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## Stroke Incidence and Case Fatality According to Rural or Urban Residence Results From the French Brest Stroke Registry

Olivier Grimaud, MD, PhD; Yacine Lachkhem, PhD; Fei Gao, PhD; Cindy Padilla, PhD; Mélanie Bertin, PhD; Emmanuel Nowak, PhD; Serge Timsit, MD, PhD

**Background and Purpose**—Recent findings suggest that in the United States, stroke incidence is higher in rural than in urban areas. Similar analyses in other high-income countries are scarce with conflicting results. In 2008, the Brest Stroke Registry was started in western France, an area that includes about 366 000 individuals living in various urban and rural settings.

**Methods**—All new patients with stroke included in the Brest Stroke Registry from 2008 to 2013 were classified as residing in town centers, suburbs, isolated towns, or rural areas. Poisson regression was used to analyze stroke incidence and 30-day case fatality variations in the 4 different residence categories. Models with case fatality as outcome were adjusted for age, stroke type, and stroke severity.

**Results**—In total, 3854 incident stroke cases (n=2039 women, 53%) were identified during the study period. Demographic and socio-economic characteristics and primary healthcare access indicators were significantly different among the 4 residence categories. Patterns of risk factors, stroke type, and severity were comparable among residence categories in both sexes. Age-standardized stroke rates varied from 2.90 per thousand (95% CI, 2.59–3.21) in suburbs to 3.35 (95% CI, 2.98–3.73) in rural areas for men, and from 2.14 (95% CI, 2.00–2.28) in town centers to 2.34 (95% CI, 2.12–2.57) in suburbs for women. Regression models suggested that among men, stroke incidence was significantly lower in suburbs than in town centers (incidence rate ratio =0.87; 95% CI, 0.77–0.99). Case fatality risk was comparable across urban categories but lower in rural patients (relative risk versus town centers: 0.76; 95% CI, 0.60–0.96).

**Conclusions**—Stroke incidence was comparable, and the 30-day case fatality only slightly varied in the 4 residence categories despite widely different socio-demographic features covered by the Brest Stroke Registry. (*Stroke*. 2019;50:00-00. DOI: 10.1161/STROKEAHA.118.024695.)

**Key Words:** demography ■ incidence ■ primary healthcare ■ rural population ■ urbanization

Urban-rural disparities in stroke epidemiology have received only modest attention. In 2008, Joubert et al<sup>1</sup> showed that contrasting urban-rural patterns exist in high-income countries. Specifically, stroke mortality rates were higher among rural than urban residents in the United States and in France,<sup>2</sup> but not in Canada.<sup>3</sup> Stroke mortality variations are mainly explained by stroke incidence and case fatality rates. Accordingly, a recent analysis of the REGARDS cohort study (Reasons for Geographic and Racial Differences in Stroke) demonstrated that the higher stroke mortality among rural residents in the United States could be attributed to its higher incidence.<sup>4</sup> In Europe, 3 studies compared stroke incidence in rural and urban areas in France (period 1989–1993),<sup>5</sup> Bulgaria (2000–2001),<sup>6</sup> and Portugal (1998–2000).<sup>7</sup> All 3 found higher rates in rural communities, and this difference

was significant in France and Bulgaria. It is surprising that, in the context of important urbanization changes, these results, reported nearly 20 years ago, did not trigger more research. This could be partly explained by the localization of most European population stroke registries in urban areas, and therefore their inability to address the question. On the contrary, the French Brest Stroke Registry (BSR), which was launched in 2008, covers the entire western area of the Brittany peninsula in France. This specific feature allowed us to investigate whether stroke incidence and case fatality varied as a function of urban/rural area.

### Methods

This study used data collected in the BSR, a continuous prospective registry of all stroke cases that occurred within the population

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of western France. Requests to access the data set from qualified researchers trained in human subject confidentiality protocols may be sent to Prof Serge Timsit with copy to [drci@chu-brest.fr](mailto:drci@chu-brest.fr). Access is subjected to current data protection guidelines compliance and prior approval from the national agency for data protection. The registry started in January 1, 2008, and uses multiple information sources, as described elsewhere.<sup>8</sup> Briefly, stroke cases are identified through public and private hospitals, radiology clinics performing brain imaging, neurologists, and general practitioners. Relevant *International Classification of Diseases* codes are also sought in 2 exhaustive databases: the Causes of Death database and the Hospital Statistics database. Cases are confirmed by a validation committee. Two definitions of stroke are considered, as previously described<sup>8</sup>: (1) acute focal neurological deficit with symptoms and signs consistent with the World Health Organization definition of stroke, lasting for > 24 hours, or death within the first 24 hours of symptom onset and (2) all neurological focal deficits that last at least 1 hour or resolved within 1 hour, but with abnormal brain imaging associated with clinically relevant signs. BSR performance evaluation based on the capture-recapture analysis suggested a level of completeness of 91% (95% CI, 80–96) in 2008.<sup>8</sup> The vital status of patients included in the BSR is updated by contacting the municipal offices yearly.

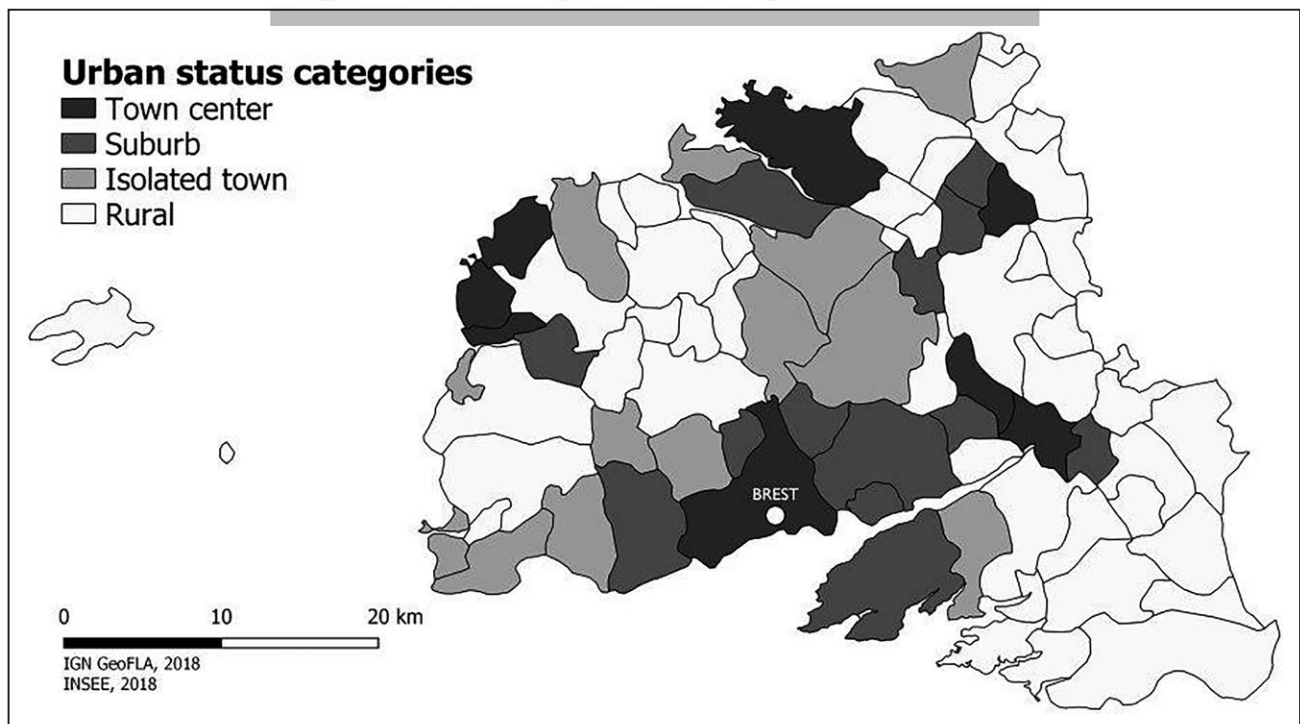
For the present study, all incident ischemic and hemorrhagic stroke cases in  $\geq 25$ -year-old patients that occurred between January 1, 2008, and December 31, 2013, were included. For each case, information on age, sex, risk factors, stroke type, stroke severity (National Institutes of Health Stroke Scale [NIHSS] score and vital status at 30 days) were extracted. High blood pressure, cardiac arrhythmia, diabetes mellitus, and dyslipidemia were ascertained on the basis of their diagnosis and treatment before stroke. Smoking status (former or current smoker and nonsmoker) and high alcohol intake (3 or more drinks per day) were collected at stroke onset directly from the patient or his/her relatives.

Patients were classified as residing in town centers, suburbs, isolated towns, or rural areas. These categories were created using the definition from the French national statistical office. Specifically, an urban unit describes a municipality or a group of municipalities with at least 2000 inhabitants and where no building is farther than 200 m away from its nearest neighbor. All other municipalities were

classified as rural. Urban units localized in a single municipality were classified as isolated towns, whereas urban units that included several municipalities were divided in town centers (ie, towns with more than 50% of the residing population of a given urban unit) and in suburbs. Each of the 79 municipalities included in the BSR geographic area was assigned to one of these urban/rural categories (Figure). Age and sex breakdown of the population for the years 2007 and 2012 was also obtained to derive person-years for the study period. For each residence category, demographic, socio-economic, and healthcare data were obtained from INSEE and information on accessibility to general practitioners from the Institute for Research and Information in Health Economics. This takes into account general practitioners availability in a given municipality and in neighboring municipalities and the local healthcare demand (percentage of < 5-year-old children and of elderly).<sup>9</sup>

Missing data concerned mainly smoking and alcohol intake (30% and 26% of missing data, respectively). Patients with missing data were older and more often women. The missing data rate did not differ according to the residence category. Data were also missing for the NIHSS score (13%) without difference among urban/rural categories.

As stroke incidence varies between sexes, analyses were performed separately for men and women. First, patients' characteristics, risk factors, stroke type, and stroke severity were described according to the urban/rural categories using means and proportions for continuous and categorical variables, respectively. Differences were assessed with the Kruskal-Wallis test for continuous variables, the  $\chi^2$  test for binary variables, and ordered logistic regression for the NIHSS score. Then, the population data from INSEE were used to calculate and analyze the incidence rates. For each sex and urban/rural category, both cases and person-years were grouped in 6 age groups (25–44; 45–54; 55–64; 65–74; 75–84; and 85+). Crude and age-standardized rates were calculated using the 2013 European standard population. Poisson regression was used to model the risk of stroke according to the urban/rural category. In these analyses, the number of incident cases in each age-urban/rural category was modeled using the relevant person-years denominator as offset. Finally, a Poisson regression model was used to calculate the relative risk of 30-day fatality according to the urban/rural category adjusting for stroke type, severity, and stroke unit admission. As



**Figure.** Map of the 79 municipalities included in the Brest Stroke Registry catchment area, classified according to the 4 urban/rural categories (town centers, suburbs, isolated towns, and rural).

case fatality did not differ between sexes, this outcome was modeled for the whole sample. Multiple imputation by chained equations was used to take into account the missing data concerning NIHSS score, stroke type, and stroke unit admission. After the recommendations by White et al,<sup>10</sup> 15 imputations were performed. Finally, the E-values were computed to assess the robustness of our results. The E-value represents the minimum strength of association required to explain an observed association by an unmeasured confounder.<sup>11</sup> All analyses were performed using Stata (Statacorp. 2015 Release 14.2).

BSR is accredited by the French national agency of health surveillance (Santé Publique France) and complies with the French regulation on patient's consent, ethics, and data confidentiality. Specific authorizations were obtained from the national "Comité consultatif sur le traitement de l'information en matière de recherche" and from the "Commission nationale informatique et liberté" for this study.

## Results

From the 3870 incident stroke cases registered in the BSR during the study period, 16 patients were excluded because younger than 25 years (Figure I in the [online-only Data Supplement](#)). The final analysis concerned 3854 patients (n=2039 women, 53%; 1815 men) with a mean age of 74 years and among whom 88% had an ischemic stroke. Patients were from 79 municipalities that included 365564 inhabitants in 2009 (Table 1). Nearly half (48%) resided in the 8 municipalities that were classified as town centers, and the others in isolated towns (17%), suburbs (19%), and rural areas (16%). Town centers were characterized by a higher proportion of women, older residents and unemployed people as well as higher population density compared with the other 3 categories (Table 1). The 45 rural municipalities had a much lower population density, higher proportion of farmers, and a more limited primary healthcare supply. Analysis of the patients' characteristics according to sex and urban/rural categories (Table 2) showed that women were on average 8 years older and had more frequently high blood pressure than men (67% versus 52%,  $P < 10^{-3}$ ). Conversely, smoking and high alcohol consumptions were more frequent in men, but this comparison was hampered by missing data. The stroke type distribution was similar between sexes, whereas NIHSS score  $\geq 14$  (stroke severity) was more frequent among women (women versus men age-adjusted odds ratio for NIHSS  $\geq 14 = 1.43$ ; 95% CI, 1.14–1.78). Overall, age, risk factors, and stroke type/severity were similar in patients from the 4 urban/rural categories in both sexes, but for smoking (in men) and high alcohol intake (in women) that were lower among patients residing in isolated towns and rural areas, respectively. Moreover, diabetes mellitus was less frequent among rural female patients compared with all other patients (8% versus 13%,  $P = 0.02$ ). Admission to intensive care was rare, but was twice more frequent in men than women (6.1% versus 3.3%), without differences according to the urban/rural category within each sex. During the study period, 35.5% of patients were admitted to stroke units, with a slightly higher proportion of men than women (39.5 versus 32.0%,  $P < 10^{-3}$ ). In both sexes, admission to a stroke unit was higher in patients from suburbs and isolated towns compared with those from urban and rural areas (eg, 37.6% versus 44.1% for men from urban areas and isolated towns, respectively). These variations became statistically significant

**Table 1. Demographic, Socio-Economic and Healthcare Characteristics of the 79 Municipalities Included in the Brest Stroke Registry Catchment Area**

	Town Centers	Suburbs	Isolated Towns	Rural
Number of municipalities	8	13	13	45
Demography				
Population	175255	73490	58751	58068
Women (%)	51.6	51.0	51.0	49.4
Aged 75 or more (%)	10.3	7.1	8.7	7.5
Population density, /km <sup>2</sup>	6.7	3.7	2.6	1.0
Socio-economic context				
Manual workers in active pop.(%)	21.4	28.4	25.4	27.3
Farmers in active pop (%)	3.2	4.1	5.2	16.6
Unemployment (%)	9.0	6.5	7.0	6.9
Median annual income (€)*				
Mean	19048	20375	19951	18585
Minimum	17498	17896	17439	15303
Maximum	21139	25018	22326	22228
Primary healthcare				
Municipalities with a GP (%)	87.5	69.2	92.3	51.1
GP density, /1000 pop	1.1	0.9	0.9	0.6
GP accessibility†	72.6	74.6	71.8	49.6

All indicators are for the year 2009 with the exception of Municipalities with GP and Density of GP that are for the year 2016. GP indicates general practitioners.

\*Calculated at the municipal level; it represents the median annual income per unit of consumption in all households of the municipality.

†By taking into account demand and supply factors (source: IRDES).

when men and women were analyzed together ( $P$  value for differences across urban status categories =0.02)

The overall crude annual stroke incidence rate was 2.56 per 1000, and the age- and sex-standardized rate (using the 2013 European standard population as reference) was 2.67 per 1000 (95% CI, 2.59–2.76). Table 3 shows the crude and age-standardized annual stroke incidence rates according to the urban/rural category by sex (the age and sex breakdown of cases and population denominators is available in Table I in the [online-only Data Supplement](#)). As the 2013 European standard population was older than the male population in the territory covered by the BSR, the standardized rates for men were significantly higher (and for women significantly lower) than the crude rates for the total population. After standardization, rate variations among urban/rural categories increased in men (highest incidence in rural areas and lowest in suburbs), and decreased in women. In both sexes and in total, the 95% CI of the standardized rates for the 4 geographic categories overlapped. Poisson regression analyses did not find any significant difference among urban/rural categories, with the exception of a lower stroke risk for men residing in suburbs (incidence rate ratio suburbs/town centers =0.87; 95% CI, 0.77–0.99; Table 4). The E-value

**Table 2. Demographic Data, Risk Factors, Stroke Type, and Severity According to Sex and to the 4 Urban-Rural Categories—Brest Stroke Registry 2008–2013**

	Total	Town Centers	Suburbs	Isolated Towns	Rural	P Value*
<b>Men</b>						
No. of cases	1815	820	347	320	328	
Age (mean [sd]), y	70.0 (13.6)	69.8 (14.3)	71.2 (13.2)	70.1 (13.0)	69.5 (12.9)	0.30
<b>Risk factors (%)</b>						
High blood pressure	52.3	51.1	53.5	52.7	53.8	0.81
Cardiac arrhythmia	19.8	18.0	22.2	20.8	20.6	0.37
Diabetes mellitus	13.1	13.0	12.5	14.2	13.0	0.92
Dyslipidemia	36.8	36.9	38.0	38.6	33.5	0.55
Smoking†	69.5	72.1	70.9	63.0	68.0	0.049
High alcohol intake†	27.2	28.0	29.1	25.3	25.1	0.62
<b>Stroke type (%)</b>						
Ischemic	89.0	88.9	89.3	88.7	89.0	0.99
Hemorrhagic	11.0	11.1	10.7	11.3	11.0	
<b>NIHSS score (%)†</b>						
0–5	73.2	73.8	73.3	71.0	73.7	
6–13	17.5	16.9	15.8	19.2	18.9	0.82
≥14	9.3	9.3	10.9	9.8	7.4	
<b>Stroke care admission to (%)</b>						
Intensive care	6.1	6.2	5.8	6.0	6.2	0.99
Stroke unit	39.5	37.6	41.3	44.1	37.9	0.18
<b>Women</b>						
No. of cases	2039	1011	423	316	289	
Age (mean [sd]), y	78.0 (12.9)	78.4 (13.1)	77.1 (13.4)	77.9 (12.2)	78.0 (12.6)	0.12
<b>Risk factors (%)</b>						
High blood pressure	66.8	67.9	64.4	67.9	65.3	0.56
Cardiac arrhythmia	22.9	22.6	20.0	26.3	24.7	0.19
Diabetes mellitus	12.2	13.1	13.4	11.5	8.0	0.10
Dyslipidemia	32.6	32.2	32.7	34.3	31.9	0.91
Smoking†	22.3	23.8	17.8	24.1	21.3	0.22
High alcohol intake†	4.7	5.6	5.7	3.5	1.4	0.055
<b>Stroke type (%)</b>						
Ischemic	87.2	86.2	87.8	88.6	88.2	0.59
Hemorrhagic	12.8	13.8	12.2	11.4	11.8	
<b>NIHSS score (%)†</b>						
0–5	64.7	66.9	64.2	61.6	61.3	
6–13	19.1	18.8	18.9	18.5	20.9	0.16
≥14	16.2	14.3	16.9	19.9	17.8	
<b>Stroke care admission to (%)</b>						
Intensive care	3.3	3.5	3.8	3.0	3.2	0.52
Stroke unit	32.0	30.0	36.3	33.5	30.8	0.11

NIHSS indicates National Institutes of Health Stroke Scale.

\*Kruskal-Wallis test for age,  $\chi^2$  test for binary variables, and ordered logistic regression for the NIHSS score.

†Former or current; data were missing for smoking (men 22%; women 37%) alcohol (men 21%; women 30%) and NIHSS score (men 10%; women 15%). Percentages were calculated for the whole population.

**Table 3. Crude and Standardized Annual Incidence Rates of Stroke (/1000) According to the Urban and Rural Categories—Brest Stroke Registry, 2008–2013**

	No. of Cases	Person-Years (1000)	Crude Rate (/1000)	Standardized Rate (/1000; 95% CI)*	
<b>Total</b>					
Town centers	1831	699	2.62	2.67	(2.54–2.80)
Suburbs	770	305	2.52	2.62	(2.43–2.81)
Isolated towns	636	248	2.57	2.66	(2.45–2.87)
Rural	617	245	2.52	2.83	(2.60–3.06)
<b>Men</b>					
Town centers	820	328	2.50	3.20	(2.98–3.43)
Suburbs	347	144	2.40	2.90	(2.59–3.21)
Isolated towns	320	119	2.69	3.17	(2.82–3.52)
Rural	328	121	2.71	3.35	(2.98–3.73)
<b>Women</b>					
Town centers	1011	370	2.73	2.14	(2.00–2.28)
Suburbs	423	161	2.63	2.34	(2.12–2.57)
Isolated towns	316	129	2.45	2.15	(1.91–2.39)
Rural	289	124	2.33	2.31	(2.04–2.58)

\*Using the European standard population 2013.

calculation suggested that a minimum strength of association between an unmeasured confounder and stroke incidence of 1.53 would be required to explain away this lower risk. Compared with town centers, risk estimates were marginally higher in rural areas for both sexes. A model comparing rural areas to all the other categories together and adjusted for age and sex also showed a marginally higher (not significant) risk of stroke in rural areas (incidence rate ratio rural/others = 1.07, 95% CI, 0.98–1.17). Analyses performed including only patients with ischemic stroke gave similar results (not shown).

Only 10 patients were lost to follow-up, and 458 patients died within 30 days of stroke onset (30-day case fatality: 11.9%; 95% CI, 10.9%–13.0%). Age, hemorrhagic stroke, and stroke severity were strong, and significant predictors of 30-day fatality (Table 5). No difference was found among patients in the town center, suburb, and isolated town categories, whereas the 30-day fatality was lower in patients residing in rural areas (relative risk versus town centers: 0.76; 95% CI, 0.60–0.96; E-value = 1.97).

### Discussion

Our analysis of a large population-based stroke registry shows that stroke risk did not vary significantly for most categories across the rural/urban spectrum. Only men living in suburbs displayed lower level of risk. With the exception of smoking (lower prevalence among male patients in isolated towns), the risk factor profile and stroke severity were not significantly different among the 4 urban/rural categories. Our results also suggest that the 30-day case fatality is comparable in town centers, suburbs, and isolated towns, but lower in rural areas. Overall, stroke risk varied only moderately across the urban-rural spectrum, despite their very different demographic, socio-economic, and healthcare access features.

A previous registry-based study in the Burgundy region (France) in 1989 to 1993 found that stroke incidence in a small rural town (population = 8900) was 2 times higher than in the city of Dijon (140 000) in both sexes.<sup>5</sup> In the same period, higher (≈30%) stroke mortality was reported in rural areas of the Brittany region (included in the BSR). These differences could be mostly explained by variations in stroke incidence due to the limited effective treatment available at that time.<sup>2</sup> Altogether, these data suggest that the rural disadvantage concerning stroke risk has decreased over the past 3 decades in Brittany, and perhaps in the entire France. Better management of vascular risk factors in rural areas, which was found to be an issue in Burgundy in the 1990s, might have been one of the drivers for this change.

In our study, the 30-day case fatality was comparable in patients from town centers, suburbs, and isolated towns, whereas it was significantly lower among rural patients. Although risk factor prevalence, stroke type, and stroke severity did not vary significantly among urban/rural categories,

**Table 4. Comparison of Stroke Incidence According to the Urban-Rural Categories in Men and Women—Brest Stroke Registry, 2008–2013**

	Men			Women		
	IRR*	95% CI	P Value	IRR*	95% CI	P Value
Town centers (ref)	1			1		
Suburbs	0.87	(0.77–0.99)	0.04	1.10	(0.98–1.23)	0.10
Isolated towns	0.98	(0.86–1.11)	0.73	1.01	(0.89–1.15)	0.83
Rural	1.05	(0.92–1.19)	0.45	1.08	(0.95–1.23)	0.24

Goodness of fit, pseudo R-squared: 0.94 (men); 0.96 (women). IRR indicates incidence rate ratio.

\*IRR derived from age-adjusted Poisson regression models—separate models for men and women.

**Table 5. Demographic, Residence, and Stroke Characteristics Associated With the 30-Day Fatality Risk**

	RR*	95% CI	P Value
<b>Demographic</b>			
Age (+ 1 y)	1.01	(1.00–1.02)	0.01
Male	1.06	(0.90–1.24)	0.52
<b>Stroke type</b>			
Ischemic (ref)	1		
Hemorrhagic	1.57	(1.32–1.87)	<10 <sup>-3</sup>
<b>Stroke unit admission</b>			
No (ref)	1		
Yes	0.44	(0.36–0.54)	<10 <sup>-3</sup>
<b>Residence category</b>			
Town centers (ref)	1		
Suburbs	0.93	(0.77–1.12)	0.44
Isolated towns	0.91	(0.75–1.12)	0.38
Rural	0.76	(0.60–0.96)	0.02
<b>NIHSS score</b>			
0 (ref)	1		
6	4.54	(3.18–6.47)	<10 <sup>-3</sup>
14	15.21	(11.25–20.58)	<10 <sup>-3</sup>

Relative risks from multi-adjusted models. Brest Stroke Registry, 2008–2013. Goodness of fit, pseudo R-squared: 0.26. NIHSS indicates National Institutes of Stroke Scale; and RR, relative risk.

\*RR: adjusted risk ratios from Poisson multiple regression analysis.

the risk factor profile was more favorable in rural patients, with lower prevalence of diabetes mellitus among women for instance. A study on the pre- and post-stroke management of cardiovascular risk factors and on the formal and informal care trajectories could help to understand the better prognosis of rural patients. Admission to intensive care or to stroke units was comparable among urban/rural categories, suggesting that acute care is homogeneous in the territory covered by the BSR. Conversely, an analysis of the Ontario stroke registry involving 153 acute care hospitals showed that rural patients were less likely to be admitted to stroke units, and to benefit from brain imaging and from rehabilitation.<sup>12</sup> Furthermore, the rural/urban disparity in tissue plasminogen activator use for patients with acute ischemic stroke seems to have widened in the United States between 2000 and 2010.<sup>13</sup> Conversely, no difference in secondary prevention, medication persistence and outcomes was observed in the 12 months after stroke occurrence in a nationwide analysis comparing rural and urban patients.<sup>14</sup> As long-term stroke care requires access to and coordination among health and social services, an analysis of the long-term outcomes would be useful to determine whether urban-rural equity in acute care continues also in the long-term. Findings from the Dijon stroke registry in France demonstrated that although chance of survival up to discharge from acute care was comparable, the residential level of affluence was inversely associated with longer (90 days) survival,<sup>15</sup> underlining the interest of performing a similar analysis using the urban/rural categories.

One difficulty in reviewing the literature is the variety of the urban/rural categorizations. The United Nation defines rural areas as what is not urban.<sup>16</sup> Some authors used this principle to distinguish rural and urban areas, with specific differences in population size and density.<sup>6,7</sup> Other researchers (and also this study) used existing classifications from governmental bodies or national statistics agencies to define the urban-rural continuum. Although these classifications differ among countries, they are usually based on explicit criteria that help to understand, interpret, and compare data. The INSEE classification is based on population size and building continuity and allows the identification of well-differentiated categories (Table 1). Another advantage of such tools is that they can extend beyond the simple urban-rural dichotomy by providing a richer and meaningful categorization of areas along the urban/rural spectrum. Another difficulty is that some studies compared areas that are not neighboring and are sometimes quite distant from each other. In these cases, besides the degree of urbanicity, other factors related to geographic distance may also play a role in the risk differentiation. As the BSR encompasses the whole urban-rural spectrum within its boundaries, we were able to avoid this limit.

Other strengths of our study include the population-based large sample and the demonstrated exhaustive case ascertainment. However, a degree of exhaustiveness variation according to the urban status might have occurred. For instance, rapidly fatal strokes in rural patients are less likely to be recorded in the BSR. This might have underestimated the stroke incidence in rural areas, but it should not have altered substantially the conclusion of no major variation of incidence across urban/rural categories. However, it could have contributed to the lower fatality rate observed in rural patients. Inability to adjust for the patients' socio-economic status, a variable that is not commonly collected in disease registries, is another limitation of our study. Indeed, socio-economic status can influence stroke incidence and survival.<sup>17,18</sup>

In conclusion, our findings suggest that within the BSR territory, stroke incidence did not vary across urban and rural areas, despite their significantly different demographic and socio-economic characteristics and healthcare access. This suggests that providing equitable primary prevention and acute care for patients with stroke is achievable across different areas. Whether this applies to the whole of France and to other comparable countries is open to question because national database-based analyses tend to reveal disparities.<sup>19</sup> Additional investigations are required to confirm the lower case fatality observed in rural patients and to understand its determinants. Achieving universal health coverage and healthcare access is a challenge that all countries are facing to different extents. In France, for instance, primary healthcare coverage is an issue in remote rural territories and in suburban areas. Such considerations highlight the importance of monitoring the health system efficacy in preventing and managing chronic diseases equitably across territories.

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## Disclosures

None.

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