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ORIGINAL ARTICLE

Living standard is related to microregional differences in stroke characteristics in Central Europe: the Budapest Districts 8–12 Project

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Abstract
Objectives To test whether stroke features relate to living standard within one city by comparing 2 districts.
Methods District-8 (D-8) ranks the last, whereas District-12 (D-12) is the second regarding personal monthly income of the 23 districts of Budapest, Hungary. Stroke cases hospitalized in 2007 were identified by the database of the National Health Insurance Fund and postal codes for living address. Case certification was performed by personal visits to the general practitioners. Demographic data, risk factors and survival status in 2010 were analyzed using the anonymized database.
Results Three-year case fatality was 36.6 % in D-8 and 31.5 % in D-12 ($p = 0.24$). Of the fatal cases, men were more than 12 years younger in D-8 than in D-12 (69.2 ± 13.3 vs. 82.4 ± 9.2 years, $p < 0.001$). Men died younger than women in D-8 (69.2 ± 13.3 vs. 75.2 ± 12.4; $p = 0.036$), but not in D-12 (82.4 ± 9.2 vs. 81.9 ± 7.3, $p = 0.8$). Non-treated hypertension, alcohol dependence, and smoking were significantly more prevalent in the poor district ($p < 0.01$ for all).
Conclusion In national stroke programs of former Eastern Block countries, primary prevention should focus especially on male populations of less wealthy regions.

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Keywords Living standard · Age at stroke · Gender differences · Neighborhood

Introduction

Despite the recent worldwide decrease in stroke mortality (Mirzaei et al. 2012), stroke is still a major public health issue in developed as well as developing countries (Johnston et al. 2009). There is a clear West–East gap in stroke epidemiology: former communist countries of Central-Eastern Europe are leading the mortality statistics of those countries that are regularly able to submit national data (Roger et al. 2012). In a systematic review comparing countries, Sposato and Saposnik (2012) found that lower gross domestic product (GDP) was associated with the higher incident risk of stroke, higher case fatality, a greater proportion of hemorrhagic strokes, and lower age at stroke onset.

The relationship between disadvantaged living conditions and worse stroke characteristics has been recognized, with stronger evidence for incidence and mortality (Cabral et al. 2011), but stroke severity and outcome have also been suggested to be worse in lower socioeconomic groups (Cox et al. 2006). Such associations have mostly been seen in large scale studies: international surveys comparing countries (Mackenbach et al. 2000) large areas within one country (Lavados et al. 2011; Kapral et al. 2012), or studies across cities (Grimaud et al. 2011). Even when small areas were used as the unit of measurement, the values were combined for larger regions (Smits et al. 2002). A recent study indeed suggested that country-level income inequalities reflecting larger populations more likely show association between income and poor health, and such relationship is more difficult to detect among populations <820 thousand inhabitants (Kondo et al. 2012).

Interestingly, in a preliminary study comparing 135 patients in 3 regions of the catchment area of our tertiary stroke center, we found that both hospital and 1-year case fatality were higher in the least wealthy region (Szőcs et al. 2012). In the current study, we compared stroke characteristics and long-term outcome in 2 districts in the city of Budapest, Hungary to test whether living conditions relate to stroke characteristics at the microregional level as well. As in the feasibility study, we found that in this region, the combination of telephone- and mail questionnaire-based follow-up can reach only 84 % of patients 1 year after stroke, we applied a more efficient follow-up method in the current study. We identified stroke cases hospitalized in 2007 in the 2 districts in the database of the single national health insurance system, based on the 10th international classification of diseases (ICD-10) and postal codes for living addresses. Case certification was performed by personal visits to the general practitioners (GPs). Follow-up of survival status was performed at 3 years after stroke.

Methods

Study setting

Budapest is the capital and the largest city of Hungary, with 1.8 million inhabitants. The population of the city is relatively homogeneous: according to the 2011 census, no Hispanics live in the districts, and the proportion of the African and Asian population combined is less than 0.6 % in both districts (Hungarian Central Statistical Office 2013a). The city is divided into 23 districts: District 8 ranks last whereas District 12 is the second, regarding the monthly net income among the districts of Budapest. Population size and net income per person of the districts were obtained from the published surveys for 2009 (CID 2011). The Budapest District 8–12 project is a 3-year follow-up of those inhabitants who are residents of the 8th or the 12th district (a population of 71,257 and 59,229 inhabitants, respectively), and had been hospitalized for stroke in 2007. Data from the census of Hungary in 2011 (Hungarian Central Statistical Office 2013b) and the 2013 version of the European standard population (Pace et al. 2013) were used to calculate age-standardized rates for the incidence of ischemic strokes in the 2 districts. Age distribution in the 2 districts based on the 2011 census data separately for each district was used during standardization.

Case identification

Case identification was based on the hospital reports of those with a postal code address of any of the two districts and discharged from any hospital in Hungary with the diagnosis of stroke in 2007. Cases and their general practitioners were identified from the database of the National Health Insurance Fund (NHIF)—the universal state insurance organization: the total population of Hungary is covered by the NHIF including acute hospital care. Identification was based on the postal code of residence and ICD-10 codes I60, I61, I63 and I64. Private hospitals are exceptional in Hungary and their contribution to hospitalization for acute stroke is negligible. In the region of the study, there are no private hospitals treating patients with acute stroke. Hospitalization is the routine practice in stroke in Hungary. An anonymized database was created from the downloaded NHIF data, and the NHIF case number was used in the further data collection at the GPs.

Case certification

Case certification was performed by personal visits of the study team to the general practitioners. From the GPs' records, first it was checked if the patient indeed was in his/her care and was hospitalized for acute stroke in 2007. For cases hospitalized for acute stroke, the GP filled out an anonymized questionnaire about his/her patient covering the history of the patient, risk factors, events during hospital stay, treatment during and after the acute period, and the condition of the patient by the modified Rankin scale. Survival status of the patients 3 years after stroke was confirmed by the database of the NHIF. No attempt was made to contact patients or their families, and patient anonymity was kept throughout the study.

Statistical analysis

Descriptive statistics were used to analyze patient characteristics. The Shapiro–Wilk test was used to check if continuous variables were normally distributed. Continuous variables were compared by ANOVA and frequencies by the Chi squared test. Statistical significance was assumed when $p < 0.05$. Statistica for Windows v.9. (StatSoft, Tulsa) was used for data analysis.

Results

All GPs in both districts agreed to participate in the study. Of the 840 patients identified with a discharge diagnosis of a cerebrovascular disease, 43 (5.1 %) could not be identified during the visit of the study team, and 437 had acute stroke in 2007 (227 in D-8 and 210 in D-12; Fig. 1). Strokes were ischemic in 393 cases ($n = 194$ and $n = 199$ in D-8 and D-12, respectively); whereas 35 patients had intracerebral hemorrhage and 9 had subarachnoid

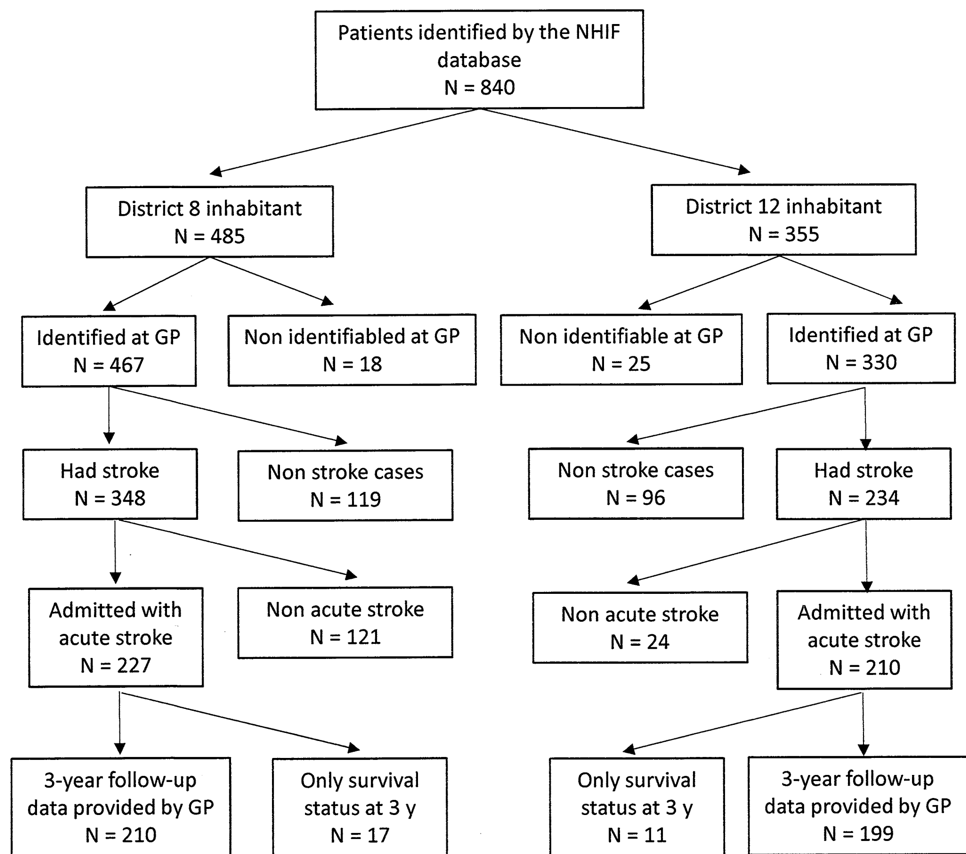

Fig. 1 Flowchart of patient inclusion in the analysis of the Budapest Districts 8–12 Project in Hungary, 2007

Table 1 Demographic characteristics in the Budapest Districts 8–12 project in Hungary, 2007

Feature	District 8	District 12
Population	71,257	59,229
Population density (inhabitants/km^2)	12,003	2120
Net income per person per month (HUF)	85,976	153,796
Net income per person per month (EURO)	291	521
Rank in income among 23 Budapest districts	23	2
Acute stroke cases in 2007	227	210
3-year case fatality (%)	36.6	31.5
Age at stroke onset (years, mean ± SD)	67.2 ± 14.8	74.0 ± 11.4*
General practitioners serving the district (*n*)	58	54
Inhabitants/GP	1228	1096

* $p < 0.001$ between the two districts

hemorrhage. Age-standardized incidence rates for ischemic hospitalized strokes were higher in the less wealthy district: 291/100.000 in D-8 and 277/100.000 in D-12 using the 2013 values for the European Standard Population. Demographic features of the 2 districts are presented in Table 1. The less wealthy region (D-8) is over 5 times more densely populated, the net income is 44 % less, and age at stroke onset is 7 years younger than of those in the wealthier district. The intensity of primary health care—expressed as the number of inhabitants served by one GP—is similar in the 2 districts.

Age distribution at stroke onset in the 2 districts shows a different pattern: whereas in the wealthier D-12 the peak is between 70 and 85 years of age, in the less wealthy D-8 an

additional peak between 55 and 65 years of age can be observed (Fig. 2).

After 3-year follow-up, case fatality was 36.6 % in D-8 and 31.5 % in D-12 ($p = 0.24$). The age of stroke survivors is several years younger in both sexes in D-8 than in D-12 (62.0 ± 14.0 vs. 69.9 ± 11.9; $p < 0.001$ for men and 66.1 ± 15.5 vs 71.1 ± 10.2; $p = 0.017$ for women); while there is no gender difference in age in the wealthy district ($p = 0.5$), men tend to be younger than women in D-8 ($p = 0.10$) (Fig. 3).

Patients with fatal outcome are older than survivors in both districts. Within this group, there is no gender difference in age in the wealthy district (men: 82.4 ± 9.2, women: 81.9 ± 7.3 years, $p = 0.8$), whereas men are younger than women in D-8 (69.2 ± 13.3 vs. 75.2 ± 12.4 years, $p = 0.036$). Comparing the 2 districts, there is a surprisingly large, over 12 years difference between men with fatal outcome 69.2 ± 13.3 in D-8 vs. 82.4 ± 9.2 years in D-12 ($p < 0.001$, Fig. 4).

There were 27 intracerebral hemorrhage (ICH) cases in D-8 and 8 cases in D-12 (Chi square test, $p < 0.01$). Although the number of cases in D-12 is low for statistical analysis, it is worth to note that those with ICH in the poor district (D-8) are over 10 years younger than those with

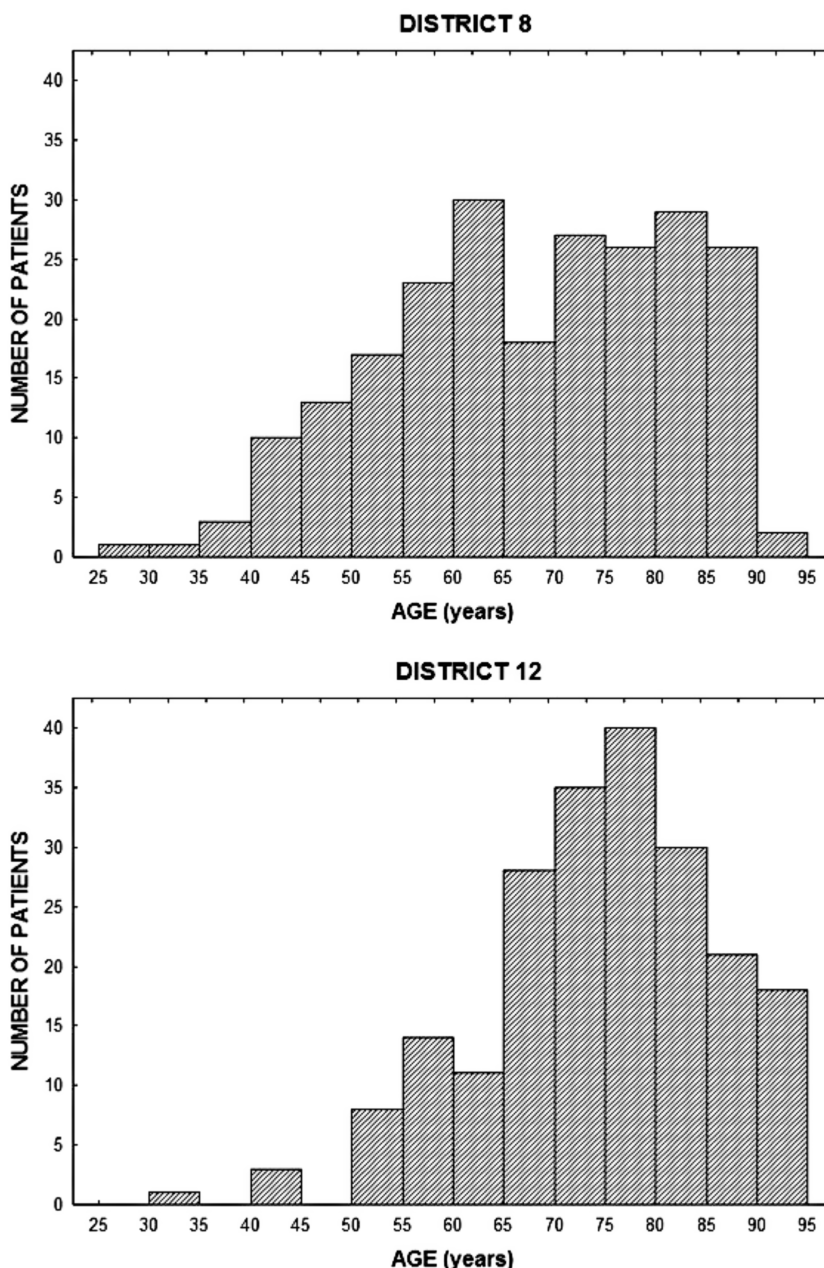

Fig. 2 Age distribution for all strokes at stroke onset in the 2 districts in Budapest, Hungary, 2007

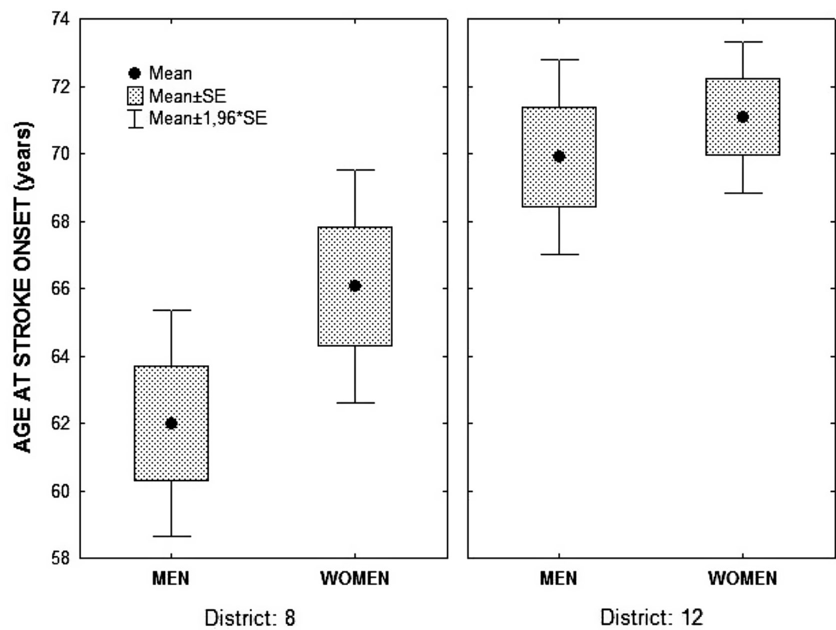

Fig. 3 Age at stroke onset in survivors 3 years after their stroke in Budapest, Hungary, 2007. There is no sex difference in D-12 ($p = 0.5$), whereas men tend to be younger in D-8 ($p = 0.1$)

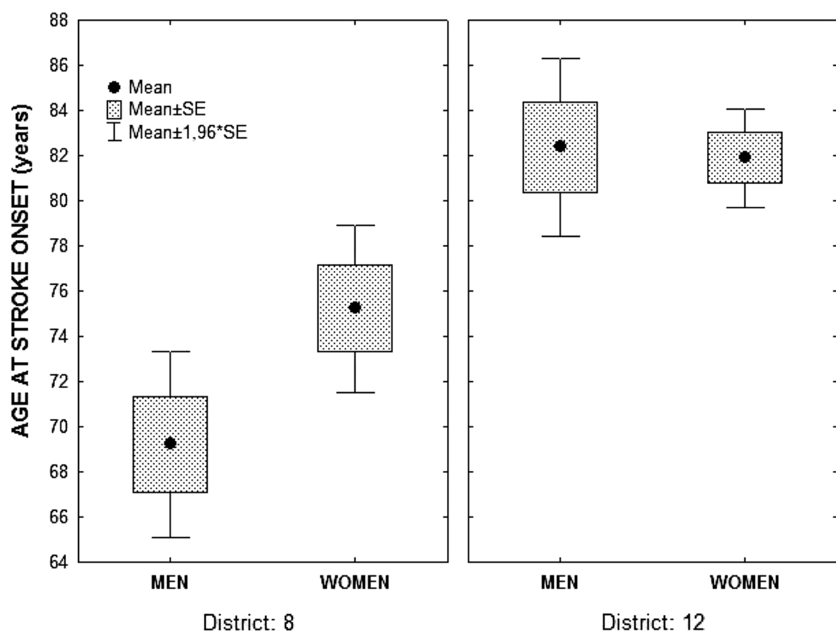

Fig. 4 Age at stroke onset in those with fatal outcome 3 years after their stroke in Budapest, Hungary, 2007. There is no sex difference in D-12 ($p = 0.8$), whereas men are younger than women in D-8 ($p = 0.036$)

ICH in the wealthy district (64.5 ± 17.2 and 74.8 ± 10.4 years, $p = 0.13$), and this difference again, comes from the young mean age of men with ICH in the less wealthy district (men in D-8: 58.9 ± 15.5 years, men in D-12: 77.0 ± 11.3). For ICH cases, although the number is insufficient for reliable statistical comparison, it may be of note that almost all patients with ICH had hypertension, 10 out of the 27 cases in D-8 but none of the 8 subjects in D-12 had non-treated or non-regularly treated hypertension ($p = 0.046$).

Distribution of risk factors among all stroke patients is compared in Table 2. The rate of hypertension is uniformly high in both districts and both genders. Of the risk diseases, only diabetes differs significantly between the districts with higher value in the less wealthy district. Life style risk factors, however, are significantly more prevalent among stroke patients of the less wealthy district. Despite the similar rate of hypertension and primary care intensity in the 2 districts, the rate of non- or non-regularly treated hypertension is significantly larger in the less wealthy district.

Table 2 Risk diseases and lifestyle risk factors in stroke patients in the Budapest Districts 8–12 project in Hungary, 2007

Risk factor	D8 men	D8 women	D8 all	D12 men	D12 women	D12 all	*p* D8 vs D12
Hypertension	86	82	84	80	87	84	NS
AF	15	15	15	18	18	18	NS
Other heart diseases	33	32	32	34	38	36	NS
PAD	20	13	16	15	9	11	NS
Diabetes	32	19	25	21	14	17	0.04
Previous stroke/TIA	21	30	26	20	24	22	NS
Smoking	59	29	43	22	13	17	<0.001
Heavy smoking	26	9	17	6	2	3	<0.001
Alcohol dependence	34	6	19	9	2	5	<0.01
Non- or non-regularly treated HT	32	18	24	3	7	6	<0.001

Values are %

D8 District-8, *D12* District-12, *AF* atrial fibrillation, *PAD* peripheral arterial disease, *HT* hypertension

Discussion

The major findings of our study are the following. In less wealthy regions, stroke hits several years earlier, and the difference is largest in fatal cases in men. ICH is more frequent and occurs at a younger age; and the rate of risk diseases is similar whereas life style risk factors are more prevalent in the poor district. Despite the universal healthcare availability, primary prevention, especially control of hypertension is less efficient in poor neighborhoods. Finally, in contrast to the assumption that larger populations are needed to detect the effect of living standard on health (Kondo et al. 2012), differences related to stroke are large enough to be detected even within one city comparing relatively small populations.

Living standard and age at stroke onset

The association of living standard with stroke features may involve several factors like level of education, personal income, household income, unemployment status, occupation, level of social support, etc. To evaluate these factors, patients or their families have to be interviewed. Such individual data are not available if anonymized hospital discharge reports are used in epidemiological studies. When comparing the 2 districts, we used the mean district net income per person in this study. For regional comparisons, neighborhood income was reported to be an effective substitute for individual income (Southern et al. 2005). Although area-based household income poorly correlated with self-reported income in another study, both values were found relevant in cardiac disease (Hanley and Morgan 2008). Further, area-based estimations were found appropriate when investigating larger differences in income (Hanley and Morgan 2008), as is the case between the two districts in our study.

Stroke databases from different countries also suggest that living standard has an effect on age at stroke onset: in countries with lower socioeconomic situation, stroke hits several years earlier. For example, the mean age in a Nigerian stroke database is 57 years (Gbiri and Akinpelu 2012), 68 years in Hungary (Bereczki et al. 2009), 70 years in Bergen, Norway (Sand et al. 2012), 71.4 years in Finland (Meretoja et al. 2010) and 73 years in Canada (Grimaud et al. 2011). These age values at stroke onset reflect the general health condition of the population, and the numbers run in parallel with life expectancy at birth in these countries: Nigeria, 54; Hungary, 74; Norway, 81; Finland, 80; and Canada, 81 years (WHO 2012). This general trend of better health condition with higher income was found at the microregional level as well in our study within one city. Overall, the disadvantaged socioeconomic environment in the less wealthy district resulted in a temporal anteposition (like "anticipation") of stroke.

Rate of intracerebral hemorrhage

ICH was found to occur more frequently and at a younger age by a recent systematic review in less wealthy countries (Sposato and Saposnik 2012). Again, the conclusions of this review at the international level are reflected in our findings at the microregional level.

Greater vulnerability of men

Disadvantaged socioeconomic status has more health effect in men than in women. For example, Steenland et al. (2004) comparing 4 quartiles of socioeconomic status

found that compared to those in the highest status, women have 1.53 whereas men have 2.25 higher stroke mortality in the lowest quartile. In our study, the higher rate of some risk factors may be one of the reasons for the higher vulnerability of men. In the Hungarian culture, men are expected to provide the financial support for the family. The frustration associated with the failure in this field of life in the deprived environment might result in depression, excessive alcohol use, heavy smoking—further increasing stroke risk in the younger male population (Roelfs et al. 2011; Sposato et al. 2012).

Stroke outcome

We did not find difference in 3-year case fatality between the 2 districts. No effect of socioeconomic position and case fatality was found by an Italian study as well (Cesaroni et al. 2009). Similar to Italy, Hungary also has a universal healthcare system, i.e., the whole population is covered by the national health insurance. This certainly means that health care availability is similar in the 2 districts of our study—also signed by the similar rate of population per GPs.

The role of risk factor difference in the findings

Hungary has a universal healthcare system. Equal healthcare availability, however does not mean equal use of healthcare resources, as reflected in our study by the significantly larger proportion of those with not properly treated hypertension in the poor district (Table 2). Our unfavorable findings in the less wealthy district might be fully or partly explained by the more prevalent lifestyle stroke risk factors. Of the stroke risk diseases, only diabetes was more prevalent in the poor district—a finding similar to that of a study from London (Stringhini et al. 2012). In our parallel study, we found that dietary habits also differ between the 2 districts: for example, in the less wealthy district, people spend on fruits 62 % and on vegetables only 26 % compared to those living in the wealthy district (Folyovich et al. 2014). Several reports found that poverty was a strong and independent risk factor, explaining about one third of the variation between populations with different socioeconomic status in wealthy as well as less wealthy countries (Johnston et al. 2009; Liao et al. 2009; Lavados et al. 2011).

Our study has several limitations. First, our study was not designed to define standard epidemiological terms like incidence, prevalence and mortality, but our patients were identified based on hospital discharge reports. For this reason, accurate population-based epidemiological features cannot be calculated from our numbers. According to our recent survey, the hospitalization rate for ischemic stroke was 77 % for D-8 and 70 % for D-12 (Bereczki and Ajtay 2014). Similar to those who were hospitalized for their strokes, stroke cases treated only as outpatients were also 6 years younger in the less wealthy district. As there are no financial limitations due to the universal health care system, we do not think that differences in hospitalization habits in the two districts could have resulted in considerable selection bias distorting our conclusions. The system of medical private insurances has not been developed at a considerable volume yet in Hungary for hospital care, the few exceptional cases if any, could not result in selection bias.

Second, as this was an epidemiological survey with no direct contact with patient or family, supplementary information not included on the GPs report forms could not be collected and the data supplied by the GPs could not be checked. Therefore, accuracy of data on risk factors depended on the GPs reports. For the same reason, no direct information could be obtained on several life style risk factors. Although in a parallel study, we found less fruit and vegetable consumption in the less wealthy district (Folyovich et al. 2014), we do not have data on physical activity. Further, the availability of supplementary information on stroke cases only did not allow to evaluate if the risk factors found to be different between the districts (Table 2) are the factors linking socioeconomic status and stroke. In fact, we cannot exclude that the same differences observed among cases could be found also between D8 and D12 in the stroke-free population.

The strength of our study is the population base for the hospitalized cases. It is also important, that we personally contacted all involved GPs and could confirm if the diagnosis reported at discharge by the treating hospitals indeed reflected acute stroke. With this approach, a considerable rate of stroke misdiagnosis in medical records could be excluded or at least decreased (Stegmayr and Asplund 1992).

We conclude that living standard has a strong effect on stroke characteristics, and these effects can be identified not only in international comparisons but also at the microregional level. National stroke prevention programs should have a special focus on male populations of less wealthy regions. The 3 major targets of these campaigns could be: to decrease heavy smoking, to decrease alcohol dependence and to achieve regular treatment of hypertension.

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Conflict of interest The authors have nothing else to disclose regarding the content of this manuscript.

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