M.A. Busch · A. Schienkiewitz · E. Nowossadeck · A. Gößwald
Department of Epidemiology and Health Monitoring, Robert Koch Institute, Berlin

Prevalence of stroke in adults aged 40–79 years in Germany

Results of the German Health Interview and Examination Survey for Adults (DEGS1)

Stroke is the second most frequent cause of death worldwide, a main cause of disability and a major cost factor for health care systems [1, 2, 3, 4]. Advances in stroke prevention and therapy have led to steadily falling incidence and mortality rates in high-income countries in recent decades [5, 6]. Nevertheless, due to demographic change, an increase in the total number of strokes is to be expected in many countries in the coming years [7, 8]. In this context, up-to-date epidemiological data on stroke and its temporal trends are an important basis for the estimation of the future burden of stroke and associated care needs within the population.

In Germany, too, stroke remains the second most frequent cause of death after coronary heart disease, despite the mortality rate from stroke decreasing continually in the last few decades [9]. There are currently no up-to-date data available from Germany regarding temporal trends in stroke incidence. Therefore, it is unclear whether the positive trend in mortality is caused mainly by declining incidence, decreasing case fatality, or both. Data from other countries, however, suggest that both trends are occurring at the same time [5, 10, 11].

In addition to incidence and mortality, the prevalence of stroke also has a high relevance for public health and health care planning, since it indicates the percentage of stroke survivors within the general population. Up to three quarters of all strokes are survived [12, 13] and the persons affected must subsequently be provided with secondary preventive measures such as vascular surgery and specific medical therapies as well as with rehabilitative or care services [14]. Current representative data from the first wave of the "German Health Interview and Examination Survey for Adults" (DEGS1) for people aged 40–70 years can be used to describe this population group. It is also possible to investigate the temporal trend in stroke prevalence for this age group in comparison with data from the German National Health Interview and Examination Survey 1998 (GNHIES98) [15].

This article presents the findings of DEGS1 regarding the lifetime prevalence of physician-diagnosed stroke in adults aged 40–79 years in Germany and examines trends in prevalence since GN-HIES98.

Methods

Study design and sample

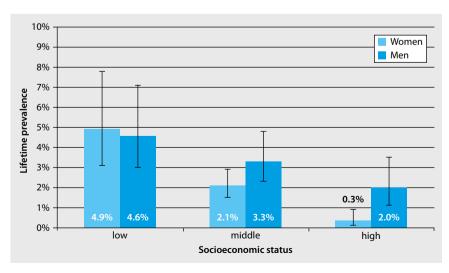The "German Health Interview and Examination Survey for Adults" (DEGS) is

Fig. 1 ▲ Lifetime prevalence of stroke in percent (95% confidence interval) according to sex and socioeconomic status, n=5,751

Tab. 1 Lifetime prevalence of stroke in adults aged 40–79 years in Germany in DEGS1 (n=5,842) according to age group and sex

Age group in years	40–49	50–59	60–69	70–79	Overall
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Women	1.1 (0.4–3.1)	0.8 (0.3–2.1)	3.1 (1.7–5.5)	6.3 (4.3–9.1)	2.5 (1.8–3,4)
Men	0.7 (0.3–1.7)	1.8 (1.0–3.4)	5.4 (3.6–8.0)	8.1 (5.5–11.9)	3.3 (2.6–4.2)
Overall	0.9 (0.4–1.8)	1.3 (0.8–2.2)	4.2 (3.0–5.9)	7.1 (5.2–9.7)	2.9 (2.3–3.6)

Tab. 2 Trends in lifetime prevalence of stroke over time in adults aged 40–79 years in Germany between GNHIES98 (n=4,268) and DEGS1 (n=5,842)

	GNHIES98[a]	GNHIES98, age-adjusted[b]	DEGS1[b]	Change	Change, age-adjusted
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Women	2.3 (1.7–3.2)	2.3 (1.7–3.2)	2.5 (1.8–3.4)	+0.2 (−0.9; +1.2)	+0.2 (−0.9; +1.2)
Men	2.4 (1.8–3.2)	2.8 (2.1–3.9)	3.3 (2.6–4.2)	+0.9 (−0.1; +1.9)	+0.5 (−0.6; +1.6)
Overall	2.4 (1.9–2.9)	2.6 (2.1–3.2)	2.9 (2.3–3.6)	+0.5 (−0.2; +1.3)	+0.3 (−0.5; +1.1)

[a]Adjusted to population structure as of 31 December 1997 [b]Adjusted to population structure as of 31 December 2010

part of the health monitoring programme at the Robert Koch Institute (RKI). The concept and design of DEGS are described in detail elsewhere [16, 17, 18, 19, 20]. The first data collection wave (DEGS1) was conducted from 2008 to 2011 and comprised interviews, examinations and tests [21, 22]. The target population was the resident population of Germany aged 18–79 years. DEGS1 has a mixed design, which permits both cross-sectional and longitudinal analyses. For this purpose, a random sample from local population registries was drawn to supplement former participants of GNHIES98. A total of 8,152 people participated, including 4,193 first-time participants (response rate 42%) and 3,959 former participants of GN-HIES98 (response rate 62%). In all, 7,238 persons visited one of the 180 examination centres, and 914 were interviewed only. The net sample permits representative cross-sectional analyses for the age range of 18–79 years (n=7,988, including 7,116 in study centres) and time trend analyses in comparison with GNHIES98 to be carried out [17]. The analyses presented here refer to the sample of 5,901 people (3,110 women and 2,791 men) aged 40–79 years [17].

Variables

As part of a standardised, computer-assisted, personal interview (CAPI) conducted by a study physician, the following question was asked in DEGS1 to es-

tablish whether a stroke had ever been diagnosed by a physician: "Has a doctor ever diagnosed you as having a stroke?" In GNHIES98 it was asked analogously in a physician interview: "Has a doctor ever diagnosed the following illnesses or disorders: stroke?"

Socioeconomic status was determined using an index that was based on information on school and further education, vocational training, professional status and net household income (weighted by household needs) and which allows classification into either the low, middle or high status group [23].

Statistical analysis

The lifetime prevalence of stroke was calculated as a percentage with 95% confidence interval (95% CI) of the total number of participants with valid answers ("Yes" or "No") to the question about ever-diagnosed stroke. Participants with missing data or who answered "Don't know" were excluded from the analyses.

The cross-sectional analyses on stroke prevalence in DEGS1 were carried out using a weighting factor, which corrects sample deviations from population structure (as of 31 December 2010) with regard to age, sex, region and nationality, as well as type of community and education [17]. When calculating the weighting factor for former participants of GNHIES98, the probability of repeated participation,

based on a logistic regression model, was taken into account. A non-response analysis and a comparison of selected indicators with data from official statistics indicate a high level of sample representativeness for the resident population of Germany aged 18–79 years [17].

For the analysis of the temporal trend, stroke prevalence in DEGS1 was compared with the prevalence in GNHIES98 [15]. To this end, prevalence figures not yet available for GNHIES98 participants aged 40–79 years were calculated. In the course of this the GNHIES98 sample was adjusted to the population structure as of 31 December 1997 by weighting the results for age, sex, region, nationality, community type and education analogous to the weighting method in DEGS1 [17]. In order to take into account the demographic changes in population structure since GNHIES98, in the second step of the trend analysis, the GNHIES98 data were age-adjusted to the population structure as of 31 December 2010.

In order to take into account both the weighting and the correlation of the participants within sample points, the confidence intervals were determined using survey procedures in Stata 12.1 and SAS 9.3 [24]. Differences were deemed to be statistically significant if the respective 95% confidence intervals of the prevalence estimates did not overlap.

Results

Data from the CAPI regarding physician-diagnosed stroke were available for 5,842 participants (99.0%) aged 40–79 years, of whom 3,073 were women and 2,769 men.

The lifetime prevalence of stroke in the age group 40–79 years overall is 2.9%. The prevalence is 2.5% in women and 3.3% in men. In both sexes, as well as in total, prevalence increases continually with age: in women from 1.1% in the age group 40–49 years to 6.3% among persons 70–79 years old; for men in the same age groups it increases from 0.7 to 8.1%, respectively (◘ **Tab. 1**).

Both overall and in women and men separately, the lifetime prevalence of stroke is at its highest among people of low socioeconomic status and at its lowest amongst those of high socioeconomic

status (Fig. 1). This inverse social gradient is more clearly pronounced amongst women than men and remains if age differences between the status groups are controlled for in the statistical analysis.

 Tab. 2 compares lifetime prevalence of stroke in the age group 40–79 years in DEGS1 with those in GNHIES98. In GNHIES98, stroke prevalence in the age group 40–79 years, adjusted to the population structure as of 31 December 1997, was 2.4% (women, 2.3%; men, 2.4%). After age-adjustment to the population structure as of 31 December 2010, the prevalence increased overall to 2.6% and to 2.8% amongst men. Given broadly overlapping confidence intervals of the prevalence estimates, there are no statistically significant differences in stroke prevalence between GNHIES98 and DEGS1, either as a whole or in both sexes separately.

Discussion

In view of the demographic change in Germany, up-to-date data on stroke prevalence and its trends are of major importance for the estimation of the future burden of disease and associated care needs within the population. The analyses from DEGS1 presented here make an important contribution towards this. According to these data, the lifetime prevalence of stroke among people aged 40–79 years in Germany is 2.9%. There is no clear evidence for a change in the prevalence in this age group in the last 12 years.

Owing to the restriction to the 40–79-year age group, the prevalence estimate resulting from DEGS1 is not directly comparable with that of other studies. The median age at which a first stroke occurs is 73 years in Europe, with an interquartile range of 62–81 years [25]. This allows us to roughly estimate that up to two thirds of the cases in the total population may be recorded in the sample of 40–79 years investigated in DEGS1. Based on the data from the nationwide telephone health survey "German Health Update" (GEDA) 2009–2010 conducted by the Robert Koch Institute, stroke prevalence in adults aged 18 years and above—with no upper age limit—was estimated at 2.5% [26]. For the age group 40–79 years investigated in

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Abstract

In the German Health Interview and Examination Survey (DEGS1), data on the prevalence of physician-diagnosed stroke were collected from 2008 to 2011 in a representative population-based sample of 5,901 adults aged 40–79 years. The stroke prevalence in DEGS1 was compared with prevalence estimates from the German National Health Interview and Examination Survey 1998 (GNHIES98). The lifetime prevalence of stroke in adults aged 40–79 years is 2.9% (women: 2.5%; men: 3.3%). In both sexes, the prevalence increases continuously with age, up to 6.3% in women and 8.1% in men 70–79 years old. More pronounced in women than in men, the prevalence of stroke decreases with increasing socioeconomic status. Compared to GNHIES98, there is no evidence for a change in stroke prevalence over time. The prevalence of stroke in adults aged 40–79 years in Germany is comparable to prevalence estimates from other national and international studies. Further studies should examine the reasons behind stable prevalence rates, accounting for population ageing and changes in incidence, mortality and case fatality rates.

Keywords

Stroke · Prevalence · Trend · Health survey · Population

Prävalenz des Schlaganfalls bei Erwachsenen im Alter von 40 bis 79 Jahren in Deutschland. Ergebnisse der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1)

Zusammenfassung

In der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1) wurden von 2008 bis 2011 in einer bevölkerungsrepräsentativen Stichprobe von 5901 Personen im Alter von 40 bis 79 Jahren Daten zur Prävalenz des ärztlich diagnostizierten Schlaganfalls erhoben. Die zeitliche Entwicklung der Schlaganfallprävalenz wurde durch einen Vergleich mit dem Bundes-Gesundheitssurvey 1998 (BGS98) untersucht. Die Lebenszeitprävalenz des Schlaganfalls in der Altersgruppe von 40 bis 79 Jahren beträgt insgesamt 2,9% (Frauen 2,5%; Männer 3,3%). Bei beiden Geschlechtern steigt die Prävalenz mit zunehmendem Alter kontinuierlich an, bis auf 6,3% bei Frauen und 8,1% bei Männern im Alter von 70 bis 79 Jahren. Die Schlaganfallprävalenz sinkt mit steigendem Sozialstatus bei Frauen deutlicher als bei Männern. Im Vergleich mit dem BGS98 ergeben sich keine eindeutigen Hinweise auf eine Veränderung der Schlaganfallprävalenz im zeitlichen Verlauf. Die Ergebnisse zur Schlaganfallprävalenz bei 40- bis 79-Jährigen in Deutschland sind mit Prävalenzschätzungen aus anderen nationalen und internationalen Studien vergleichbar. Die Ursachen für gleichbleibende Prävalenzen sollten in ergänzenden Studien unter Berücksichtigung des demografischen Wandels und der Veränderungen von Inzidenz, Mortalität und Letalität untersucht werden.

Schlüsselwörter

Schlaganfall · Prävalenz · Trend · Gesundheitssurvey · Bevölkerung

DEGS1, the prevalence in GEDA is similar to DEGS1 at 3.2% (95% CI 2.9–3.5).

However, time trends in stroke prevalence cannot be assessed using the GEDA results since no earlier data exist for this purpose. This gap is now closed by the DEGS1 results, even though the trend analysis is limited to the age group examined. Data from other countries show that stroke prevalence in the general population aged 18 years and above is of comparable magnitude—for example—in England (2.3–2.4%) [27] and in the USA (2.6–3.0%) [28]. In England, there was no relevant change over time in recent years [27]. Trend analyses for the age group 40–79 years investigated in DEGS1 are not available from other countries.

The lifetime prevalence of stroke in the population can remain constant over

time if incidence and mortality change to the same extent. Stroke mortality has been falling for some time in Germany [9]. On the other hand, no data are available with regard to trends in stroke incidence in Germany. The number of hospital admissions for stroke could be used as a proxy for stroke incidence, since stroke patients in Germany are generally admitted to hospital and treated as in-patients, and in recent years increasingly in stroke units in accordance with treatment guidelines [14, 29]. Data on the number of hospitalizations for stroke are provided by official hospitalization statistics. However, it must be noted that these statistics capture information on hospitalized cases, not on individual persons. Thus, a recurrent stroke in the same calendar year in the same person would lead to two cases of stroke hospitalization. Based on the data from hospitalization statistics, the number of hospitalized patients with a diagnosis of cerebrovascular disease (ICD10-Codes I60-I69) fell by 9% overall from 2000 to 2009, in women by 15% and in men by 1% [30]. This trend occurred in spite of demographic ageing, which in itself should have led to an increase in the number of hospitalizations (overall, +18%; women, +12%; men, +26%). On the other hand, without demographic ageing, numbers of hospitalizations would have fallen (overall, −23%; women, −24%; men, −22%) [30]. Therefore, differences in the development of hospitalizations between women and men resulted from the stronger ageing effects amongst men.

Possibly the falling number of hospitalizations for stroke reflects the trend in incidence. In line with this, the drop in both incidence rates [5] and hospitalizations has been reported from other western countries [10, 11, 31]. In addition, the assumption of declining incidence rates is plausible in the light of falling mortality rates and lack of evidence for a change in prevalence.

Numerous studies from many countries have shown consistently that a lower socioeconomic status is associated with an increased stroke risk [32]. A possible explanation for this inverse social gradient is the difference in the prevalence of vascular risk factors between the status groups, which is also found in cross-sectional analyses in DEGS1 [33]. Further population-based incidence studies and longitudinal studies are required in order to better explain the complex inter-relationship between socioeconomic status and stroke [32].

Strengths and limitations

DEGS1 is a nationwide, population-representative study, which permits generalisations with regard to stroke prevalence for the adult resident population of Germany aged 40–79 years. In further analyses using additional health information from DEGS1, it will be possible to draw conclusions concerning the influences of risk factors, consequences of illness and associated utilisation of health care.

It should be noted that the data presented here are based on self-reports of participants regarding physician-diagnosed strokes. However, there is evidence from population-based studies that self-reported diagnoses on stroke have a high validity [34, 35]. Furthermore, it must be assumed that people with severe functional impairment following a stroke are underrepresented in the sample, especially if they live in care institutions. However, this probably affects only a very small percentage of people with stroke within the population, so that stroke prevalence will only be slightly underestimated. For example, in an analysis of remuneration data from the "Gmünder Ersatzkasse" (a statutory health insurance fund), only 3% of people with stroke received in-patient care in the first year following a stroke and only 1% had the highest care level of 3 [36]. It is also known that severe strokes have a high case fatality, which means people who suffer these less often become prevalent cases. Nevertheless, because of the aforementioned selection, the prevalence estimates reported here are to be viewed overall as conservative.

The trend analysis between GNHIES98 and DEGS1 may potentially be limited by technical differences between the studies in the way data were collected in the medical interview (computer-assisted CAPI in DEGS1, record sheet with illnesses listed in tabular form in GNHIES98). However, collection of information on stroke was standardised in both studies and interviewers explicitly and specifically asked for physician-diagnosed strokes using very similar wordings. Thus, relevant influences through the technical implementation of data collection are unlikely. With regard to the trend analysis, it must also be mentioned that a small yet statistically significant difference between the surveys may be possibly overlooked because of the low number of cases and correspondingly lower statistical power.

Conclusion

These results from the first wave of the German Health Interview and Examination Survey for Adults (DEGS1) present a stroke prevalence for the age group examined that is comparable with prevalence estimates from other national and international studies. There is no reliable evidence of an increase in stroke prevalence amongst 40–79-year-olds in Germany.

Corresponding address

Dr. M.A. Busch
Department of Epidemiology and Health Monitoring, Robert Koch Institute
General-Pape-Str. 62–66, 12101 Berlin
Germany
BuschM@rki.de

Conflict of interest. On behalf of all authors, the corresponding author states that there are no conflicts of interest.

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