Stroke incidence and prevalence in Europe: a review of available data

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Reliable data on stroke incidence and prevalence are essential for calculating the burden of stroke and the planning of prevention and treatment of stroke patients. In the current study we have reviewed the published data from EU countries, Iceland, Norway, and Switzerland, and provide WHO estimates for stroke incidence and prevalence in these countries.Studies on stroke epidemiology published in peer-reviewed journals during the past 10 years were identified using Medline/PubMed searches, and reviewed using the structure of WHO's stroke component of the WHO InfoBase. WHO estimates for stroke incidence and prevalence for each country were calculated from routine mortality statistics. Rates from studies that met the 'ideal' criteria were compared with WHO's estimates.Forty-four incidence studies and 12 prevalence studies were identified. There were several methodological differences that hampered comparisons of data. WHO stroke estimates were in good agreement with results from 'ideal' stroke population studies. According to the WHO estimates the number of stroke events in these selected countries is likely to increase from 1.1 million per year in 2000 to more than 1.5 million per year in 2025 solely because of the demographic changes.Until better and more stroke studies are available, the WHO stroke estimates may provide the best data for understanding the stroke burden in countries where no stroke data currently exists. A standardized protocol for stroke surveillance is recommended.

Introduction

Routine mortality statistics indicate that there are considerable differences in stroke mortality between different European countries with several East European countries having high and increasing stroke mortality rates whilst low and decreasing rates are reported from most West European countries [1]. Projections for the European region suggest that the proportion of the population aged 65+, in which most stroke events occur, will increase from 20% in 2000 to 35% in 2050, and the median age will rise from 37.7 years in 2000 to 47.7 years in 2050 [2]. The projected population for Europe will decrease from 728 million in 2000 to 705 million in 2050, thus the dependency ratio will shift with fewer young people supporting an increasing proportion of elderly people. This will be a tremendous challenge for societies and health systems.

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Planning future need of health services and improved primary and secondary prevention of stroke require data on stroke occurrence. The present study reviews the available data on stroke from studies in Member States of the European Union, and three countries participating in the European Fair Trade Association (EFTA) Iceland, Norway, and Switzerland, published during the past 10 years using the stroke component of World Health Organization (WHO) InfoBase (Stroke Component of WHO NCD InfoBase). In addition, we present WHO estimates on stroke incidence, prevalence, and projections for these countries.

Materials and methods

Studies on stroke epidemiology in European populations, published in peer-reviewed scientific journals, were identified through Medline/PubMed using the following keywords: stroke, cerebrovascular, ischemic stroke, hemorrhagic stroke, subarachnoid hemorrhage, epidemiology, neurological diseases, incidence, prevalence, rate, and 'country name'. Additional papers were identified from reference lists of retrieved articles.

The search was restricted to prospective studies published during the period January 1993 to June 2004,

and written in English. Data collection had to be predetermined to include descriptive epidemiological data on stroke (first, first and recurrent, or recurrent stroke), and present crude age- and sex-specific data on stroke incidence, and/or prevalence. In each paper the following elements were searched and assessed: methods of case ascertainment; whether the definition of stroke was in accordance with the WHO stroke definition [3]; type of event (first-ever-in-a-lifetime, first and recurrent); stroke subtype definition (ischemic stroke, intracerebral hemorrhage, subarachnoid hemorrhage, undetermined, and all stroke events combined); diagnostic methods used; data collection type (hot or cold pursuit); study duration; statistical method used for sampling; size of study population; response rate; total number of strokes. Whilst this information is available online at http://www.who.int/ncd_surveillance/infobase/web/StrokeWeb/index.aspx the present study includes only selected items.

WHO estimates of stroke incidence and prevalence

The Global Burden of Disease 2000 study

In 1993 the World Bank sponsored a study to assess the global burden of disease in collaboration with the WHO and the Harvard School of Public Health [4]. As well as generating summary measures of the disease burden, the Global Burden of Disease (GBD) study provided comprehensive and consistent set of estimates of mortality and morbidity for world regions by cause, age, and sex [5]. The WHO has since undertaken new assessments of the GBD for the years 2000 and beyond. The study has drawn on a wide range of data sources to develop internally consistent estimates of incidence, prevalence, duration, and mortality for over 130 major causes, for 17 subregions of the world [6] and results are published in the World Health Report [7].

Regional incidence and prevalence for stroke

Because the available population-based studies of stroke incidence and the prevalence of stroke survivors are for different years, sometimes as much as a decade or more ago, and are generally confined to a subnational population, it is difficult to extrapolate from these studies to current national and regional estimates of stroke incidence and prevalence. For this reason, the GBD 2000 study developed a model for stroke based on estimates of stroke mortality in 2002 together with available population data on the case fatality rate (CFR) within 28 days for incident cases of first-ever stroke and on long-term survival in subjects surviving this initial period [8]. A consistent relationship between incidence, prevalence and mortality was established using recent data from stroke studies in the USA and the resulting age- and sex-specific 28-day and survivor CFR were used as the basis for subregional CFR after adjustment for the observed relationship between gross domestic product per capita (measured in purchasing power parity adjusted dollars) and overall 28-day CFR in 32 published studies from various countries. Using this relationship, overall 28-day CFR in 2002 for incident cases amongst people aged 30 or more was estimated to be 20% in European countries with very low child and adult mortality (essentially the countries of Western Europe), and 28% in the remaining European countries.

Consistent epidemiological models for each subregion were then estimated using these CFR and observed mortality after adjustment to account for the fact that not all excess mortality in long-term survivors of stroke is recorded as stroke on death certificates. Some of the excess deaths in long-term stroke survivors are because of heart disease and other causes. Different studies, all from developed countries, indicate that between one-third and half of all stroke patients die from stroke [9–14]. It was assumed that the proportion of long-term stroke survivors who die from stroke is constant in all countries. With these assumptions, it was possible to extrapolate stroke incidence and the prevalence of stroke survivors by age and sex from estimated stroke mortality for all regions of Europe.

Country-specific estimates of stroke incidence and prevalence

Death registration data provided by WHO Member States in the European region were used to estimate death rates by age, sex for underlying causes of death as defined by the classification rules of the International Classification of Diseases, Injuries and Causes of Death (ICD). Data from 1980 or the earliest later available year up to latest available year were analyzed as a basis for projecting recent trends for specific causes, and these trend estimates were used to project age- and sex-specific stroke mortality rates for 2002 from the latest available year of vital registration data.

To produce unbiased estimates of cause-specific death rates, and to maximize comparability across Member States, deaths coded to general ill-defined categories (ICD-9 Chapter XVI, ICD-10 Chapter XVIII) were redistributed pro-rata across all causes excluding injuries.

Subregional age- and sex-specific ratios of stroke incidence and survivor prevalence to stroke mortality were used together with country-specific mortality to estimate the prevalence of stroke survivors for each

selected Member State. This approach effectively assumes that short-term and long-term age-sex specific CFR for stroke are constant within all countries.

Projections and comparisons of data

WHO estimates of stroke incidence rates were used to calculate the absolute number of new stroke events if rates remain stable based on demographic information and projections for the selected countries [2]. The effect on the absolute number of new stroke events that would occur, assuming a 2% increase or decrease in stroke incidence rates over a 5 years period, were also estimated.

Age- and sex-specific stroke incidence rates from population-based studies were compared with WHO estimates by plotting the respective rates against each other.

Results

Incidence studies

We identified 44 population-based studies on stroke incidence from 14 different countries and one multinational, the WHO MONICA study (Table 1). Of these, 16 provided trends analyses on stroke incidence, and seven gave updates of rates of the same populations. Two-thirds of the studies were either from Sweden ($n = 8$), the UK ($n = 8$), Italy ($n = 7$), or Finland ($n = 4$), and only four were from East European countries – two from Estonia, and one each from Poland and Lithuania. In total the studies included more than 20 million subjects in the source population.

Case ascertainment included hospital registers and death certificates, and in several studies information obtained from general practitioners and nursing homes. Case ascertainment was predominantly focused around larger urban areas with only one study reporting from both urban and rural areas [15]. The majority of studies used the WHO stroke definition, and collected data on first-ever stroke. Data on stroke subtypes (ischemic, hemorrhagic, subarachnoid, and undetermined) were provided in 16 papers, whereas data on all types of stroke were combined in 25 studies, and three studies provided rates only for ischemic stroke. In half of the incidence studies there was no upper age limit, whilst most of incidence trend studies limited the age range. Detailed information about age- and sex-specific rates are presented in Appendix 1 and Appendix 2.

Data for men and women were presented separately in almost all papers. Rates were generally higher in men than in women, but in seven papers rates were higher in women than in men in subjects aged 75 years or older [15–21]. Studies of subtype of stroke suggested that rates of ischemic stroke and intracerebral hemorrhage were higher in men than in women whereas rates for subarachnoid hemorrhages were higher in women, or no gender differences were reported. One paper on stroke incidence in a multiethnic population demonstrated higher rates in blacks than in whites [22].

Prevalence studies

Details on prevalence are shown in Table 2, and sex- and age-specific rates are listed in Appendix 3. There were 12 publications, including one multinational [23], on stroke prevalence from six countries. The majority of studies were from populations in Italy ($n = 4$) or the UK ($n = 3$).

Three of the studies did not use age limits whilst the remaining concentrated on elderly people with different lower (55 or 65 years) and upper (84, 96, or 100 years) age limits. Most studies included data for both men and women. In total, 92 309 events were included in the source populations in which the number of prevalent cases was registered. Whilst type of stroke event (first-ever, recurrent, all strokes) was stated in four studies [24–27], none of the studies provided separate rates for subtypes of stroke.

The WHO's estimates for stroke incidence and prevalence

The WHO's estimates for stroke incidence in men and women aged 25 to 85+ years are presented in Table 3. In both men and women stroke rates increase exponentially with age, and in most countries rates are higher for men than for women.

In men, the lowest stroke incidence rates are estimated for France and Switzerland. Highest rates are estimated for Latvia where age specific stroke incidence rates are more than twice that for France and Switzerland. In women, low incidence rates are estimated for France, Switzerland and Slovakia, whereas high incidence rates are estimated for Greece and Latvia. Rates in the latter two are up to three times higher than in countries with the lowest estimated stroke incidence rates.

Stroke prevalence rates are presented in Table 4. Stroke prevalence increases exponentially with age and are in most countries higher for men than for women. In men, the lowest stroke prevalence rates are estimated for Cyprus, Lithuania, Poland, and Slovakia, whilst the highest rates are estimated for Czech Republic, Greece, Portugal, and Slovenia. In women, low prevalence rates are estimated for Cyprus, France, Lithuania, Poland,

Table 1 Stroke incidence studies published 1993–2004

Study reference	Data collection	Case ascertainment	Sample size (% of responders if dropouts/ non-responders)	Event type	Number of all strokes (first-ever)
UK [53]	May 1996 to Apr 1997	GP, hospital registers, death certificates	182 000	First-ever and recurrent	330
Sweden [29]	Feb 1999 to Jan 2000	Hot pursuit	123 503	First-ever	(388)
Italy [35]	Jan 1994 to Dec 1998	GP, hospital registers, death certificates, rehabilitation services	297 838	First-ever	(819)
Portugal [15]	Oct 1998 to Sept 2000	GP, hospital and outpatient registers, death certificates	123 112	First-ever	(688)
Poland [54]	Jan 1991 to Dec 1992	GP, hospital registers, death certificates	182 285	First-ever and recurrent	633 (462)
Italy [30]	Jan 1996 to Dec 1996	Hospital, nursing homes, GP' office, death certificates	5632	First-ever	408 (321)
Italy [38]	1992 to 1996	Home interview, medical records	176 186	First-ever and recurrent	(124)
UK [56]	Jul 1994 to Jun 1995	GP, hospital registers, death certificates, rehabilitation services	534 287	First-ever	932 (642)
Norway [39]	Sept 1994 to Aug 1996	GP, hospital registers, death certificates	69 295	First-ever	593 (432)
UK [57]	Sept 1978 to Dec 1997	GP, hospital registers, death certificates	5308	First-ever	433 (333)
The Netherlands [58]	1990 to 1999	GP, hospital registers, death certificates	7721 (100)	First-ever	(432)
Germany [36]	Apr 1994 to Mar 1996	GP, hospital registers, nursing homes, death certificates	101 450	First-ever	(354)
Germany [65]	Apr 1994 to Mar 7998	GP, hospital registers, nursing homes, death certificates	100 330	First-ever	(752)
Italy [20]	1993 to 1995	GP, hospital registers, death certificates	41269	First-ever	(174)
Italy [34]	Jun 1992 to May 1993	GP, hospital registers, death certificates	211 389	First-ever	(474)
Sweden [21]	Jul 1986 to Jun 1987	Interview, medical records	826	First-ever	(56)
Italy [59]	Jan 1994 to Dec 1998	Hospital registers	174 875	First-ever	(89)
Italy [60]	1994 to 1998	Hospital registers	12 218	First-ever	(1316)
Sweden [61]	Jan 1996 to Dec 1996	Hospital, pathology/forensic departments	1 140 000	First-ever and recurrent	447
Lithuania [62]	1986 to 1988	Retrospective, hospital registers, death certificates	430 000	First-ever and recurrent	973
Italy [18]	1984 to 1987	Retrospective door-to-door survey, death certifiactes	24 496	First-ever	(138)
UK [37]	Jan 1995 to Dec 1996	GP, community therapists, hospital registers, death certificates	234 533	First-ever	(612)
WHO MONICA [82][a]	1985 to 1987	Hospital registers, death certificates	2 625 000	First-ever and recurrent	11909
Greece [40]	Nov 1993 to Oct 1995	Hospital registers, death certificates	80 774	First-ever	(555)
UK [63]	Aug 1989 to Aug 1990	GP, hospital registers, death certificates	621 966[b]	First-ever	(386)
UK [64]	Aug 1989 to Jul 1991	GP, hospital registers, rehabilitation services	322 500	First-ever	(456)
UK [22]	1995 to 1998	GP, hospital registers, death certificates	234 533	First-ever	(1254)
Italy [66]	Jan 1989 to Dec 1989 and Nov 1996 to Dec 1997	Hospital registers, outpatient registers, death certificates	118 723	First-ever	(255) + (343)
Germany [67]	Dec 1972 to Dec 1973 and Jan 1985 to Dec 1988	Hot pursuit, Hospital registers, death certificates	107 377 + 803 979	First-ever	213 (151) + 5114 (3854)

Table 1 Continued

Study reference	Data collection	Case ascertainment	Sample size (% of responders if dropouts/ non-responders)	Event type	Number of all strokes (first-ever)
Finland [68]	Sept 1985 to Aug 1986 and Jan 1993 to Dec 1993	Hospital registers, death certificates	114 669 + 123 547	First-ever	(219) + (189)
Finland [69]	Jan 1982 to Dec 1992	Hospital registers, death certificates	160 000	First and recurrent	5904
Sweden [70]	Jan 1983 to Dec 1985 and Jan 1993 to Dec 1995	Hospital registers, death certificates	200 191 + 224 126	First-ever	(998) + (1318)
Estonia [16]	Jan 1970 to Dec 1973 and Jan 1991 to Dec 1993	Hospital registers, outpatient registers death certificates	90 459 + 110 631	First-ever	(667) + (829)
France [71]	Jan 1985 to Dec 1994	Hospital registers, outpatient registers death certificates	148 277	First-ever	(1130)
Sweden [72]	Jan 1989 to Dec 2000	Hospital registers	8 882 792*rmd*	First-ever	(43 389)
Finland [17]	Jan 1972 to Dec 1973, Apr 1978 to Mar 1979 and Aug 1989 to Aug 1991	Hospital registers, death certificates	113 100 + 136 850 + 183 199	First-ever	(244) + (255) + (594)
UK [31]	Nov 1981 to Oct 1984/ Apr 2002 to Mar 2004	Hospital registers, outpatient registers death certificates, diagnostic referrals[c]	86 487 + 90 542	First and recurrent	(429)/(262)
Finland [73]	Jan 1983 to Dec 1985/ Jan 1987 to Dec 1989	Hospital registers, death certificates	380 000	First and recurrent	8163
Sweden [75]	Jan 1985/Dec 1991	Hospital registers, death certificates	238 948	First and recurrent	6083
Sweden [74]	1985/1999	Hospital registers, death certificates, outpatient registers	Not stated	First and recurrent	13 908
Sweden [76]	May 1975 to Apr 1978/ Sept 1983 to Aug 1987/ Sept 1987 to Aug 1991	Hospital registers, death certificates, outpatient registers, nursing homes	32 230 + 30 736 + 29 686	First-ever	(1186)
Denmark [19]	Jan 1984 to Dec 1985/ Jan 1986 to Dec 1987/ Jan 1988 to Dec 1989/ Jan 1990 to Dec 1991	Hospital registers, death certificates, outpatient registers,	419 300 + 42 300 + 428 700 + 435 500	First and recurrent	5262 (4243)
Denmark [77]	Mar 1976 to Feb 1980/Mar 1980 to Feb 1984/Mar 1984 to Feb 1988/Mar 1988 to Feb 1993	Direct contact, hospital registers, death certificates	19 698	First-ever	(882)
Estonia [32]	2001 to 2002	Hospital registers, GP, death certificates, autopsy reports	101 122	First-ever	(234)

[a]Sudden onset of focal brain dysfunction resulting from occlusive or hemorrhagic lesions of the vascular supply of the brain, or global brain dysfunction with documentation of subarachnoid or intraventricular hemorrhage; symptoms persisted for over 24 h, or the event led to death within 24 h (excluded subdural and traumatic hemorrhages).

[b]Stroke diagnosis was based on all available medical information. In case of no hospitalization, mention of a 'cerebrovascular accident' in the GP records was required to confirm the self-reported information. When possible, information on signs and symptoms was used in the final classification. In case of hospitalization, the diagnosis of a neurologist was used. Prevalence rates are calculated for self reported strokes.

[c]Information on stroke was derived from three different sources of information: self-reported, key informant, and hospital linkage system (ICD-9; codes 430–438 for stroke). Only stroke patients with a definite history of acute focal symptoms (hemiparesis or acute aphasia) were included.

Table 2 Stroke prevalence studies published 1993 to 2004

Study reference	Data collection	Study design	Initial size/% response	Event type	Number of strokes
FIN, IT, NL [23]	1984–1994	Longitudinal, physical exam, estimates	FIN 716[a], NL, 877, IT 682, 2275	Not stated	Not shown
Spain [45]	1988–1992	Cross-sectional, door-to-door survey	862/98.1 + 397/85.6	Not stated	29 + 60
France [78]	Jul 1986 to Dec 1986	Cross-sectional	2600/60	Not stated	22
Italy [55]	Mar 1992 to Jun 1993	Longitudinal/cross-sectional	5462/83	Not stated	Not shown
Italy [27]	1 April 2001	Cross-sectional, door-to-door survey, physical exam	2390/94.6	First and recurrent stroke	146
Italy [26]	Mar 1992 to Feb 1993	Cross-sectional, door-to-door survey, physical exam	1147/90	First and recurrent stroke	75
Italy [25]	1987	Cross-sectional, door-to-door survey, physical exam	26692/92	First-ever strokes	189
NL [24]	Not stated	Survey	7983/78	First and recurrent stroke	285
Sweden [21]	Not stated	Cross-sectional, survey, physical examination, overlapping sources	826/63	Not stated	53
UK [79]	1993	Cross-sectional	18827	Not stated	415
UK [80]	Jan 1995 to Jun 1996	Longitudinal, primary care data	27658	Not stated	Not stated
UK [81]	Not stated	Questionaire, overlapping sources, physical examination	2000/88	Not stated	104

[a]The diagnosis was based on history of stroke with permanent paralysis, paresis or aphasia, or occurrence of paralysis or paresis, after exclusion of other causes.

Table 3 Stroke incidence estimates, the World Health Organization, men and women per 100 000

	Austria		Belgium		Cyprus		Czezh Republic		Denmark		Finland		France		Germany		Greece		Iceland		Ireland		Italy		Luxembourg		Malta	
Age	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
25–34	13	10	19	12	10	5	17	7	30	15	23	12	19	9	14	9	21	11	11	9	14	21	14	8	15	18	16	10
35–44	26	20	37	23	20	11	33	14	60	30	46	24	37	18	28	17	42	21	23	19	28	42	27	16	31	36	32	20
45–54	153	69	139	84	83	40	271	119	194	80	201	74	131	49	131	60	215	98	107	74	126	99	124	63	146	103	153	81
55–64	324	172	312	186	229	134	678	347	351	184	384	191	253	109	316	152	533	288	212	187	315	192	295	154	366	231	381	203
65–74	877	613	812	550	672	463	1989	1449	882	580	987	653	630	364	899	588	1541	1216	690	647	877	672	918	585	988	721	1126	789
75–84	1631	1376	1446	1237	1752	1726	3474	2918	1514	1250	1708	1391	1105	837	1696	1395	3131	3312	1381	1493	1621	1396	1946	1569	1852	1584	1870	1637
85+	2005	1801	1754	1661	2535	2753	4056	3513	1771	1628	2009	1784	1325	1113	2096	1857	4032	4671	1697	1990	1992	1732	2521	2214	2314	2087	2098	2021

	The Netherlands		Norway		Portugal		Spain		Sweden		Switzerland		UK		Estonia		Latvia		Hungary		Lithuania		Poland		Slovakia		Slovenia	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
25–34	11	12	13	8	47	20	12	8	8	6	8	6	16	9	27	12	18	14	27	14	17	9	17	12	7	4	21	11
35–44	21	25	26	17	93	39	24	15	16	13	17	12	32	18	54	25	37	27	54	29	35	17	34	25	14	9	41	22
45–54	119	93	123	69	362	149	132	57	122	65	58	49	129	94	367	133	455	205	367	141	268	138	250	103	156	58	194	139
55–64	284	175	287	148	842	390	298	143	294	164	171	110	301	209	877	407	1155	587	877	332	670	332	613	289	469	183	612	296
65–74	847	565	905	530	2299	1431	804	498	841	535	515	329	845	652	1858	1171	2563	1645	1824	907	1404	882	1255	800	1132	631	1467	858
75–84	1567	1265	1796	1359	3769	3193	1413	1207	1579	1287	1074	822	1512	1453	2641	2473	3963	3539	2607	1680	2029	1659	1619	1459	1568	1102	2344	1754
85+	1889	1657	2234	1887	4262	4153	1682	1647	1943	1767	1401	1158	1809	1925	2953	3284	4656	4757	2953	2070	2320	2081	1706	1792	1654	1251	2784	2244

Table 4 Stroke prevalence rates, estimates from the World Health Organization, men and women per 100 000

Age	Austria Men	Austria Women	Belgium Men	Belgium Women	Cyprus Men	Cyprus Women	Czech Republic Men	Czech Republic Women	Denmark Men	Denmark Women	Finland Men	Finland Women	France Men	France Women	Germany Men	Germany Women	Greece Men	Greece Women	Iceland Men	Iceland Women	Ireland Men	Ireland Women	Italy Men	Italy Women	Luxembourg Men	Luxembourg Women	Malta Men	Malta Women
25–34	77	56	114	65	59	25	99	39	196	87	150	67	118	50	83	46	114	55	66	52	85	132	79	42	95	107	99	58
35–44	147	106	218	124	113	48	189	74	374	165	285	127	225	95	158	87	217	104	126	99	161	252	150	80	180	203	188	111
45–54	1163	634	1072	804	380	171	2037	1103	1607	775	1652	695	1048	465	992	535	1481	838	788	702	950	1044	868	548	1129	1022	1180	787
55–64	2246	1304	2185	1476	929	553	4604	2637	2658	1484	2887	1490	1849	857	2172	1122	3318	2037	1417	1464	2148	1708	1864	1114	2552	1914	2666	1639
65–74	5359	3791	5052	3568	2354	1507	11 959	8965	5869	3820	6529	4168	4064	2324	5472	3524	8497	6996	3998	4140	5318	4777	5095	3416	6149	4854	6968	5167
75–84	8656	6807	7830	6260	4215	3112	18 711	15 171	8974	6554	10 032	7148	6242	4218	8947	6646	14 616	14 686	7066	7537	8522	8178	9172	7038	9872	8441	10 582	8878
85+	10 619	8733	9403	8362	5998	4881	21 192	17 156	10 198	8342	11 497	8890	7371	5553	11 072	8759	19 308	21 217	8668	9954	10 454	9681	12 237	10 178	12 425	10 944	11 291	10 422

Age	The Netherlands Men	The Netherlands Women	Norway Men	Norway Women	Portugal Men	Portugal Women	Spain Men	Spain Women	Sweden Men	Sweden Women	Switzerland Men	Switzerland Women	UK Men	UK Women	Estonia Men	Estonia Women	Latvia Men	Latvia Women	Hungary Men	Hungary Women	Lithuania Men	Lithuania Women	Poland Men	Poland Women	Slovakia Men	Slovakia Women	Slovenia Men	Slovenia Women
25–34	62	73	72	42	282	109	68	40	43	32	48	33	93	50	106	52	72	57	95	55	68	38	73	53	28	18	131	68
35–44	119	139	138	80	538	208	130	76	81	62	91	63	177	94	222	108	150	119	198	104	142	79	156	114	59	38	250	130
45–54	893	919	851	589	2770	1400	965	509	827	554	415	455	952	857	1363	647	1661	984	1283	838	982	697	1228	661	710	349	1566	1418
55–64	1924	1464	1798	1060	5841	3020	1973	1061	1800	1155	1094	847	2021	1589	3326	2108	4320	2994	2862	2037	2517	1769	2877	1523	2032	902	4432	2524
65–74	5059	3780	4962	3049	14 151	9038	4714	3017	4550	3090	2933	2062	5016	4041	6153	4772	8326	6628	5608	6996	4603	3746	5569	3584	4583	2617	9714	5966
75–84	8260	6752	8583	6060	21 026	16 185	7306	5698	7428	5750	5132	3911	7918	7101	7631	6434	10 893	8994	6979	14 686	5710	4741	6492	4920	5816	3726	13 444	9760
85+	9824	8681	10 733	8534	22 701	20 578	8527	7805	9127	7953	6926	5639	9315	9288	7391	6669	11 456	9548	5942	21 217	5742	4402	5296	4627	4757	3035	15 631	12 098

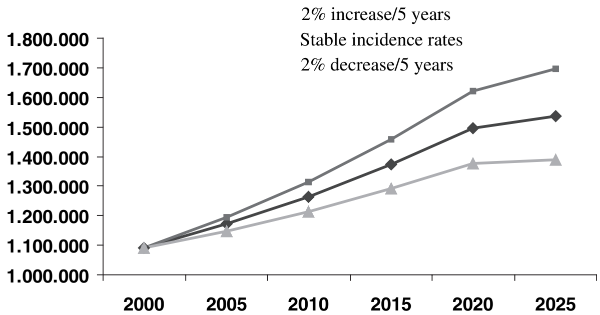

Figure 1 Projections of stroke events in men and women in EU and EFTA countries, 2000–2025, men and women combined.

and Slovakia, whilst high prevalence rates are estimated for Czech Republic, Greece, Hungary, and Portugal.

Based on WHO stroke estimates we calculated population projections for EU and the three selected EFTA countries assuming stable incidence rates, a 2% increase in incidence per 5 years, and a 2% decrease in rates per 5 years, Fig. 1. Even if it is possible to maintain stable rates, the demographic changes in these countries will lead to a substantial increase in the number of stroke events from approximately 1.1 million per year in 2000 to more than 1.5 millions per year in 2025.

Comparison of 'ideal' studies with WHO estimates

According to a recent review of stroke incidence and prevalence papers published in the 1990s there were a total of 9 stroke incidence studies (including two based on overlapping populations) and three prevalence studies from European countries that met 'ideal' criteria [28]. Thirteen incidence and two prevalence studies have been published since January 2003. Of these seven stroke incidence studies meet the 'ideal' criteria [15,20,22,29–32]. Comparisons of incidence rates from these studies [15,17,20,29,31–40] with estimates from the WHO are shown in Fig. 2 and show that the WHO estimates were in good accordance with rates from studies.

Discussion

In the present study we have reviewed stroke studies published since 1993 on incidence and prevalence from Members States of the European Union and three EFTA countries. Incidence data were available from studies in 14 countries and prevalence data from studies in six countries. The majority of these studies were based on observations in urban populations and predominantly from West European countries. Only 16 incidence and three prevalence studies met 'ideal' criteria. WHO estimates were often close to rates from

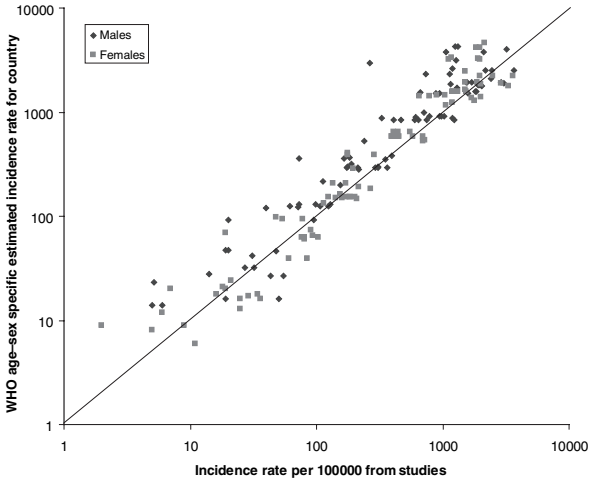

Figure 2 Stroke incidence rates in men from 'ideal' studies compared with WHO estimates, per 100 000.

'ideal' stroke incidence studies. Projections to year 2025 suggest that even with stable stroke incidence rates there will be a marked increase in the number of stroke patients in the next decades.

The majority of stroke studies are from only a few West European countries. Most studies used hospital registers and death certificates for identification of stroke events, combined with a validation process where the WHO stroke definition was used. Expansion of case ascertainment to rehabilitation services, general practitioners, and other potential sources for identifying stroke patients is important for registration of non-fatal, non-hospitalized stroke events, and thereby provide incidence and CFR for the population under observation, but this was undertaken in only some studies. Probable reasons for this are: increased complexity and costs associated with expanding case ascertainment. Legal difficulties in obtaining permission to contact non-hospitalized stroke patients may also be a factor.

There are more studies on incidence than on prevalence and in both cases studies come from a limited number of countries. Approximately half of all surviving stroke patients make incomplete recovery and half of them will need assistance in activities of daily living [41]. A considerable proportion of all costs to stroke patients is because of the long-term care, rehabilitation, nursing, and lost production [42–44]. The low number of stroke prevalence studies will hamper future projections and planning of the need for care and rehabilitation of stroke patients.

Within a country, extrapolation of current stroke incidence and prevalence studies to the rest of the population is questionable. First, most studies are from urban populations and it is known that rates are likely to differ markedly between urban and rural populations even within the same country [15,45]. Secondly, the results are based on relatively small populations that may not reflect the composition of the entire population of the country. Thirdly, methodological differences may constrain any meaningful comparison of data between populations and lead to spurious findings. Fourthly, rates are likely to be associated with the exposure to stroke risk factors, for example, income and access to prevention of cerebrovascular disease and could therefore be higher in low-income populations, which often are those where no data are available. None of the studies have been designed specifically to be representative of national populations.

The WHO estimates are based on death certificates where the issuing person has diagnosed cerebrovascular disease as the cause of death. Routine mortality statistics are often the only data collected nationwide. Whilst such data can provide an overview of trends and occurrence of stroke, several stroke studies, including European ones, have concluded that the validity of routine mortality stroke data is of varying quality [46–51]. Data may be either an over- or under-estimate of the number of stroke deaths compared with standard criteria, which would have effect on the WHO estimates for incidence and prevalence rates because of the methodology described. The WHO incidence rates were compared with 'ideal' stroke studies and the rates were largely within the range of rates from studies. It should be noted that WHO estimates for Portugal and Greece were markedly higher than reported [15,40]. It remains unclear if routine mortality statistics from these countries over-report the number of stroke deaths, or if the studies have registered stroke events in subpopulations with low stroke rates, and is a good example of the need to increase stroke data collection in countries. Despite these limitations the WHO estimates may provide the best possible source for estimating the regional burden of stroke in EU and the selected EFTA countries until more and better stroke data become available.

Based on the WHO stroke estimates and the UN's population projections we calculated the expected number of new stroke events that will occur during the period 2000–2025. Even with stable stroke incidence rates there will be a marked increase in the number of stroke events from approximately 1.1 million per year in 2000 to 1.5 million per year in 2025. We also estimated the effect of slight increases or decreases in stroke incidence rates ($\pm 2\%$ per 5 years) which could result from increased exposure to, or better control of, major stroke risk factors such as level of blood pressure, tobacco smoking, diabetes, body mass index, and level of physical activity. The difference by 2025 would be $\pm 150\,000$ stroke events when compared with stable

rates. These numbers strongly advocate for intensified primary prevention of stroke.

The future strategy

The present study show that there is an urgent need for a collection of standardized stroke data. Routine data from health facilities and death registers, combined with a validation process, have been used in all published studies and may be the most cost-effective method for obtaining stroke data in the future. There are several advantages of using these systems: they are often already established, there is easy access to data, they are inexpensive to use for analyses, and they often cover the entire population living in the country. Several disadvantages limit the use of the data: there is no control with how changing physicians diagnose diseases; changes in admission policy and diagnostic procedures may bias the results; and only countries with a known near-to-complete admission of all stroke patients will be able to estimate meaningful stroke incidence and CFR for the population.

The WHO STEPwise to stroke surveillance (STEPS Stroke) provides a framework and the tools for setting up stroke surveillance activities starting with stroke patients admitted to health facilities and expanding to include non-fatal non-hospitalized events [52]. All countries should be able to establish surveillance of hospitalized stroke patients, and expand to include fatal and non-fatal events when capacity and resources allow. The WHO STEPS Stroke system was originally developed for low- and middle-income countries but is flexible in design and can easily be expanded to include even highly sophisticated data. Establishment of a European stroke surveillance system based on the core provided by the WHO STEPS Stroke would permit future comparisons with countries outside Europe.

In conclusion, the available data on stroke in EU, Iceland, Norway, and Switzerland are very limited. This may severely hamper effective prevention and future planning of health services for stroke patients. Projections to year 2025 suggest that the burden of stroke will increase markedly. Until better and more stroke studies are available the WHO stroke estimates may provide the best possible data for understanding the stroke burden. Standardized protocols for stroke surveillance that can be used in all European countries, such as the WHO STEPS Stroke surveillance system, are recommended.

Conflict of interest

Authors alone are responsible for views expressed in signed articles, which are not necessarily those of the World Health Organization.

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Appendix 1 Stroke incidence rates (per 100 000)

Study	Sex	Type	0–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–100
UK [53]	All	All	233																	
Sweden [29]	M	All	0			0		50 (1–99)		72 (26–157)		366 (232–549)		1241 (927–1626)		1844 (1419–2360)		2878 (1844–2488)		
	F	All	0			11 (0–62)		25 (3–91)		93 (40–183)		155 (74–285)		725 (515–993)		1770 (1417–2177)		3285 (2552–4172)		
	All	All	0			6 (0–34)		38 (14–89)		83 (45–140)		259 (178–363)		951 (765–1170)		1801 (1530–2118)		3168 (2556–3897)		
Italy [35]	M	IS	0	0		0		24 (10–56)		82 (48–140)		216 (156–299)		800 (664–964)		1379 (1144–1660)		3048 (2300–4029)		
		ICH	0	5 (0.8–27)		0		14 (5–42)		13 (3–46)		54 (28–103)		132 (84–209)		266 (174–406)		389 (178–846)		
		SAH	0	0		5 (1–26)		5 (1–27)		13 (3–46)		18 (6–53)		15 (4–53)		13 (2–72)		0		
	F	IS	0	0		0		15 (5–44)		56 (29–107)		114 (75–173)		581 (479–704)		1273 (1082–1496)		1935 (1497–2499)		
		ICH	0	0		0		0		19 (6–55)		41 (21–82)		79 (47–132)		212 (143–315)		407 (233–711)		
		SAH	0	0		0		10 (3–36)		6 (1–35)		16 (5–46)		28 (12–66)		27 (9–78)		0		
Portugal [15]	M r	All	0	0		20 (1–112)		20 (1–111)		73 (15–213)		466 (276–737)		1128 (820–1515)		2095 (1467–2901)		1327 (487–2889)		
	M u	All	0	0		19 (2–69)		95 (45–174)		164 (96–263)		405 (280–565)		728 (551–943)		1055 (760–1426)		1252 (667–2142)		
	F r	All	0	0		19 (1–105)		61 (13–178)		141 (52–307)		177 (76–348)		787 (548–1094)		1972 (1454–2615)		1961 (1121–3184)		
	F u	All	9 (0–47)	9 (0–52)		7 (0–40)		84 (43–147)		160 (99–244)		286 (196–404)		649 (511–812)		1111 (890–1368)		1832 (1384–2380)		
Poland [54]	M	First	4				44			88		324		533		647	1259			
		Recurr	4				53			96		408		761		818	1778			
	F	First	2				19			71		134		323		774	1092			
		Recurr	1				19			96		189		435		1014	1798			
Italy [30]	M	IS	3 (1–8)							51 (6–97)		120 (49–191)		603 (423–783)		1435 (1029–1841)		1622 (801–2442)		
		ICH	2 (0–5)							10 (0–30)		44 (1–86)		126 (44–209)		389 (177–600)		432 (9–856)		
		SAH	2 (0–5)							0		11 (0–32)		28 (1–67)		30 (0–88)		0		
		UND	0							0		0		28 (1–67)		0		108 (0–320)		
		All	7 (1–14)							62 (12–111)		175 (89–260)		785 (580–991)		1854 (1392–2315)		2162 (1215–3110)		
	F	IS	7 (1–14)							44 (1–87)		93 (32–154)		300 (185–415)		833 (581–1084)		1338 (813–1862)		
		ICH	2 (0–5)							22 (1–52)		10 (0–31)		69 (14–125)		218 (89–347)		482 (167–796)		
		SAH	4 (1–8)							11 (0–33)		21 (1–50)		12 (0–34)		20 (0–59)		0		
		UND	0							0		0		12 (0–34)		119 (24–214)		161 (1–342)		
		All	12 (3–22)							77 (20–134)		125 (54–195)		392 (260–524)		1189 (888–1490)		1980 (1342–2618)		
Italy [55]	M	First												454 (139–768)	1009 (534–1476)	2442 (1655–3229)	2628 (1757–3498)			
	F	First												615 (252–979)	1212 (667–1757)	1833 (1128–2537)	1984 (1222–2747)			
UK [56]	M	First	8								127	126	263	486	605	772	1384	1952	2407	
	F	First	11								45	61	241	348	449	854	1358	2056	2152	
Norway [39]	All	IS		7 (2–16)						22 (6–56)		175 (113–259)		579 (463–718)		1399 (1183–1654)		1937 (1470–2499)		
		ICH		4 (1–12)						9 (1–32)		14 (2–51)		74 (37–133)		215 (135–325)		167 (54–389)		
		SAH		1 (0–6)						9 (0–32)		21 (4–61)		27 (7–69)		39 (5–141)		33 (1–184)		
		UND		0						0		7 (0–39)		34 (11–79)		186 (112–290)		900 (593–1305)		
	M	All		13 (4–30)						60 (24–124)		223 (128–361)		727 (542–952)		1994 (1591–2472)		3346 (2319–4684)		
	F	All		11 (3–28)						19 (2–69)		209 (117–345)		701 (527–911)		1697 (1390–2053		2882 (2182–3747)		
UK [57]	M	IS									186 (definite diagnosis)									
		ICH									27									
		SAH									8									
		All									117 (51–183)	275 (199–351)	429 (342–516)	652 (521–784)	1119 (862–1376)					

Appendix 1 Continued

Study	Sex	Type	0–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–100
The Netherlands [58]	M	All										170 (40–660)	230 (120–470)	760 (540–1080)	900 (630–1270)	1810 (1360–2400)	1990 (1400–2830)	2550 (1590–4110)	3340 (1670–6680)	6980 (2250–2160)
	F	All										120 (30–470)	210 (110–390)	310 (190–500)	570 (400–820)	1430 (1110–1810)	1170 (860–1890)	2060 (1560–2720)	2650 (1860–3800)	3310 (1780–6160)
	All	IS										150 (100–250)		400 (320–510)		900 (750–1090)		690 (490–980)		
		ICH										20 (0–70)		60 (30–100)		180 (120–270)		110 (40–250)		
		UND										30 (10–80)		140 (100–210)		420 (320–560)		1660 (1330–2070)		
Italy [20]	M	IS	6 (0–13)									172 (60–278)		978 (669–1248)		1329 (812–1734)		1570 (608–2392)		
		ICH	6 (0–13)									38 (0–91)		51 (0–123)		212 (4–421)		315 (0–753)		
		All	12 (2–22)									211 (86–335)		1030 (712–1347)		1542 (985–2099)		1896 (833–2958)		
	F	IS	4 (0–10)									184 (75–293)		373 (205–540)		1106 (736–1435)		2539 (1514–3563)		
		ICH	6 (0–13)									0 (0–0)		78 (2–155)		130 (3–257)		441 (10–873)		
		All	10 (1–19)									184 (75–293)		451 (267–635)		1236 (845–1626)		2980 (1873–4087)		
Italy [34]	M	IS	0					20 (4–58)		54 (21–111)		200 (125–302)		631 (473–820)		1261 (909–1702)		2083 (1039–3728)		
		ICH	0					20 (4–58)		54 (21–111)		90 (43–165)		210 (124–331)		60 (7–216)		0		
		SAH	0					13 (1–46)		15 (1–54)		0		11 (0.2–61)		30 (0.7–167)		0		
		UND	0					0		0		18 (2–64)		81 (32–166)		210 (84–432)		378 (45–1364)		
		All	0					55 (23–108)		124 (70–200)		309 (214–432)		936 (742–1160)		1562 (1160–2046)		2462 (1309–4210)		
	F	IS	0					7(1–38)		22 (2–79)		74 (35–136)		350 (255–469)		951 (739–1207)		2885 (2155–3779)		
		ICH	0					14 (1–50)		59 (25–116)		89 (46–155)		171 (105–258)		96 (38–197)		221 (60–565)		
		SAH	0					14 (1–50)		14 (1–50)		7 (0–38)		0		13 (0–72)		0		
		UND	0					0		7 (1–38)		14 (1–59)		70 (32–133)		151 (75–270)		499 (228–948)		
		All	0					36 (11–83)		103 (56–173)		186 (120–275)		576 (452–725)		1212 (972–1490)		3607 (2784–4580)		
Sweden [21]	M	All																3250 (1590–6290)		
	F	All																6690 (5010–8870)		
Italy [59]	M	IS	1.62 (0.2–5.83)	0.95 (0.02–5.27)		2.73 (0.56–7.97)		22.15 (13.85–33.61)												
		ICH	0	0.95 (0.02–5.27)		2.73 (0.56–7.97)		9.63 (4.62–17.7)												
		SAH	0.81 (0.02–4.5)	1.89 (0.23–6.83)		3.64 (0.99–9.31)		4.81 (1.56–11.24)												
		UND	2.42 (0.5–7.08)	3.78 (1.03–9.68)		9.09 (4.36–16.72)		36.59 (25.79–50.48)												
	F	IS	0	0.97 (0.02–5.39)		4.57 (1.48–10.67)		15.98 (9.14–25.96)												
		ICH	0	0.97 (0.02–5.39)		0.91 (0.02–5.09)		2 (0.24–7.21)												
		SAH	0	0		1.83 (0.22–6.6)		5.99 (2.2–13.05)												
		UND	0	1.94 (0.23–6.99)		7.32 (3.15–14.41)		23.98 (14.82–36.71)												
Italy [60]	M	IS															1831 (1627–2053)	2878 (2478–3326)	3303 (2487–4294)	
	F	IS															1682 (1459–1930)	2795 (2476–3144)	2853 (2324–3467)	

Appendix 1 Continued

Study	Sex	Type	0–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–100
Sweden [61]	M	ICH	0			5.1 (1.4–13)		8.2 (3–17.7)		28.8 (18.4–42.8)		50 (33.5–71.8)		101.1 (74.8–133.6)		208.1 (160.6–265.2)		147.8 (69.7–237.3)		
		SAH	0	0		0		3.1 (0.8–11.9)		13.2 (6.6–23.6)		13.8 (6–27.2)		16.5 (7.1–32.5)		12.8 (3.5–32.8)		12.3 (0.3–68.6)		
	F	ICH	0			1.4 (0–7.6)		4.2 (0.9–12.2)		13.6 (6.8–24.3)		29 (16.9–46.5)		61.5 (42.6–85.9)		128.9 (97.6–167.1)		167 (112.7–238.4)		
		SAH	0	1.4 (0–8)		2.7 (0.3–9.8)		8.4 (3.1–18.2)		22.2 (13.2–35.1)		22.2 (11.8–37.9)		25.3 (13.8–42.5)		27.1 (14–47.4)		27.8 (9–65)		
Lithuania [62]	M	All						230 (208–252)												
	F	All						131 (117–145)												
Italy [18]	M	All	0						70		130		550		1550		650			
	F	All	0						20		170		330		1320		2560			
	All	All	0						40		150		430		1420		1760			
	M	All	10									370		750		1860				
	F	All	10									240		730		1780		3390		
	All	All	10									300		740		1820		2110		
UK [37]	M	All	2 (0–12)	3 (0–17)		19 (9–34)		32 (15–60)		98 (60–152)		308 (237–394)		599 (485–732)		879 (683–1115)		1913 (1199–2896)		
	F	All	0	5 (0–19)		9 (3–20)		34 (10–51)		78 (43–123)		136 (90–196)		445 (354–552)		898 (737–1083)		1887 (1482–2369)		
Greece [40]	M	All		4.5				30.8		112.7 (51–174)		240.3 (162–319)		662.4 (512–813)		1275.3 (1023–1503)		3218.9 (2502–3936)		
	F	All		10.7				18.1		47.5 (6–89)		195.9 (125–267)		478 (353–603)		1165.5 (937–1394)		2137.1 (1568–2706)		
UK [63*]	All 1	All	10 (5–18)							57 (26–108)		209 (140–300)		409 (303–541)						
	All 2	All	6 (3–10)							35 (18–63)		144 (105–192)		388 (319–468)						
	All 3	All	3 (0.9–9)							21 (7–50)		120 (78–176)		403 (316–507)						
UK [64]	M	All	6 (3–10)							47 (28–73)		254 (204–314)		531 (446–629)						
	F	All	6 (3–10)							48 830–76)		124 (90–168)		403 (336–478)						
UK [22]	White	All	2 (0–7)	2 (0–8)		6 (3–11)		25 (15–38)		81 (60–107)		185 (153–222)		438 (387–494)		911 (817–1013)		1874 (1613–2166)		
	Black	All	0 (0–6)	6 (0–22)		34 (20–55)		67 (36–115)		91 (50–152)		358 (268–471)		1003 (773–1281)		2165 (1471–3072)		6410 (3074–11788)		
	Other	All	0 (0–17)	3 (0–7)		12 (8–18)		30 (21–42)		156 (71–296)		306 (158–535)		956 (523–1604)		1506 (722–2770)		2907 (944–6783)		
	All	All	1 (0–4)	3 (0–7)		12 (8–18)		30 (21–42)		87 (68–110)		219 (188–253)		496 (444–551)		934 (841–1034)		1972 (1708–2265)		
Germany [36]	M	IS	0			4 (1–13)		7 (0–32)		96 (56–156)		160 (102–240)		531 (401–690)		1017 (733–1377)		1932 (1216–2920)		
		ICH	0			2 (0–10)		0		16 (3–50)		19 (3–59)		66 (26–139)		203 (89–401)		242 (43–758)		
		SAH	0			0		7 (0–32)		16 (3–50)		9 (0–45)		0		0		0		
		UND	0			0		0		0		0		13 (1–63)		68 (12–213)		242 (43–758)		
		All	0			6 (2–16)		14 (2–43)		128 (80–195)		188 (125–273)		610 (470–779)		1288 (966–1685)		2415 (1606–3491)		
	F	IS	0			2 (0–19)		22 (6–56)		32 (11–74)		136 (85–206)		353 (265–463)		957 (764–1185)		1594 (1196–2084)		
		ICH	0			0		0		32 (11–74)		42 (17–89)		74 (37–134)		207 (123–330)		0		
		SAH	0			0		7 (0–34)		16 (3–51)		25 (7–66)		9 (0–44)		16 (1–76)		0		
		UND	0			0		0		0		0		5 (0–26)		33 (9–84)		374 (216–605)		
		All	0			2 (0–10)		29 (10–66)		81 (44–137)		203 (140–286)		437 (338–557)		1197 (980–1448)		2013 (1564–2554)		
Germany [65]	All	IS	3.9 (1.6–8.1)					9.6 (3.5–20.9)		62.8 (42.2–89.7)		147.4 (115.1–185.8)		408.1 (345.7–481.6)		887 (766.2–1028.1)		1153.2 (923.7–1418.5)		
Vibo, Estonia	M	All	19 (4–35)							184 (64–304)		327 (156–499)		1161 (789–1534)		1201 (575–1826)		2265 (606–3925)		
	F	All	15 (2–27)							114 (30–198)		178 (73–283)		1052 (767–1301)		1499 (1064–1933)		1916 (1105–2728)		
	All	All	17 (7–27)							145 (74–216)		239 (146–333)		1092 (863–1298)		1415 (1057–1774)		1993 (1262–2724)		

Rates are shown for rural (r) and urban (u) populations.

All 1, 2, 3: incidence rates in West Lambeth, Lewisham and North Southwark, and Tunbridge Wells.

Appendix 2 Studies on trends in incidence (rates per 100 000)

Study	Sex	Type	Year	0–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–100
Italy [66]	M	All	1997	20 (5–35)							106 (37–175)		382 (240–524)		979 (718–1240)		1821 (1277–2365)		3459 (1979–4939)		
	F	All	1997	13 (1–25)							51 (1–101)		182 (87–277)		629 (443–815)		1755 (1144–2166)		2787 (1954–3620)		
	All	All	1997	17 (7–27)							141 (83–199)		280 (195–365)		783 (628–938)		1780 (1452–2108)		3070 (2329–3811)		
Germany [67]	M	All	1985–1988				6.6 (4–9)		21.8 (17–26)		102.9 (93–113)		296.4 (276–317)		731.1 (673–789)						
	F	All	1985–1988				9.5 (7–12)		26.1 (21–31)		55.6 (49–63)		161.7 (149–175)		594.9 (557–633)						
Finland [68]	M	All	1993				0		39 (11–100)		1301 (65–234)		230 (119–402)		647 (410–970)		1392 (873–2103)		2465 (988–5077)		
	F	All	1993				10 (0–58)		30 (6–87)		35 (7–103)		269 (154–436)		573 (392–808)		1137 (805–1558)		2073 (1207–3317)		
	All	All	1993				5 (0–29)		35 (14–71)		83 (45–139)		251 (167–364)		602 (453–782)		1219 (930–1573)		2174 (1393–3239)		
Finland [69]	M	IS	1992				187 (175–199)										1630 (1476–1784)		2559 (2067–3051)		
		ICH	1992				30 (25–35)										156 (108–204)		49 (19–117)		
		SAH	1992				18 (14–22)										30 (9–51)		0		
	F	IS	1992				99 (92–106)										1485 (1392–1578)		2892 (2625–3159)		
		ICH	1992				18 (15–21)										153 (123–183)		154 (92–216)		
		SAH	1992				18 (15–21)										39 (24–54)		51 (15–87)		
Johansson *et al.* [70]	M	All	1993–1995		5.6 (1.8–13.2)				45.5 (32.1–62.4)				264.1 (206.6–332.7)		756.3 (643.2–883.6)		1621.7 (1398.1–1871.1)		2147.7 (1626.6–2782.6)		
	F	All	1993–1995		8.1 (3.2–16.7)				21.9 (12.9–34.6)				128.5 (89.9–177.9)		463.3 (381.8–557.2)		1183 (1027.6–1355.3)		1734 (1406.1–2115.4)		
Estonia [16]	M	All	1991–1993	29 (21–41)								455 (364–569)		748 (612–913)		1223 (954–1568)		2296 (1742–3027)			
	F	All	1991–1993	17 (10–26)								222 (167–294)		506 (416–614)		1296 (1102–1525)		2716 (2361–3125)			
France [71]	M	IS	1994	69.2 (52–86.5) World standardization																	
	F	IS	1994	40 (29.4–50.6) World standardization																	
Sweden [72]	M	All	1998–2000					32.4 (30.6–34.2)				186.8 (180.5–193)		445.7 (430.6–460.8)							
	F	All	1998–2000					21.7 (20.1–23.2)				99.2 (94.6–103.8)		243.8 (232.8–254.8) till 65							

Appendix 2 Continued

Study	Sex	Type	Year	0–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–94	95–100
Finland [17]	M	All	1989–1991		17.3		5.2		47.8		155		397.2		708.3		1606.8				
	F	All	1989–1991		0		6		20.9		90.4		217.1		553.2		1615.4				
UK [31]	M	All	2002–2004	0					27 (7–69)		73 (33–138)		177 (103–284)		646 (470–868)		942 (656–1310)		1972 (1149–3158)		
	F	All	2002–2004	0					16 (2–57)		54 (20–117)		175 (100–284)		408 (271–589)		1051 (789–1371)		1508 (1017–2152)		
Finland [73]	M	All	1987–1989				252 (239–265)														
	F	All	1987–1989				143 (134–152)														
Sweden [74]	M	IS	1998				41						388		1217						
		ICH	1998				18						108		172						
		All	1998				59						396		1389						
	F	IS	1998				28						242		638						
		ICH	1998				5						51		90						
		All	1998				33						293		728						
Sweden [75]	M	SAH	1991						15						12						
		All	1991						160						1059						
		All f and r	1991						199						1360						
	F	SAH	1991						40						44						
		All	1991						76						657						
		All f and r	1991						88						959						
Sweden [76]	M	All	1987–1991		325 (281–376)																
	F	All	1987–1991		398 (346–458)																
Denmark [19]	M	All	1990–1991				15 (7–30)		48 (32–70)		176 (138–222)		358 (295–431)		754 (625–902)		1460 (1143–1839)		1738 (973–2867)		
	F	All	1990–1991				17 (8–32)		36 (22–55)		78 (53–110)		181 (137–234)		514 (418–626)		1504 (1252–1792)		2189 (1577–2958)		
Denmark [77]	M	All	1988–1993								152 (79–291)		561 (423–746)		824 (653–1040)		1746 (1375–2263)				
	F	All	1988–1993								99 (45–221)		296 (208–4219)		556 (444–698)		1250 (994–1573)				

Appendix 3 Stroke prevalence studies (rates per 100 000)

Study	0–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89	90–100
Bermejo *et al.* [45]												
Urban							8500 (5500–11 500)					
Rural						2100 (600–3600)						
FIN, IT, NL [23]												
FIN							9300					
NL							3600					
IT							5000					
France [78]		1468 (905–2228)										
Italy [55]							5900					
Italy [27]												
M							4800	7500	9600	10 200	10 700	9100
F							2600	3400	550	7900	9800	10 000
Italy [26]												
M							7900 (4700–11 200)		11 500 (6500–16 400)		16 000 (4500–36 100)	
F							3400 (1400–5300)		7400 (3900–10 800)		11 600 (3900–25 100)	
Both							5800 (3900–7600)		9600 (6600–12 600)		14 700 (7300–25 000)	
Italy [25]												
Male	39.6	409.8				2992.8		5649.7		6341.5		0
M	41	573				1069		4424		8042		3074
Both	40.5	492.9				1959.8		4977.7		7332		
The Netherlands [24]												
M					2500		5000		8900		11 600	
F					1600		3300		6700		10 500	
Sweden [21]												
M 1st							3250 (1590–6290)					
M							16 800 (11 300–24 100)					
F 1st							6690 (5010–8870)					
F							19 700 (15 700–24 300)					
UK [79]												
M					2160 (1500–3020)		4680 (3600–5970)		11 010 (8750–13 650)		8220 (4370–14 050)	
F					1140 (690–1780)		3390 (2560–4400)		7970 (6480–9730)		10 410 (7700–13 730)	
Both					1640 (1230–2150)		3980 (3330–4770)		9110 (7850–10 570)		9840 (7550–12 600)	
UK [80]												
1st	205 (183–230)											
Rec	42 (33–55)											
UK [81]												
M			1100 (0–2610)		4760 (1730–7800)		6990 (3330–10 650)		14 360 (9350–19 370)		7140 (3250–11 040)	
F			510 (0–1490)		3080 (650–5500)		5130 (2030–8220)		7730 (3970–11 490)		11 230 (6700–15 760)	

FIN, Finland; NL, the Netherlands; IT, Italy.

[a]A focal neurological deficit consisting in signs or symptoms of carotid or vertebrobasilar impairment lasting more or less 24 h was defined as stroke or TIA, respectively.

[b]All numbers are given for urban + rural samples

[c]Rural sample contains patients older than 60 years, whilst urban those older than 65 years.

MANAGE-PD

Tool for Making Informed Decisions to **Aid Timely Management of Parkinson's Disease**

MANAGE-PD allows you to:

- Identify PD patients inadequately controlled on oral medications
- Determine which patients with PD may be adequately controlled on their current treatment regimen or may require changes to their treatment regimen

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PD: Parkinson´s Disease

Parkinson's Foundation

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