aged ≥75 years. Among Jews, the highest rates occurred in men aged ≥75 years. The mortality rate for this group (863.5/100 000) was 3.6 times higher than the rate for men aged 65 to 74 years. Among Jewish women, the difference between rates for the different age groups was even greater: the highest rate occurred in the group aged ≥75 years (805.4/100 000). This rate is 5.7 times the rate for the group aged 65 to 74 years. The difference between age group rates has been constant for the last 15 years.

Population Group Differences in Trends
Age-adjusted stroke mortality rates have declined in all population groups during the last 25 years, but the decline has been much greater in the Jewish population than in the Arab population. Linear regression analysis shows that the decline in rates is statistically significant among all age groups except for Arab men aged 20 to 44 years and for Arab men and women aged ≥75 years (Table 2). In the group with the highest mortality rates (≥75 years), we found the greatest difference in trends between Jews and Arabs. No decrease in mortality rates is apparent for Arabs aged ≥75 years during 1973–1997, while a statistically significant reduction is evident for Jews in the same age group. Trends in log mortality rates for the population aged ≥65 years, by population group and sex, are shown in Figure 2.

International Comparisons
Age-adjusted stroke mortality rates for 1996 were lower in Israel than the European Union average and than the rates for most of the European countries.12 Compared with most European countries, Israeli women ranked higher than men, and Israeli Arabs ranked much higher than Israeli Jews (Figure 3). Secular trends in mortality rates are similar in Israel and the United States: during 1970–1997 the age-adjusted mortality rates decreased by >50% in both countries. The rates are consistently higher in Israel than in the United States.14
Morbidity
Preliminary data from the 1996/1997 National Health Survey show a self-reported lifetime population stroke prevalence of 26,023 cases (15,904 men and 10,119 women), indicating prevalence rates of 480/100,000 for the total population, 610/100,000 for men, and 360/100,000 for women. Among the population aged $\geq$65 years, prevalence rates are almost 7 times higher for both sexes.

Hospitalization Data
In 1990, 10,569 hospitalization cases were due to stroke, 5,815 (55%) of them among males. The crude rate of hospitalizations due to stroke in 1990 was 230/100,000 (251/100,000 for men and 203/100,000 for women). According to 1990 hospitalization data, 13,000 persons (an approximate estimate) were hospitalized during 1997 for stroke. Among Jews, hospitalization rates for men are higher than for women; among Arabs, hospitalization rates are identical for both sexes. These data do not include cases not hospitalized and include first and recurrent strokes. Recurrent hospitalization is present among 9.6% of stroke patients. An increasing trend in hospitalization rate is evident in the last years: the crude hospitalization rate for stroke increased from 170/100,000 in 1987 to 230/100,000 in 1990.

Discussion
Population Group Differences in Stroke Mortality
On the basis of 1997 data, we calculated the ratio between mortality rates for Jews and Arabs, by sex, for the different age groups. Rate ratios and 95% CI show that rates for Arab men aged 20 to 44 and 45 to 64 years were statistically significantly higher than for women; among Arabs, hospitalization rates are identical for both sexes. These data do not include cases not hospitalized and include first and recurrent strokes. Recurrent hospitalization is present among 9.6% of stroke patients. An increasing trend in hospitalization rate is evident in the last years: the crude hospitalization rate for stroke increased from 170/100,000 in 1987 to 230/100,000 in 1990.

### Table 1. Age-Specific Stroke Mortality Cases and Rates per 100,000 by Sex and Population Group, Israel 1997

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Jewish Men</th>
<th>Arab Men</th>
<th>Jewish Women*</th>
<th>Arab Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>20–44 y</td>
<td>11</td>
<td>10</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Rate</td>
<td>1.4</td>
<td>4.6</td>
<td>0.6</td>
<td>1.5</td>
</tr>
<tr>
<td>Rate ratio Jews/Arabs (95% CI)</td>
<td>0.3 (0.1–0.7)</td>
<td>0.4 (0.1–1.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45–64 y</td>
<td>116</td>
<td>27</td>
<td>65</td>
<td>21</td>
</tr>
<tr>
<td>Rate</td>
<td>28.0</td>
<td>45.5</td>
<td>14.3</td>
<td>34.0</td>
</tr>
<tr>
<td>Rate ratio Jews/Arabs (95% CI)</td>
<td>0.6 (0.4–0.9)</td>
<td>0.4 (0.3–0.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65–74 y</td>
<td>324</td>
<td>34</td>
<td>251</td>
<td>44</td>
</tr>
<tr>
<td>Rate</td>
<td>237.9</td>
<td>317.8</td>
<td>141.3</td>
<td>305.6</td>
</tr>
<tr>
<td>Rate ratio Jews/Arabs (95% CI)</td>
<td>0.8 (0.5–1.1)</td>
<td>0.5 (0.3–0.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\geq$75 y</td>
<td>810</td>
<td>58</td>
<td>1047</td>
<td>78</td>
</tr>
<tr>
<td>Rate</td>
<td>863.5</td>
<td>950.8</td>
<td>805.4</td>
<td>1200</td>
</tr>
<tr>
<td>Rate ratio Jews/Arabs (95% CI)</td>
<td>0.9 (0.7–1.2)</td>
<td>0.7 (0.5–0.8)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*There was 1 death from stroke among Jewish women aged 0 to 20 years.

### Table 2. Coefficients of the Variable “Year” in Regression Curves for Stroke Mortality Rates 1973–1997: Estimates, Standard Error, and P-Value by Sex, Age, and Population Group

<table>
<thead>
<tr>
<th></th>
<th>Coefficient Estimate</th>
<th>SE</th>
<th>P</th>
<th>Coefficient Estimate</th>
<th>SE</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jews</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>20–44 y</td>
<td>-0.06</td>
<td>0.02</td>
<td>0.0004</td>
<td>-0.09</td>
<td>0.02</td>
<td>0.0001</td>
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<tr>
<td>45–64 y</td>
<td>-2.6</td>
<td>0.19</td>
<td>0.0001</td>
<td>-3.21</td>
<td>0.19</td>
<td>0.0001</td>
</tr>
<tr>
<td>65–74 y</td>
<td>-14.6</td>
<td>1.20</td>
<td>0.0001</td>
<td>-18.42</td>
<td>1.19</td>
<td>0.0001</td>
</tr>
<tr>
<td>$\geq$75 y</td>
<td>-37.54</td>
<td>4.35</td>
<td>0.0001</td>
<td>-55.03</td>
<td>4.52</td>
<td>0.0001</td>
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<tr>
<td>Arabs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–44 y</td>
<td>-0.03</td>
<td>0.07</td>
<td>0.70</td>
<td>-0.08</td>
<td>0.03</td>
<td>0.0078</td>
</tr>
<tr>
<td>45–64 y</td>
<td>-1.64</td>
<td>0.51</td>
<td>0.004</td>
<td>-3.48</td>
<td>0.54</td>
<td>0.0001</td>
</tr>
<tr>
<td>65–74 y</td>
<td>-13.37</td>
<td>3.58</td>
<td>0.0012</td>
<td>-16.14</td>
<td>2.56</td>
<td>0.0001</td>
</tr>
<tr>
<td>$\geq$75 y</td>
<td>-10.24</td>
<td>5.27</td>
<td>0.0657</td>
<td>-7.81</td>
<td>6.87</td>
<td>0.2680</td>
</tr>
</tbody>
</table>
higher than rates for Jewish men. Among women, rates were statistically significantly higher for Arabs in all age groups, except the group aged 20 to 44 years. We found that age-adjusted stroke mortality rates in Israel have declined substantially during the last 25 years among Jews and Arabs, but the decline has been much greater in the Jewish population than in the Arab population. The group aged 75 years, which accounts for the largest mortality rates, shows the greatest difference in trends between Jews and Arabs. This finding may be explained by differences in risk factor distribution and case fatality rates. As previously specified, we did not include mortality data for Arabs during 1969–1972 because a high percentage of deaths were not medically certified. As of 1973, this percentage has stabilized at approximately 3% of deaths, most of them out-of-hospital sudden deaths. Since the percentage of deaths with no assigned cause is stable during the study period, it is not reasonable that changes in this percentage could influence the reported trends in Arab mortality.

International Comparisons
Trends in mortality similar to those reported in this article have been reported in other countries. Temporal trends estimated using annual rates for 5 to 6 years (ending by 1990) in the 17 MONICA (Monitoring Trends and Determinants in Cardiovascular Disease) populations show decreasing stroke mortality rates among men in 11 of the 17 populations and, among women, in 14 of the populations. There are large differences in stroke mortality rates around the world. The highest annual rates for the population aged 35 to 74 years in 1990–1994 were observed in Eastern Europe and previous Soviet Union countries (309 to 156/100 000 for men and 222 to 101/100 000 for women). A study on trends in mortality found that countries with the lowest rates in 1994, such as the United States, Canada, Switzerland, France, and Australia, experienced steep declines in 1968–1994. The slope of the decline in these countries was reduced during the last 5 years, while mortality rates increased in the Eastern European countries, especially during the same period.

Risk Factors and Prevention of Stroke
Improved hypertension control is believed to have contributed to the reduction in stroke incidence and mortality in Western countries. In 1990–1991, a study of a Jerusalem population aged 70 years reported high rates of awareness and treatment of hypertension (87% and 86%, respectively) but disappointingly low levels of control (43%). Higher levels of control are required to reduce both stroke incidence and mortality.

Stroke is one of the principal causes of death, especially among the old and very old populations in Israel. Changes in stroke morbidity are not clear because there are no national data on incidence of stroke.

Limitations of Data
The only national data on stroke epidemiology in Israel are based on death certificates. The accuracy of the recorded
underlying cause of death is related to several factors, including physician experience and patient age. Changes in coding of causes of death may influence the consistency of the records. However, there is no evidence of substantial changes in coding processes during the discussed period. Unfortunately, no data on validity of death certificates in Israel are available. For 1997, the estimated death/hospitalization ratio for stroke is 0.2:1 (2905/13 000), and the estimated hospitalization/prevalence ratio is 0.5:1 (13 000/26 023), both of which are reasonable ratios.

Conclusions

During the last 25 years, age-adjusted stroke mortality in Israel has declined substantially. The decline has been much greater in the Jewish population than in the Arab population. Israel has declined substantially. The decline has been much

During the last 25 years, age-adjusted stroke mortality in Israel has declined substantially. The decline has been much
differed in trends between Jews and Arabs: during 1973–1997 there has been a statistically significant reduction in mortality rates for Jews but no decrease in mortality rates for Arabs. This finding may be explained by differences in risk factor distribution and case fatality rates.

The observed decline in stroke mortality rates for the whole population in Israel may be due to a reduction in stroke incidence, a decrease in case fatality, or a combination of both. Similar trends reported in other Western countries have been partially attributed to decreased incidence. Improvement in treatment of risk factors, especially control of hypertension at satisfactory levels, has been reported to reduce the risk of stroke. The absence of a National Stroke Registry makes it impossible to prove any change in stroke incidence in Israel. The marked improvement in diagnosis and treatment of stroke patients during the last decades may have contributed to a decrease in case fatality in different countries. Unfortunately, there are no available data on stroke case fatality trends in Israel. Further studies are needed to explain the decrease in stroke mortality in Israel.

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