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 GNHIES98.

**Methods**

**Study design and sample**

The “German Health Interview and Examination Survey for Adults” (DEGS) is
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 GNHIES98 (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 establish 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 (Table 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” (GE-Da) 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 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 avail-
able with regard to trends in stroke inci-
dence in Germany. The number of hospita-
al admissions for stroke could be used as
a proxy for stroke incidence, since stroke
patients in Germany are generally admit-
ted to hospital and treated as in-patients,
and in recent years increasingly in stroke
units in accordance with treatment guide-
lines [34, 29]. Data on the number of hospi-
talizations for stroke are provided by of-
ficial hospitalization statistics. However,
it must be noted that these statistics cap-
ture information on hospitalized cases,
ot on individual persons. Thus, a recur-
rent stroke in the same calendar year in
the same person would lead to two cases of
stroke hospitalization. Based on the da-
a from hospitalization statistics, the num-
ber of hospitalized patients with a diag-
nosis of cerebrovascular disease (ICD10-
Codes 160-169) 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 it-
self should have led to an increase in the
number of hospitalizations (overall, +18%;
women, +12%; men, +26%). On the other
hand, without demographic ageing, num-
bers of hospitalizations would have fall-
en (overall, –23%; women, –24%; men,
–22%) [30]. Therefore, differences in the
development of hospitalizations between
women and men resulted from the stron-
ger ageing effects amongst men.
Possibly the falling number of hospi-
talizations for stroke reflects the trend in
incidence. In line with this, the drop in
both incidence rates [5] and hospitaliza-
tions has been reported from other west-
ern 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 coun-
tries have shown consistently that a lower
socioeconomic status is associated with an
increased stroke risk [32]. A possible ex-
planation for this inverse social gradient is
the difference in the prevalence of vascu-
lar risk factors between the status groups,
which is also found in cross-sectional
analyses in DEGSI [33]. Further popula-
tion-based incidence studies and longitudi-
dinal studies are required in order to bet-
ter explain the complex inter-relationship
between socioeconomic status and stroke
[32].

Strengths and limitations
DEGS1 is a nationwide, population-repre-
sentative study, which permits generalisa-
tions with regard to stroke prevalence for
the adult resident population of Ger-
many aged 40–79 years. In further analyses
using additional health information from
DEGSI, it will be possible to draw con-
clusions concerning the influences of risk
factors, consequences of illness and asso-
ciated utilisation of health care.
It should be noted that the data pre-
sented here are based on self-reports of
participants regarding physician-diag-
nosed 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 func-
tional impairment following a stroke are un-
derrepresented in the sample, especially if
they live in care institutions. However, this
can be explained only by a very small percent-
age of people with stroke within the popu-
lation, so that stroke prevalence will on-
ly be slightly underestimated. For exam-
ple, in an analysis of remuneration data from
the “Gmünder Ersatzkasse” (a stat-
utory 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 suf-
f er these less often become prevalent cas-
es. Nevertheless, because of the aforemen-
tioned selection, the prevalence estimates
reported here are to be viewed overall as
conservative.
The trend analysis between GNHIES98
and DEGSI may potentially be limited by
technical differences between the studies
in the way data were collected in the med-
cal interview (computer-assisted CAPI
in DEGSI, record sheet with illnesses list-
ed in tabular form in GNHIES98). How-
ever, collection of information on stroke
was standardised in both studies and in-
terviewers explicitly and specifically asked
for physician-diagnosed strokes using very
similar wordings. Thus, relevant in-
fluences through the technical implemen-
tation 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 Examina-
tion Survey for Adults (DEGS1) present a
stroke prevalence for the age group ex-
amed that is comparable with preva-
ence estimates from other national and
international studies. There is no reliable
evidence of an increase in stroke prevale-
ence amongst 40–79-year-olds in Ger-
many.

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

Acknowledgements. The study was financed by
the Robert Koch Institute and the Federal Ministry of
Health.

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

References
adjusted life years (DALYs) for 291 diseases and in-
juries in 21 regions, 1990–2010: a systematic anal-
ysis for the Global Burden of Disease Study 2010.
Lancet 380:2197–2223
2. Lozano R, Naghavi M, Foreman K et al (2012) Glob-
al and regional mortality from 235 causes of death
for 20 age groups in 1990 and 2010: a systemat-
ic analysis for the Global Burden of Disease Study
3. Kolominsky-Rabas PL, Heuschmann PU, Marschall
Germany: results and national projections from
a population-based stroke registry: the Erlangen
Stroke Project. Stroke 37:1179–1183
in the United Kingdom. Age Ageing 38:27–32