Labour market participation and retirement after stroke in Denmark: registry based cohort study

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ABSTRACT

OBJECTIVE

To examine labour market participation and retirement among patients with stroke and matched people in the general population according to stroke subtype.

DESIGN

Nationwide, population based, matched cohort study.

SETTING

Danish Stroke Registry, covering all Danish hospitals, and other nationwide registries (2005-18).

PARTICIPANTS

Patients (aged 18-60 years and active in the labour market) with a first time diagnosis of ischaemic stroke (n=16 577), intracerebral haemorrhage (n=2025), or subarachnoid haemorrhage (n=4305), and individuals from the general population, matched on age, sex, and calendar year (n=134 428). The median Scandinavian stroke scale score was 55.

MAIN OUTCOME MEASURES

Unweighted prevalences of labour market participation, receipt of sick leave benefits, receipt of disability pension, voluntary early retirement, state pension, and death were computed for each week and up to five years after stroke diagnosis. A log-linear Poisson model was used to obtain exact prevalence estimates as well as propensity score weighted prevalence differences and prevalence ratios at six months, one year, two years, and five years after stroke diagnosis.

RESULTS

Most patients (62% of those with ischaemic stroke, 69% of those with intracerebral haemorrhage, and 52% of those with subarachnoid haemorrhage) went on sick leave within three weeks of diagnosis. Prevalence of labour market participation among patients with ischaemic stroke compared with matched individuals from the general population was 56.6% versus 96.6% at six months, and 63.9% versus 91.6% at two years. Prevalence of sick leave was 39.8% versus 2.6% at six months, and 15.8% versus 3.8% at two years. Prevalence of receipt of a disability pension was 0.9% versus 0.2% at six months, and 12.2% versus 0.6% at two years. Adjusting for socioeconomic and comorbidity differences between patients and matched individuals from the general population using propensity score weighting methods had little impact on contrasts. Patients with intracerebral haemorrhage had higher prevalences of sick leave and receipt of a disability pension and thus a lower prevalence of labour market participation, while prevalences for patients with subarachnoid haemorrhage were similar in magnitude to those for patients with ischaemic stroke.

CONCLUSIONS

In a highly resourced country, about two thirds of working age adults with ischaemic stroke of primarily mild severity participated in the labour market two years after diagnosis. Sick leave and receipt of a disability pension were the most common reasons for non-participation. Patients with intracerebral haemorrhage were less likely to return to the labour market than patients with ischaemic stroke and subarachnoid haemorrhage.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Stroke survival has improved in recent decades, but the extent to which the improved prognosis has led to improved social outcomes remains less clear

Returning to work after stroke is important for financial stability, independence, and mental wellbeing

Research on return to work after stroke has used small study sizes, used questionnaires or other self-reported data to assess employment status, not examined stroke subtypes, and not contextualised findings compared with what was expected among the general population

WHAT THIS STUDY ADDS

Compared with matched individuals from the general population, patients with ischaemic stroke had a 24% reduced absolute prevalence of labour market participation at two years after diagnosis, after adjusting for differences in age, sex, calendar year, education, income, and comorbidity

Labour market participation was similar for patients with ischaemic stroke and subarachnoid haemorrhage, but patients with intracerebral haemorrhage had lower participation, largely attributable to much higher prevalences of sick leave and receipt of disability pensions

Introduction

Although stroke continues to be a leading cause of death and disability worldwide, stroke mortality has decreased in most high income countries.[1] In Denmark, 30 day stroke mortality decreased between 2005 and 2018 from 2.3% to 0.1% among patients aged 18-49 years, and from 8.2% to 6.0% among patients aged at least 50 years.[2] Decreasing risks over time have been observed for some non-fatal outcomes, such as stroke recurrence and post-stroke neurological and psychiatric disorders.[3 4] The extent to which the improved prognosis has led to improved social outcomes remains less clear.

Stroke and its sequelae might hinder the ability to work, which is particularly important for adults of working age. Returning to work after stroke is important for financial stability, independence, and mental wellbeing.[5 6] On a societal level, the cost attributable to loss of productivity due to illness after

stroke is substantial: this figure was recently estimated to exceed €630m (£540m; $655m) a year in Denmark (about 25% of the total annual stroke cost).[7]

Research on return to work after stroke[8-19] has generally used small study sizes (<1000 patients),[8 9 12-14 16 18] used questionnaires or other self-reported data to assess employment status,[8 9 12 15 18] not examined stroke subtypes and relevant patient subgroups,[8-19] and not contextualised findings in comparison with what was expected among the general population.[8-12 14-16 18 19] The Danish welfare system provides universal healthcare, unemployment benefits, and retirement benefits. A unique nationwide registry with weekly longitudinal information on all public transfer payments from Danish authorities permits examination of labour market dynamics with high granularity.[20 21]

In a nationwide, population based cohort study, we examined labour market participation and retirement among patients with stroke and matched general population comparators. We assessed patterns separately for major stroke subtypes and among patient subgroups.

Methods

Setting and data sources

Denmark has a state funded healthcare system that provides free access to healthcare for all residents, regardless of employment status.[22] In addition, Denmark provides public welfare benefits and other social services to all residents. A rich infrastructure of nationwide, population based clinical and administrative registries has been created in the country.[22] All residents are assigned a unique personal identification number that allows unambiguous linkage across registries at an individual level, as well as complete long term follow-up.[23]

In the current study, we obtained data from the following nationwide registries, all with population wide coverage:

- Danish Stroke Registry,[24] which collects clinical data on all acute hospital admissions for stroke (eg, stroke subtype, stroke severity, and in-hospital acute treatment). All hospitals treating patients with stroke, as defined by the World Health Organization's criteria, must report to this registry.
- DREAM,[20] the Danish national registry on public transfer payments, which contains weekly information on residents receiving public welfare benefits of any kind.[24]
- Danish National Patient Registry[25] and Danish Psychiatric Central Research Register,[26] which collectively record all non-psychiatric and psychiatric inpatient and outpatient clinic diagnoses, coded according to ICD-8 (international classification of diseases, 8th revision) between 1977 and 1993 and ICD-10 after 1993.
- Danish National Prescription Registry,[27] which records all prescriptions filled in community pharmacies, coded according to the anatomical therapeutic chemical classification system.
- Statistics Denmark's income and education registries,[28] which collectively contain information on income and highest level of completed education.
- Danish Civil Registration System,[23] which contains information on date of birth, sex, and vital status for the entire Danish population, updated daily.

This study was registered with the Danish Data Protection Agency at Aarhus University (record No 2016-051-000001-1502). In Denmark, ethical approval is not required for registry based studies. We followed the reporting guidelines suggested by STROBE (strengthening the reporting of observational studies in epidemiology).[29]

Study cohorts

We identified a cohort of working age adults (18-60 years) admitted to hospital with a first time ischaemic stroke, intracerebral haemorrhage, or subarachnoid haemorrhage between 1 May 2004 and 31 December 2018. We required that patients were active in the labour market (defined below) at four weeks before the stroke admission date (referred to here as the index date).[30] We did not require patients to survive the length of their hospital admission. Patients with ischaemic stroke and intracerebral haemorrhage were identified from the stroke registry.[24] Diagnoses in this registry have a high positive predictive value (>90%).[31 32] Patients with subarachnoid haemorrhages were identified from the Danish National Patient Registry, as these patients were not included in the stroke registry until 2017.[25] Patients with transient ischaemic attack, epidural haemorrhage, subdural hematoma, retinal infarct, and infarct caused by trauma, infection, or an intracranial malignant process were not included.[24]

To contextualise findings on labour market participation after stroke with findings expected in the general population, we matched each patient with stroke with up to five people from the general population on birth year and sex. Matching was conducted with replacement. To be eligible for matching, comparators were required to have no stroke diagnosis before the index date of the matched patient with stroke, to be alive and living in Denmark, and to be part of the labour market at four weeks before the index date.[33] Comparators were assigned an index date corresponding to the stroke diagnosis date of their matched patient. If comparators had a stroke during follow-up, they then contributed risk time to both cohorts, to avoid informative censoring.[33]

Patients with stroke and matched general population comparators were followed for up to five years after their index date using registry data. Data were available until 31 December 2018.

Labour market participation

We compiled information on labour market participation from the DREAM registry. Founded in 1991 and administered by the Danish Ministry of Employment, DREAM contains weekly information on all public transfer payments from Danish authorities.[20]

Table 1 | Characteristics of patients aged 18-60 years with a first time stroke and individuals from the general population matched by age, sex, and calendar year, in Denmark, 2004-18

	Overall cohorts			Propensity score weighted cohorts	
	Stroke	General population	SMD	General population	SMD
Overall	22 907	98 007	—	23 075.41	—
Stroke subtype					
Ischaemic stroke	16 577 (72.4)	—	—	—	—
Intracerebral haemorrhage	2025 (8.8)	—	—	—	—
Subarachnoid haemorrhage	4305 (18.8)	—	—	—	—
Age (years)					
Median (IQR)	51 (45-56)	51 (45-56)	0.06	52 (45-57)	0.04
18-40	3468 (15.1)	16 259 (16.6)	0.04	3302.5 (14.3)	0.02
41-50	6949 (30.3)	30 547 (31.2)	0.02	6716.9 (29.1)	0.03
51-60	12 490 (54.5)	51 201 (52.2)	0.05	13 056.0 (56.6)	0.04
Male sex (No (%))	14 102 (61.6)	61 257 (62.5)	0.02	14 347.4 (62.2)	0.01
Calendar period of stroke diagnosis					
2004-06	4262 (18.6)	18 318 (18.7)	0.00	4132.8 (17.9)	0.02
2007-09	4718 (20.6)	20 123 (20.5)	0.00	4484.4 (19.4)	0.03
2010-12	4546 (19.8)	19 407 (19.8)	0.00	4375.7 (19.0)	0.02
2013-15	4656 (20.3)	19 972 (20.4)	0.00	4935.3 (21.4)	0.03
2016-18	4725 (20.6)	20 187 (20.6)	0.00	5147.2 (22.3)	0.04
Labour market participation four weeks before the index date					
Employed	18 816 (82.1)	87 049 (88.8)	0.19	18 581.5 (80.5)	0.04
Receiving state educational grants	394 (1.7)	1972 (2.0)	0.02	383.5 (1.7)	0.00
Receiving parental leave payments	139 (0.6)	853 (0.9)	0.03	136.7 (0.6)	0.00
Receiving unemployment payments unrelated to health	3558 (15.5)	8133 (8.3)	0.22	3973.7 (17.2)	0.05
Disposable income (5 year average)					
Low	8099 (35.4)	25 563 (26.1)	0.20	8434.6 (36.6)	0.02
Medium	7857 (34.3)	34 639 (35.3)	0.02	7817.6 (33.9)	0.01
High	6900 (30.1)	37 636 (38.4)	0.18	6776.3 (29.4)	0.02
Missing	51 (0.2)	169 (0.2)	0.01	46.9 (0.2)	0.00
Education level					
Low (primary or lower secondary)	7258 (31.7)	25 612 (26.1)	0.10	7381.6 (32.0)	0.01
Medium (upper secondary or academic profession degree)	13 434 (58.6)	60 790 (62.0)	0.04	13 510.1 (58.5)	0.00
High (university education at bachelor's level or higher)	1520 (6.6)	9949 (10.2)	0.09	1466.9 (6.4)	0.01
Missing	695 (3.0)	1656 (1.7)	0.31	716.8 (3.1)	0.00
Preadmission non-psychiatric comorbidity					
Hypertension	5956 (26.0)	4415 (4.5)	0.63	6787.7 (29.4)	0.08
Dyslipidaemia	5639 (24.6)	7306 (7.5)	0.48	5707.4 (24.7)	0.00
Ischaemic heart disease	1388 (6.1)	2890 (2.9)	0.15	2005.3 (8.7)	0.11
Atrial fibrillation or flutter	767 (3.3)	1079 (1.1)	0.15	1106.4 (4.8)	0.08
Valvular heart disease	329 (1.4)	339 (0.3)	0.12	534.8 (2.3)	0.07
Heart failure	527 (2.3)	683 (0.7)	0.13	613.6 (2.7)	0.02
Peripheral artery disease	398 (1.7)	864 (0.9)	0.08	517.5 (2.2)	0.04
Venous thromboembolism	245 (1.1)	333 (0.3)	0.09	342.5 (1.5)	0.04
Diabetes	1721 (7.5)	3232 (3.3)	0.19	2241.4 (9.7)	0.08
Thyroid disorder	818 (3.6)	3325 (3.4)	0.01	824.8 (3.6)	0.00
Gout	208 (0.9)	392 (0.4)	0.06	246.8 (1.1)	0.02
Chronic pulmonary disease	1583 (6.9)	5390 (5.5)	0.06	1691.3 (7.3)	0.02
Allergy	674 (2.9)	3432 (3.5)	0.03	666.9 (2.9)	0.00
Ulcer/chronic gastritis	492 (2.1)	1063 (1.1)	0.08	605.1 (2.6)	0.03
Chronic liver disease	291 (1.3)	541 (0.6)	0.08	315.8 (1.4)	0.01
Inflammatory bowel disease	241 (1.1)	872 (0.9)	0.02	235.8 (1.0)	0.00
Diverticular disease of intestine	271 (1.2)	935 (1.0)	0.02	300.3 (1.3)	0.01
Chronic kidney disease	147 (0.6)	244 (0.2)	0.06	209.0 (0.9)	0.03
Prostate disorders	203 (0.9)	881 (0.9)	0.00	205.2 (0.9)	0.00
Connective tissue disorders	373 (1.6)	1062 (1.1)	0.05	435.5 (1.9)	0.02
Osteoporosis	194 (0.8)	634 (0.6)	0.02	221.7 (1.0)	0.01
Painful conditions	1713 (7.5)	4618 (4.7)	0.12	1935.6 (8.4)	0.03
HIV/AIDS	42 (0.2)	103 (0.1)	0.02	35.2 (0.2)	0.01
Anaemias	153 (0.7)	182 (0.2)	0.07	191.0 (0.8)	0.02
Cancers	715 (3.1)	2751 (2.8)	0.02	716.0 (3.1)	0.00
Vision problems	240 (1.0)	705 (0.7)	0.04	207.2 (0.9)	0.01
Hearing problems	616 (2.7)	2477 (2.5)	0.01	611.6 (2.7)	0.00

(*Continued*)

Table 1 | Continued

	Overall cohorts			Propensity score weighted cohorts	
	Stroke	General population	SMD	General population	SMD
Migraine	361 (1.6)	147 (0.1)	0.15	418.7 (1.8)	0.02
Epilepsy	638 (2.8)	1334 (1.4)	0.10	699.3 (3.0)	0.01
Parkinson's disease	<5	<5	0.00	<5	0.01
Multiple sclerosis	42 (0.2)	123 (0.1)	0.01	40.8 (0.2)	0.00
Neuropathies	1067 (4.7)	3326 (3.4)	0.06	1089.7 (4.7)	0.00
Preadmission psychiatric comorbidity					
Organic disorders	83 (0.4)	86 (0.1)	0.06	93.1 (0.4)	0.01
Substance abuse	1673 (7.3)	2522 (2.6)	0.22	2031.2 (8.8)	0.06
Schizophrenia	26 (0.1)	41 (0.0)	0.03	42.1 (0.2)	0.02
Mood disorders	1728 (7.5)	4840 (4.9)	0.11	1893.8 (8.2)	0.03
Neurotic disorders	371 (1.6)	796 (0.8)	0.07	455.6 (2.0)	0.03
Eating disorders	12 (0.1)	30 (0.0)	0.01	23.8 (0.1)	0.02
Personality disorders	21 (0.1)	28 (0.0)	0.03	22.5 (0.1)	0.00
Intellectual disabilities	<5	<5	0.00	<5	0.00
Developmental disorders	<5	<5	0.01	<5	0.00
Behavioural disorders	51 (0.2)	110 (0.1)	0.03	59.1 (0.3)	0.01
Preadmission drug use					
Anticoagulants	424 (1.9)	746 (0.8)	0.10	586.6 (2.5)	0.05
Antiplatelets	1686 (7.4)	3538 (3.6)	0.17	2338.3 (10.1)	0.11
Statins	2372 (10.4)	7693 (7.8)	0.09	2624.1 (11.4)	0.03
Proton pump inhibitors	2101 (9.2)	6620 (6.8)	0.09	2461.0 (10.7)	0.05
Antipsychotic drugs	360 (1.6)	791 (0.8)	0.07	422.5 (1.8)	0.02
No of non-psychiatric comorbidities					
0	8631 (37.7)	63 325 (64.6)	0.56	8628.1 (37.4)	0.01
1	6653 (29.0)	21 618 (22.1)	0.16	5987.3 (25.9)	0.07
≥2	7623 (33.3)	13 064 (13.3)	0.49	8459.9 (36.7)	0.07
No of psychiatric comorbidities					
0	19 562 (85.4)	90 369 (92.2)	0.22	19 242.9 (83.4)	0.06
1	2821 (12.3)	6915 (7.1)	0.18	3204.1 (13.9)	0.05
≥2	524 (2.3)	723 (0.7)	0.13	628.5 (2.7)	0.03
Stroke severity (Scandinavian stroke scale)*					
Median (IQR)	55 (47-58)	—	—	—	—
Mild (45-58)	13 652 (73.4)	—	—	—	—
Moderate (30-45)	1760 (9.5)	—	—	—	—
Severe or very severe (0-29)	1732 (9.3)	—	—	—	—
Missing	1458 (7.8)	—	—	—	—
Essen risk score*					
0	2863 (15.4)	—	—	—	—
1	6957 (37.4)	—	—	—	—
2	4309 (23.2)	—	—	—	—
≥3	2826 (15.2)	—	—	—	—
Missing	1647 (8.9)	—	—	—	—
Thrombolysis*					
Yes	2520 (13.6)	—	—	—	—
No	1610 (8.7)	—	—	—	—
Contraindicated	10 351 (55.6)	—	—	—	—
Missing	4121 (22.2)	—	—	—	—
Thrombectomy*					
Yes	400 (2.2)	—	—	—	—
No	541 (2.9)	—	—	—	—
Contraindicated	9033 (48.6)	—	—	—	—
Missing	8628 (46.4)	—	—	—	—

IQR=interquartile range; SMD=standardised mean difference.
*Information was available only for ischaemic stroke and intracerebral haemorrhage.

The data in the registry are considered to be of high quality.[20 34] For each week, starting from the index date and continuing for up to five years, we grouped patients into six mutually exclusive categories according to the type of transfer payment received: labour market participation (ie, employed or receiving state educational grants, parental leave payments, or unemployment payments unrelated to health); sick leave (ie, receipt of sick leave payments or other unemployment payments related to health; disability pension; voluntary early retirement; state pension (received at retirement age); and death. People who were not recorded in the registry or had no entry for a given week were considered to be self-supporting and participating in the labour market.[20] In Denmark, sick leave payments are issued for a limited period to people unable to work due to illness. Retirement includes several different pension schemes: disability pensions,

available to individuals of any age with permanently reduced work capacity; voluntary early retirement, available in various forms for certain individuals at least 50 years of age; and state pensions, available to individuals on reaching the public retirement age (65-69 years, depending on birth year).

Covariates

The primary aim was to describe labour market participation and retirement in patients with stroke and a comparison cohort from the general population. Therefore, we prioritised the presentation of unadjusted estimates.[35] Yet, even when the objective is descriptive (ie, not implying a causal question), adjustment for certain differences across exposure groups might be preferable.[35] Even apart from the effects of a stroke, patients with stroke differ from the general population in factors related to socioeconomic position and comorbidity. Such differences might directly or indirectly affect labour market participation, even after matching on age and sex. Therefore, we compiled information on a range of factors: using nationwide registries on income and education, we compiled information on average five year disposable income and highest level of education attained in the year before the index date. To account for inflation and salary changes over time, we categorised income levels as low, medium, or high, according to tertiles of the income distribution in both cohorts for each index year.[36] Based on the international standard classification of education, education levels were grouped into low (primary or lower secondary), medium (upper secondary or academic professional degree), or high (university education at the bachelor's level or higher) levels.

We identified non-psychiatric and psychiatric comorbidities recorded between 1994 and the index date. Based on prior work,[37 38] non-psychiatric comorbidities included hypertension, dyslipidaemia, ischaemic heart disease, atrial fibrillation or flutter, valvular heart disease, heart failure, peripheral artery disease, venous thromboembolism, diabetes, thyroid disorder, gout, chronic pulmonary disease, allergy, ulcer/chronic gastritis, chronic liver disease, inflammatory bowel disease, diverticular disease of the intestine, chronic kidney disease, prostate disorders, connective tissue disorders, osteoporosis, painful conditions, HIV/AIDS, anaemias, cancers, vision problems, hearing problems, migraine, epilepsy, Parkinson's disease, multiple sclerosis, and neuropathies. Psychiatric comorbidities included organic disorders, substance abuse, schizophrenia, mood disorders, neurotic disorders, eating disorders, personality disorders, intellectual disabilities, developmental disorders, and behavioural disorders. Comorbidities were identified from discharge diagnoses recorded in the Danish National Patient Registry and the Danish Psychiatric Central Research Register and, when applicable, on filled prescriptions during the year before the index date recorded in the Danish National

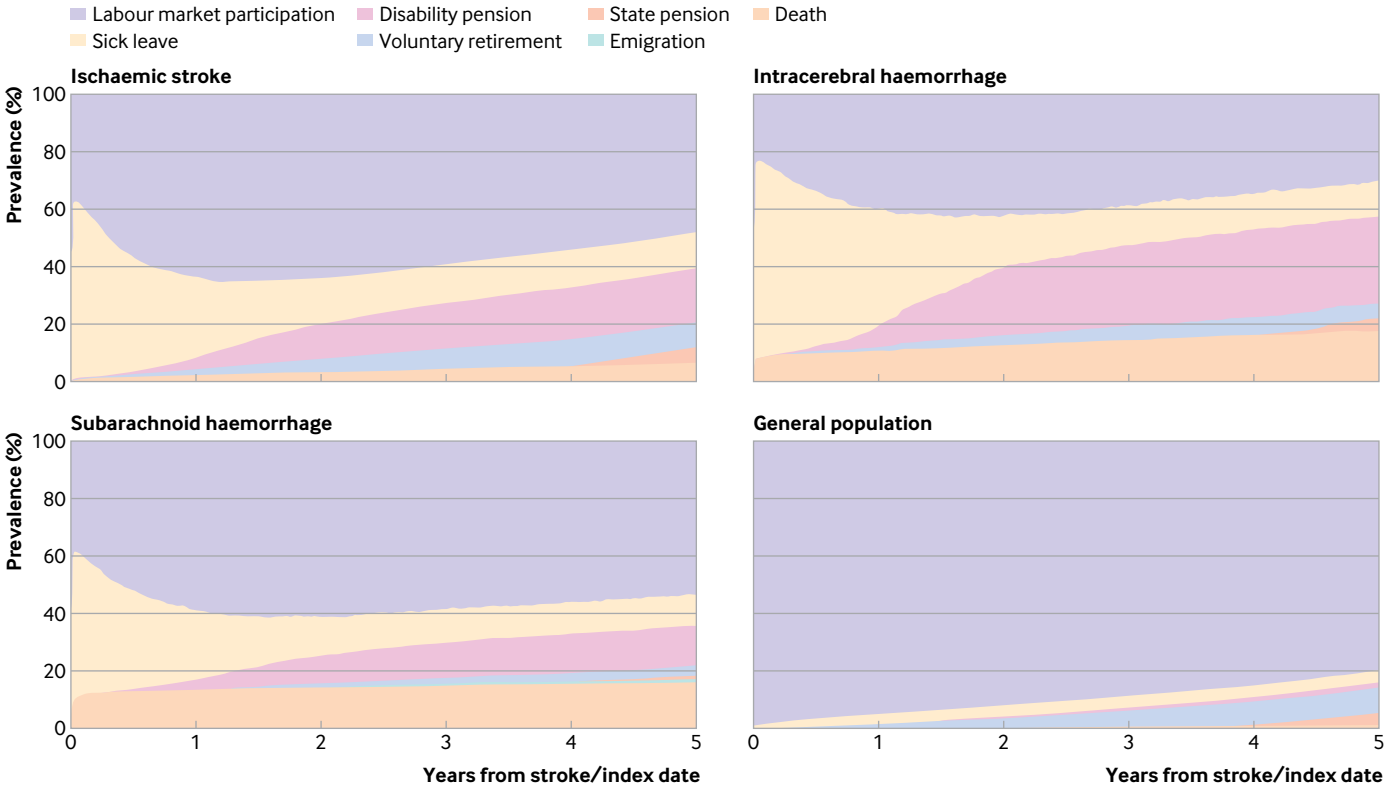

Fig 1 | Weekly prevalences of labour market participation, sick leave, receipt of a disability pension, voluntary early retirement, receipt of a state pension, and death among patients with ischaemic stroke, intracerebral haemorrhage, and subarachnoid haemorrhage and among individuals from the general population matched by age, sex, and calendar year

Table 2 | Prevalences (%) of labour market participation, sick leave, receipt of a disability pension, voluntary early retirement, receipt of a state pension, and death, and propensity score weighted differences and ratios comparing patients with stroke according to stroke subtype, with individuals from the general population matched by age, sex, and calendar year

	Time after stroke diagnosis			
Prevalence category	6 months	1 year	2 years	5 years
Labour market participation				
Ischaemic stroke				
Prevalence, ischaemic stroke	56.6	63.6	63.9	48.1
Prevalence, general population	96.6	94.9	91.6	78.4
PS weighted difference (95% CI)*	−38.48 (−39.40 to −37.57)	−28.76 (−29.76 to −27.76)	−23.95 (−25.08 to −22.81)	−23.23 (−24.83 to −21.63)
PS weighted ratio (95% CI)*	0.60 (0.59 to 0.60)	0.69 (0.68 to 0.70)	0.73 (0.72 to 0.74)	0.67 (0.66 to 0.69)
Intracerebral haemorrhage				
Prevalence, intracerebral haemorrhage	33.8	39.8	42.5	30.3
Prevalence, general population	96.5	94.6	91.9	79.1
PS weighted difference (95% CI)*	−59.27 (−62.38 to −56.16)	−51.20 (−54.46 to −47.95)	−41.96 (−46.40 to −37.51)	−40.76 (−45.15 to −36.37)
PS weighted ratio (95% CI)*	0.36 (0.34 to 0.39)	0.44 (0.41 to 0.46)	0.50 (0.47 to 0.54)	0.43 (0.39 to 0.47)
Subarachnoid haemorrhage				
Prevalence, subarachnoid haemorrhage	51.9	58.9	61.2	53.6
Prevalence, general population	96.6	95.3	93.0	84.9
PS weighted difference (95% CI)*	−43.29 (−45.04 to −41.55)	−34.25 (−36.26 to −32.24)	−28.40 (−30.52 to −26.28)	−25.49 (−28.12 to −22.86)
PS weighted ratio (95% CI)*	0.55 (0.53 to 0.56)	0.63 (0.61 to 0.65)	0.68 (0.66 to 0.70)	0.68 (0.65 to 0.71)
Sick leave				
Ischaemic stroke				
Prevalence, ischaemic stroke	39.8	28.1	15.8	12.3
Prevalence, general population	2.6	3.3	3.8	4.1
PS weighted difference (95% CI)*	36.24 (35.40 to 37.09)	23.54 (22.68 to 24.41)	10.31 (9.48 to 11.13)	6.40 (5.47 to 7.33)
PS weighted ratio (95% CI)*	11.22 (10.00 to 12.59)	6.15 (5.47 to 6.90)	2.89 (2.58 to 3.23)	2.08 (1.83 to 2.37)
Intracerebral haemorrhage				
Prevalence, intracerebral haemorrhage	53.9	40.8	18.0	12.3
Prevalence, general population	2.6	3.5	4.0	4.2
PS weighted difference (95% CI)*	48.70 (45.58 to 51.82)	34.92 (31.74 to 38.10)	9.56 (5.50 to 13.61)	7.37 (5.33 to 9.40)
PS weighted ratio (95% CI)*	10.41 (6.74 to 16.06)	6.93 (4.66 to 10.31)	2.13 (1.37 to 3.31)	2.50 (1.93 to 3.23)
Subarachnoid haemorrhage				
Prevalence, subarachnoid haemorrhage	34.3	24.1	13.4	10.5
Prevalence, general population	2.9	3.5	4.0	4.6
PS weighted difference (95% CI)*	30.42 (28.77 to 32.07)	19.64 (18.16 to 21.12)	7.85 (6.50 to 9.20)	4.03 (2.52 to 5.54)
PS weighted ratio (95% CI)*	8.78 (7.05 to 10.93)	5.38 (4.53 to 6.39)	2.41 (2.03 to 2.86)	1.62 (1.33 to 1.96)
Disability pension				
Ischaemic stroke				
Prevalence, ischaemic stroke	0.9	4.0	12.2	18.8
Prevalence, general population	0.1	0.3	0.6	1.8
PS weighted difference (95% CI)*	0.63 (0.45 to 0.80)	3.16 (2.76 to 3.56)	10.68 (10.06 to 11.29)	15.07 (14.12 to 16.01)
PS weighted ratio (95% CI)*	2.95 (2.12 to 4.11)	4.74 (3.43 to 6.55)	7.89 (6.38 to 9.75)	5.02 (4.24 to 5.95)
Intracerebral haemorrhage				
Prevalence, intracerebral haemorrhage	1.5	7.3	23.2	30.3
Prevalence, general population	0.2	0.3	0.7	1.8
PS weighted difference (95% CI)*	0.71 (−0.07 to 1.49)	6.05 (4.74 to 7.36)	21.52 (19.46 to 23.58)	25.91 (22.62 to 29.20)
PS weighted ratio (95% CI)*	1.86 (0.86 to 4.02)	6.01 (3.46 to 10.44)	13.60 (8.88 to 20.83)	6.95 (4.15 to 11.64)
Subarachnoid haemorrhage				
Prevalence, subarachnoid haemorrhage	0.7	3.1	9.6	13.8
Prevalence, general population	0.1	0.3	0.6	1.7
PS weighted difference (95% CI)*	0.35 (−0.04 to 0.74)	1.97 (0.68 to 3.25)	8.17 (7.14 to 9.20)	10.10 (8.14 to 12.05)
PS weighted ratio (95% CI)*	1.95 (0.80 to 4.75)	2.73 (0.96 to 7.80)	6.57 (4.68 to 9.21)	3.70 (2.42 to 5.67)
Voluntary early retirement				
Ischaemic stroke				
Prevalence, ischaemic stroke	0.8	1.7	4.5	8.7
Prevalence, general population	0.6	1.3	3.3	9.7
PS weighted difference (95% CI)*	−0.09 (−0.44 to 0.25)	−0.12 (−0.53 to 0.29)	0.24 (−0.39 to 0.86)	−3.06 (−4.19 to −1.93)
PS weighted ratio (95% CI)*	0.89 (0.60 to 1.33)	0.93 (0.75 to 1.17)	1.06 (0.91 to 1.22)	0.74 (0.67 to 0.82)
Intracerebral haemorrhage				
Prevalence, intracerebral haemorrhage	0.7	1.2	3.3	5.0
Prevalence, general population	0.6	1.2	2.8	9.2
PS weighted difference (95% CI)*	−0.06 (−0.68 to 0.55)	−0.27 (−1.04 to 0.50)	−1.27 (−3.23 to 0.69)	−6.31 (−8.73 to −3.88)
PS weighted ratio (95% CI)*	0.92 (0.39 to 2.13)	0.82 (0.47 to 1.44)	0.72 (0.45 to 1.15)	0.44 (0.33 to 0.59)
Subarachnoid haemorrhage				
Prevalence, subarachnoid haemorrhage	0.1	0.4	1.2	3.6
Prevalence, general population	0.3	0.6	1.8	5.9
PS weighted difference (95% CI)*	−0.26 (−0.42 to −0.09)	−0.35 (−0.64 to −0.05)	−0.87 (−1.36 to −0.37)	−3.56 (−4.86 to −2.27)
PS weighted ratio (95% CI)*	0.31 (0.12 to 0.80)	0.56 (0.33 to 0.95)	0.59 (0.43 to 0.81)	0.50 (0.39 to 0.64)

(*Continued*)

Table 2 | Continued

Prevalence category	Time after stroke diagnosis			
	6 months	1 year	2 years	5 years
State pension				
Ischaemic stroke				
Prevalence, ischaemic stroke	—	—	—	5.3
Prevalence, general population	—	—	—	4.4
PS weighted difference (95% CI)*	—	—	—	0.59 (−0.14 to 1.32)
PS weighted ratio (95% CI)*	—	—	—	1.13 (0.97 to 1.31)
Intracerebral haemorrhage				
Prevalence, intracerebral haemorrhage	—	—	—	4.3
Prevalence, general population	—	—	—	3.9
PS weighted difference (95% CI)*	—	—	—	−1.69 (−5.08 to 1.70)
PS weighted ratio (95% CI)*	—	—	—	0.72 (0.40 to 1.30)
Subarachnoid haemorrhage				
Prevalence, subarachnoid haemorrhage	—	—	—	1.4
Prevalence, general population	—	—	—	1.6
PS weighted difference (95% CI)*	—	—	—	−0.32 (−0.89 to 0.24)
PS weighted ratio (95% CI)*	—	—	—	0.81 (0.56 to 1.18)
Death				
Ischaemic stroke				
Prevalence, ischaemic stroke	1.8	2.3	3.3	6.2
Prevalence, general population	0.1	0.1	0.4	1.2
PS weighted difference (95% CI)*	1.67 (1.46 to 1.88)	2.06 (1.81 to 2.30)	2.65 (2.31 to 2.99)	4.05 (3.41 to 4.69)
PS weighted ratio (95% CI)*	15.86 (9.78 to 25.72)	8.56 (6.13 to 11.96)	5.02 (3.79 to 6.65)	2.85 (2.28 to 3.57)
Intracerebral haemorrhage				
Prevalence, intracerebral haemorrhage	10	10.7	12.7	17.5
Prevalence, general population	0.1	0.1	0.3	1.3
PS weighted difference (95% CI)*	9.93 (8.61 to 11.24)	10.39 (9.00 to 11.78)	12.11 (10.55 to 13.68)	15.73 (13.62 to 17.84)
PS weighted ratio (95% CI)*	102.38 (36.62 to 286.20)	33.73 (14.61 to 77.83)	22.50 (11.93 to 42.44)	9.66 (6.70 to 13.92)
Subarachnoid haemorrhage				
Prevalence, subarachnoid haemorrhage	12.7	13.1	14	16.1
Prevalence, general population	0	0.1	0.2	0.7
PS weighted difference (95% CI)*	12.66 (11.66 to 13.66)	12.88 (11.84 to 13.92)	13.04 (11.43 to 14.66)	14.99 (13.64 to 16.33)
PS weighted ratio (95% CI)*	172.37 (45.34 to 655.31)	50.82 (21.47 to 120.30)	14.81 (4.12 to 53.28)	14.17 (9.56 to 21.00)

CI=confidence interval; PS=propensity score.
*Propensity score weights calculated based on the following covariates: age, sex, calendar period, labour market participation at four weeks before the index date, income level, education level, hypertension, dyslipidaemia, ischaemic heart disease, atrial fibrillation or flutter, valvular heart disease, heart failure, peripheral artery disease, venous thromboembolism, diabetes, thyroid disorder, gout, chronic pulmonary disease, allergy, ulcer/chronic gastritis, chronic liver disease, inflammatory bowel disease, diverticular disease of intestine, chronic kidney disease, prostate disorders, connective tissue disorders, osteoporosis, painful conditions, HIV/AIDS, anaemias, cancers, vision problems, hearing problems, migraine, epilepsy, Parkinson's disease, multiple sclerosis, neuropathies, organic disorders, substance abuse, schizophrenia, mood disorders, neurotic disorders, eating disorders, personality disorders, intellectual disabilities, developmental disorders, and behavioural disorders, anticoagulants, antiplatelets, statins, proton pump inhibitors, and antipsychotic drugs, number of non-psychiatric comorbidities, and number of psychiatric comorbidities.

Prescription Registry. We also identified the use of other drugs, not used in a definition of a comorbidity, in the year before the index date: anticoagulants, antiplatelets, statins, proton pump inhibitors, and antipsychotic drugs. We categorised the burden of non-psychiatric and psychiatric comorbidity as the number of conditions (0, 1, ≥2) for each patient/comparator.

For patients with ischaemic stroke and intracerebral haemorrhage only, we also obtained information from the stroke registry on stroke severity according to the Scandinavian stroke scale (mild (45-58), moderate (30-44), and severe or very severe (0-29)),[39] Essen risk score (0, 1, 2, ≥3),[40] thrombolysis in hospital (yes, no, contraindicated), and thrombectomy in hospital (yes, no, contraindicated). The Scandinavian stroke scale is a validated neurological stroke scale with scores ranging from 0 (worst) to 58 (best). The score is evaluated by the attending physician early in the admission phase.[39] The scale is conceptually similar to the more widely used National Institutes of Health stroke scale.[41] The Essen risk score is a risk stratification tool that predicts the one year risk of recurrent ischaemic stroke and combined cardiovascular events on a nine point scale (one point for ages 65-75 years, two points for age >75 years, and one point for the occurrence of each of the following conditions: hypertension, diabetes, myocardial infarction, other cardiovascular disease, peripheral artery disease, smoking, and transient ischaemic attack).[40] All definitions and codes used in this study are presented in supplemental table 1.

Statistical analysis

Main analyses

For patients with stroke and matched general population comparators, we computed and illustrated graphically the prevalence of being in each of the following categories for each week up to five years after the index date: labour market participation, sick leave, disability pension, voluntary early retirement, state pension, and death. We then used log-linear Poisson regression with a robust error variance to obtain exact prevalence estimates at six months, one year, two years, and five years.[42] This analysis allowed cohort members to move in and out of each category (eg, labour market participation or sick leave) on a weekly basis, thereby capturing the dynamics of labour market participation.

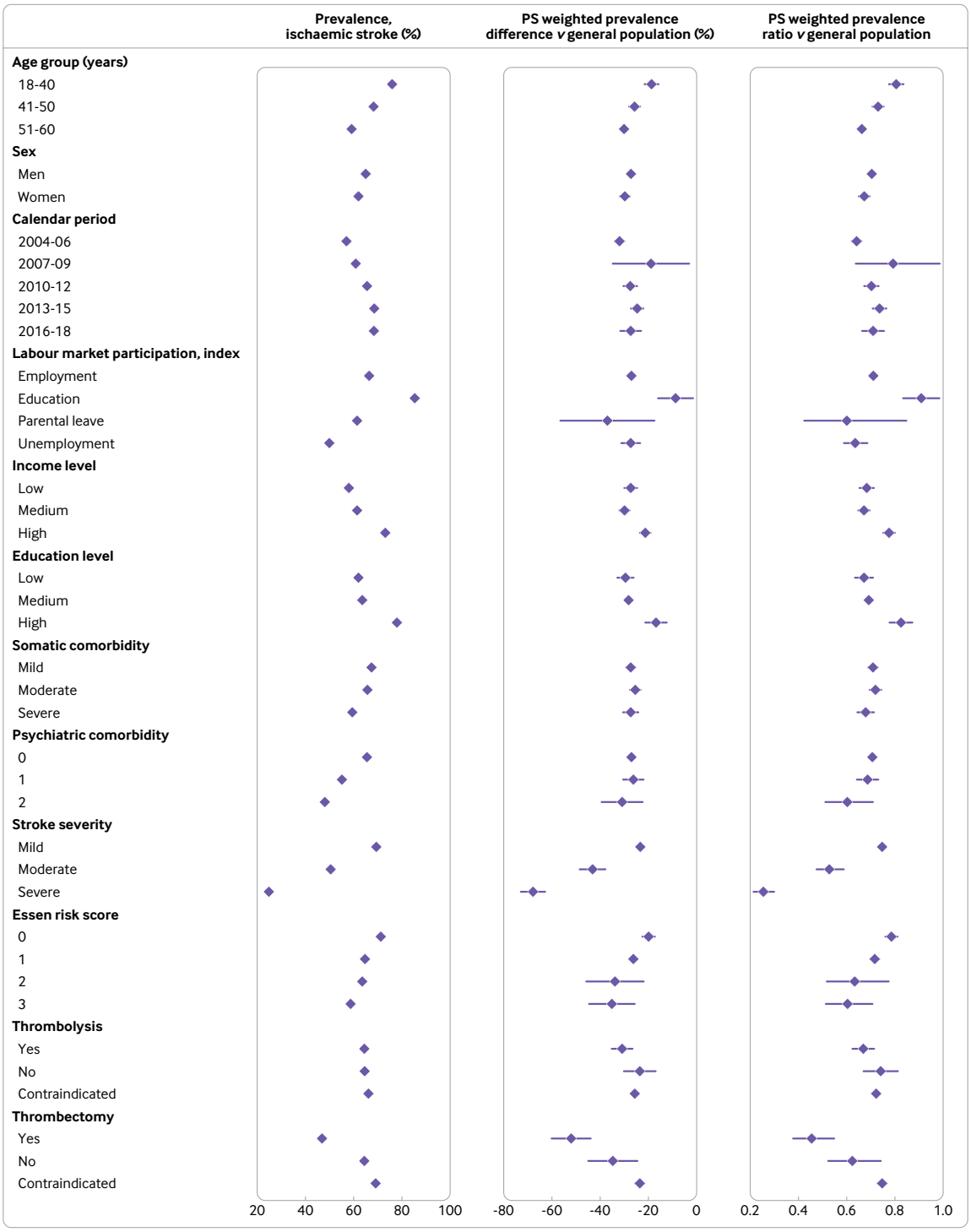

Fig 2 | Prevalence of labour market participation two years after ischaemic stroke and propensity score weighted differences and ratios compared with individuals from the general population matched by age, sex, and calendar year, in patient subgroups. Propensity score weights calculated based on the following covariates: age (omitted when stratifying by this variable), sex (omitted when stratifying by this variable), calendar period (omitted when stratifying by this variable), labour market participation at four weeks before the index date (omitted when stratifying by this variable), income level (omitted when stratifying by this variable), education level (omitted when stratifying by this variable), hypertension, dyslipidaemia, ischaemic heart disease, atrial fibrillation or flutter, valvular heart disease, heart failure, peripheral artery disease, venous thromboembolism, diabetes, thyroid disorder, gout, chronic pulmonary disease, allergy, ulcer/chronic gastritis, chronic liver disease, inflammatory bowel disease, diverticular disease of intestine, chronic kidney disease, prostate disorders, connective tissue disorders, osteoporosis, painful conditions, HIV/AIDS, anaemias, cancers, vision problems, hearing problems, migraine, epilepsy, Parkinson's disease, multiple sclerosis, neuropathies, organic disorders, substance abuse, schizophrenia, mood disorders, neurotic disorders, eating disorders, personality disorders, intellectual disabilities, developmental disorders, behavioural disorders, anticoagulants, antiplatelets, statins, proton pump inhibitors, antipsychotic drugs, number of non-psychiatric comorbidities (omitted when stratifying by this variable), and number of psychiatric comorbidities (omitted when stratifying by this variable). PS=propensity score

We performed this analysis separately for each stroke subtype (matched pairs were kept).

Then, to isolate the stroke specific effect on labour market participation, we calculated propensity score weighted prevalence differences and prevalence ratios for the same time points described above, comparing patients with stroke with matched general population comparators. Using a multivariable logistic regression model, we estimated the predicted probability of being diagnosed with stroke conditional on age (continuous), sex, calendar period, and the covariates measured for both cohorts, as listed above. Patients with stroke were assigned a weight of one and comparators a weight equal to the odds of the exposure probability. This weighting approach reweights the comparator cohort so that its covariate distribution resembles that of the stroke cohort. We handled missing data on income (about 0.1%) and education (about 2%) in the propensity score estimation using a missing data indicator variable.[43] We chose this adjustment strategy over more conventional regression methods for easier estimation of adjusted absolute probabilities. We computed 95% confidence intervals based on likelihood ratios for prevalence differences and ratios.

Subgroup analyses

To examine effect measure modification and to identify patient subgroups with particular susceptibility to poor labour market participation after stroke, we recalculated the estimates of prevalences, propensity scoreweighted prevalence differences, and prevalence ratios comparing patients who have stroke with matched general population comparators at two years after diagnosis in subgroups according to age (18-30, 31-40, 41-50, and 51-60 years), sex, calendar period of stroke diagnosis (2004-08, 2009-12, 2013-15, and 2016-18), labour market participation at four weeks before the index date (employed, receiving state educational grants, parental leave payments, or unemployment payments unrelated to health), income (low, medium, high), education (low, medium, high), number of non-psychiatric comorbidities (0, 1, ≥2), and number of psychiatric comorbidities (0, 1, ≥2). For these analyses, the matching was dissolved. In four additional subgroup analyses, we stratified the analyses by stroke severity (mild, moderate, severe), Essen risk score (0, 1, 2, ≥3), thrombolysis in hospital (yes, no, contraindicated), and thrombectomy in hospital (yes, no, contraindicated), for which the matching was kept (as matched comparators did not have information on these variables). Propensity scoreweights were re-estimated within each examined stratum.[44]

Cumulative probability of returning to the labour market

In an auxiliary analysis, we focused on patients with stroke who received sick leave payments within the first three weeks after diagnosis (>98% of patients receiving sick leave payment after diagnosis did so within the first three weeks). Thus, unlike the main analysis, this analysis examined the return to the labour market among patients leaving the labour market immediately after stroke. In a time-to-event analysis, we used the Aalen-Johansen estimator, considering death and retirement as competing events,[45] to compute the six month, one year, two year, and five year cumulative probability of return to labour market participation, defined as four consecutive weeks with the classification of labour market participation. This estimator should be interpreted as the probability of four consecutive weeks of labour market participation at any point before time t and before the occurrence of death. Unlike in the main analysis, participants in this analysis were not allowed to move in and out of the labour market. Patients were followed from the initial receipt of a sick leave payment.

Impact of stroke recurrence on labour market participation

Because stroke recurrence is associated with an adverse prognosis,[3] we performed a separate analysis among patients who had a recurrent stroke. As in our earlier work,[3] recurrent stroke was defined as any stroke subtype, occurring at least 24 hours after the onset of the first time stroke, irrespective of vascular territory. We applied the same eligibility criteria as in the main study cohort (ages 18-60 years, recurrent stroke occurring between 1 May 2004 and 31 December 2018, and requiring patients to be active in the labour market at four weeks before the admission date for the recurrent stroke). New general population comparators were sampled, using the same method as for the main study cohort. For this cohort, we then repeated the main analyses, as described above.

Patient and public involvement

No patients or members of the public were involved in determining the research question or the outcome measures, nor did they take part in developing plans for the design or implementation of the study. No patients or members of the public were asked to advise on the interpretation or reporting of results. The primary barrier was the use of pseudonymised registry data.

Results

The analyses comprised 22 907 patients with stroke (16 577 (72%) with ischaemic stroke, 2025 (9%) with intracerebral haemorrhage, and 4305 (19%) with subarachnoid haemorrhage), aged 18-60 years and participating in the labour market at four weeks before their hospital admission date (82% employed, 2% receiving state educational grants, 1% receiving parental leave payments, and 16% receiving unemployment payments unrelated to health), as well as 98 007 individuals from the general population matched by age, sex, and calendar year (table 1). In both cohorts, the median age was 51 years, 62% were men, and the median Scandinavian stroke scale score among patients with stroke was 55. Compared with matched individuals from the general population,

Table 3 | Cumulative probability of labour market participation (defined as four consecutive weeks with the classification of labour market participation) among patients with stroke who received sick leave payments within three weeks after the index date, after considering death and retirement as competing events

	Cumulative probability, % (95% CI)			
	6 months	1 year	2 years	5 years
Ischaemic stroke	35.1 (34.2 to 36.0)	55.9 (54.9 to 56.9)	71.0 (70.1 to 71.9)	75.5 (74.6 to 76.4)
Intracerebral haemorrhage	17.8 (15.7 to 19.8)	32.7 (30.2 to 35.2)	50.2 (47.5 to 52.9)	56.9 (54.1 to 59.6)
Subarachnoid haemorrhage	31.2 (29.3 to 33.2)	49.3 (47.2 to 51.4)	65.6 (63.5 to 67.6)	70.8 (68.8 to 72.8)

CI=confidence interval.

patients with stroke had lower income and education levels and were more likely to have non-psychiatric and psychiatric comorbidities. After propensity score weighting, these differences were minor (table 1, supplemental fig 1).

Main analyses

Figure 1 shows the dynamic changes in labour market participation in people who had a stroke according to stroke subtype and in matched individuals from the general population. Table 2 contains exact prevalence estimates, propensity score weighted prevalence differences, and propensity score weighted prevalence ratios compared with matched individuals from the general population at specific time points. Most patients (62% among those with ischaemic stroke, 69% among those with intracerebral haemorrhage, and 52% among those with subarachnoid haemorrhage) went on sick leave within three weeks of diagnosis. Among patients with ischaemic stroke compared with individuals from the general population, the prevalence of sick leave six months after the index date was 39.8% versus 2.6% (propensity score weighted prevalence difference 36.2% (95% confidence interval 35.4% to 37.1%)); prevalence of labour market participation was 56.6% versus 96.6% (−38.5% (−39.4% to −37.6%)).

With time elapsed since the index date, the prevalence of sick leave decreased while that of labour market participation and receipt of a disability pension increased. For example, the prevalence of sick leave was 15.8% for patients with stroke versus 3.8% for people from the general population two years after an ischaemic stroke diagnosis (propensity score weighed prevalence difference 10.3% (95% confidence interval 9.5% to 11.1%)). Corresponding prevalences of labour market participation was 63.9% versus 91.6% (−24.0% (−25.1% to −22.8%)), and prevalences of disability pension receipt was 12.2% versus 0.6% (10.7% (10.1% to 11.3%)). These patterns generally appeared for all stroke subtypes, but the prevalences of sick leave and receipt of a disability pension were higher for people who had an intracerebral haemorrhage than for those with ischaemic stroke or subarachnoid haemorrhage. For example, six months after intracerebral haemorrhage, prevalence of sick leave was 53.9% versus 2.6% (48.7% (45.6% to 51.8%)). For all stroke subtypes, retirement schemes showed a substitution effect: receipt of a disability pension was much more frequent in patients with stroke, while voluntary early retirement appeared to be as likely or less likely in these patients compared with matched individuals from the general population.

Subgroup analyses

Prevalence estimates of labour market participation at two years after stroke, as well as propensity score weighted prevalence differences and propensity score weighted prevalence ratios in different patient subgroups, are depicted in figure 2 (ischaemic stroke), supplemental figure 2 (intracerebral haemorrhage), and supplemental figure 3 (subarachnoid haemorrhage), with exact estimates presented in supplemental tables 2-4. In patients who had an ischaemic stroke, the prevalence was higher among those aged 18-40 years (76.0%, propensity score weighted prevalence difference *v* the general population −18.7%) than among those aged 51-60 years (59.2%, −30.1%). Men and women had similar prevalences. The prevalence was slightly higher for strokes diagnosed during 2016-18 (68.4%, propensity score weighted prevalence difference *v* general population −27.3%) than for those diagnosed in 2004-06 (57.0%, −32.0%).

We observed a socioeconomic gradient in labour market participation for patients who had an ischaemic stroke: the prevalence was higher for those with high education level (77.9%, propensity score weighted prevalence difference *v* general population −16.8%) than for those with low education level (61.9%, −29.6%). A similar pattern was observed for income levels, albeit less strongly. Although the prevalence of labour market participation was higher with decreasing numbers of non-psychiatric and psychiatric comorbidities, differences within these groups were slight when compared with matched individuals from the general population. The strongest predictor of labour market participation was stroke severity: after two years, the prevalence was 69.4% for mild stroke (−23.4%), 50.5% for moderate stroke (−43.1%), and 24.8% for severe or very severe stroke (−67.9%). These patterns of effect measure modification were generally apparent for all stroke subtypes.

Cumulative probability of returning to the labour market

Among patients with ischaemic stroke receiving sick leave payments within three weeks after stroke, the cumulative incidence of return to labour market participation, after considering death and retirement as competing events, was 35.1% at six months, 55.9% at one year, 71.0% at two years, and 75.5% at five years (table 3). The corresponding estimates

after intracerebral haemorrhage were 17.8%, 32.7%, 50.2%, and 56.9%, and those after subarachnoid haemorrhage were 31.2%, 49.3%, 65.6%, and 70.8%.

Impact of stroke recurrence on labour market participation

In a separate analysis comprising 1147 patients with recurrent stroke (694 (61%) with ischaemic stroke, 74 (6%) with intracerebral haemorrhage, and 379 (33%) with subarachnoid haemorrhage), the prevalence of labour market participation was slightly higher at six months after recurrent stroke than after first time stroke (ie, in the main analysis) (supplemental fig 4, supplemental table 5). However, this pattern reversed after one year. For example, among patients with ischaemic stroke compared with individuals from the general population, the prevalence of labour market participation was 58.5% versus 96.8% (propensity score weighted prevalence difference −38.8% (95% confidence interval −43.0% to −34.7%)) at six months after recurrent stroke and 56.6% versus 91.9% (−24.1% (−35.8% to −12.4%)) at two years after recurrent stroke. Mortality was higher after recurrent stroke than after first time stroke.

Discussion

Principal findings

Among working age adults with ischaemic stroke of primarily mild severity, about two thirds participated in the labour market at two years after stroke diagnosis, with sick leave and receipt of disability pension being the most common reasons for non-participation. Compared with matched individuals from the general population, patients with ischaemic stroke had a 24% reduced absolute prevalence of labour market participation at two years after diagnosis, after adjusting for differences in age, sex, calendar year, education, income, and comorbidity. While a similar impact on labour market participation was observed for patients with subarachnoid haemorrhage, patients with intracerebral haemorrhage had lower prevalences, largely attributable to much higher prevalences of sick leave and receipt of a disability pension.

Research in context

Based on 29 studies, most of them small in size, a 2018 systematic review reported that the probability of returning to work was 41% at six months, 53% at one year, and 66% at two years after stroke.[46] Our findings regarding ischaemic stroke correspond reasonably well with the findings of this meta-analysis. However, the results from the individual studies in the meta-analysis, as well as the results from newer studies, have varied greatly. For example, in a Finnish cohort of 769 patients with ischaemic stroke aged 15-49 years from the Helsinki young stroke registry, 62% were working after one year and 58% were working after two years, aligning with the results from our study and those from the meta-analysis.[16] In one of only two studies that included a comparison cohort from the general population, the Dutch FUTURE study (a follow-up study of risk factors and prognosis among young patients with stroke) reported results based on 694 patients with stroke aged 18-50 years. The FUTURE study's finding that patients with stroke were two to three times more likely to be unemployed than the general Dutch population after a mean follow-up of eight years largely agrees with the relative contrasts found in our study.[13] By contrast, in the South London stroke register, among 940 patients with stroke in paid employment before diagnosis (mean age 53 years), only 18% were working after one year, decreasing to 12% after five years.[18] Discrepancies between these findings probably stem from a variety of causes, including varying cohort inclusion criteria (eg, age, stroke subtype, and employment status at baseline), measures of employment (eg, questionnaire data, other self-reported data, or registry data), and national government structures (eg, universal welfare states or more selective welfare states).

This study adds to the literature in several important areas. Principally, the large cohort size and the nationwide, weekly data on public transfer payments from Danish authorities permitted a comprehensive assessment of labour market dynamics after stroke. In our main analyses, patients could move in and out of the labour market (eg, from labour market participation to sick leave to disability pension) during follow-up. This approach allowed us to capture and illustrate labour market participation dynamically. We found that the prevalence of labour market participation was highest at about two years after stroke, and began to decline after that owing to a rise in receipts of disability pensions and other pensions. Another important finding is that although stroke affected labour market participation with the general population as a reference, more than half of patients with ischaemic stroke were part of the labour market just six months after their diagnosis, increasing to around two thirds after two years. On one hand, this high labour market participation is an encouraging finding, which could be explained by the relatively young age of working age adults compared with the total adult population, the establishment of specialised stroke units, better acute care including scaling up thrombolysis and thrombectomy, and increasing rates of mild strokes.[2] The slightly increasing prevalence of labour market participation over calendar periods supports this view. On the other hand, while much focus has been on stroke prevention, diagnosis, and acute treatment, less focus has been on rehabilitation and long term consequences.

In the newly presented national stroke action plan (the first of its kind in Denmark), the Danish Stroke Association called for increased and sustained cross disciplinary focus on both physical and cognitive rehabilitation.[47] Although mental illness after stroke is well described,[4] a clear approach to organising cognitive rehabilitation services is lacking.[47] With the ongoing implementation of a national action plan and tangible goals, it seems likely that the impact of stroke on labour market participation could decline in

years to come. Unlike most previous studies,[8 9 12 15-18] we examined labour market participation separately for each stroke subtype, because these have distinct pathophysiology and impact on prognoses.[3 4] Although patients with intracerebral haemorrhage accounted for only around a tenth of patients with stroke in the current study, these patients were much less likely to return to the labour market (43% at two years) than either patients with ischaemic stroke (64% at two years) or patients with subarachnoid haemorrhage (61% at two years). Stroke severity is on average higher for intracerebral haemorrhage, as also evidenced by the higher probabilities of sick leave and receipt of a disability pension for these patients, which could explain this finding. Similarly, while subarachnoid haemorrhage is associated with high short term mortality (mortality risk at six months 12.7%), after considering death and retirement as competing events, both prevalences and cumulative probabilities for labour market participation were similar in magnitude to those found for ischaemic stroke. This finding demonstrates that early survivors of subarachnoid haemorrhage generally have a favourable prognosis.

Many factors have been identified as being predictive of labour market participation after stroke. Unlike studies that assessed predictors within a stroke cohort,[8-12 14-16 18 19] we assessed effect measure modification, which assessed whether the impact of stroke, in reference to matched individuals from the general population, differed across patient subgroups. As such, this type of analysis might be better suited to identify patients with susceptibility to poor labour market participation specifically in a stroke population. For example, although the prevalence of labour market participation after two years was higher among patients with ischaemic stroke without non-psychiatric comorbidities (67%) than among those with two or more non-psychiatric comorbidities (55%), the propensity score weighted prevalence difference, compared with matched individuals from the general population, was −34% and −27%, respectively, indicating little effect modification.

Our findings confirm that younger patients are more likely than older patients to return to the labour market.[9 11 12 18 19] Younger patients might be more likely to resume working owing to less disabling strokes (ie, lower stroke severity),[2] a higher probability of being offered cognitive rehabilitation services,[47] a lower risk of cognitive impairment (eg, dementia and delirium),[4] and the strict criteria in Denmark for receiving a disability pension for people younger than 40 years. Unlike a previous Danish study[11] and other research on this topic,[9 13 19] we did not find evidence of clear sex differences in labour market participation after stroke. As the risk of stroke recurrence and mortality is higher among women than among men,[3] the similar propensity between the sexes to return to the labour market is reassuring. In alignment with several other studies,[12 13 16 18 19] stroke severity strongly predicted labour market participation. As for other outcomes, such as recurrence, mortality, and mental illness,[3 4] stroke severity (measured by, for example, the Scandinavian stroke scale) could be a useful tool to predict an adverse prognosis. However, whether a targeted focus on patients with severe stroke (only 8% of the participants in our study) is cost effective is questionable.

In a separate, auxiliary analysis of the impact of recurrence, the prevalence of labour market participation was slightly higher at six months after recurrent stroke than it was at six months after first time stroke. Survivor bias is a likely explanation for this seemingly counterintuitive result. Another possible explanation is that because recurrent strokes are more likely than first time strokes to be ischaemic rather than haemorrhagic,[3] recurrent strokes are on average milder, thereby leading to a higher probability of labour market participation.

Limitations and generalisability of the study

Our study has some limitations. Firstly, the DREAM registry does not capture short term sick leave (ie, sick leave periods of less than four weeks). Therefore, some patients on short term sick leave might have been misclassified as having never left the labour market; consequently, we might have underestimated the proportion of patients with stroke going on sick leave immediately after diagnosis. However, the impact of this source of misclassification on prevalence estimates after six months or longer is probably negligible. Secondly, receipt of a disability pension has been difficult for people under 40 years old since 2013, even in case of reduced work capacity, owing to a new law. This difficulty could have affected estimates after subarachnoid haemorrhage, because the average age of patients at diagnosis with this stroke subtype was lower (45 years in our study) than that of ischaemic stroke (50 years) and intracerebral haemorrhage (50 years). Thirdly, we lacked detailed clinical data on, for example, the underlying causes of stroke for all subtypes. Knowledge of these causes can guide treatment choice and is most likely an important predictor of labour market participation.[16]

If valid, our results likely generalise to other Nordic countries with a welfare and support system similar to Denmark's.[48] Notably, in this study, stroke severity was on average mild (median Scandinavian stroke scale score 55). This relatively lower stroke severity is principally because the study population included working age adults, and stroke severity increases with age.[2] The incidence of mild stroke has increased over time in Denmark,[2] attributable to improved awareness of stroke symptoms in the Danish general population and prehospital response leading to faster diagnostics as well as more accessible neuroimaging.[49 50] In this context, stroke severity could be milder on average in Denmark than in other countries.

Conclusions

In this large cohort study of working age adults with first time stroke of primarily mild severity, the majority participated in the labour market at two years after

diagnosis. Labour market participation was lower for patients with intracerebral haemorrhage than for patients with other stroke subtypes. Denmark has a strong welfare and support system, which might limit the generalisability of these results to other settings. Nonetheless, the absolute and relative probabilities of labour market participation reported in this study could serve as a starting point when designing and implementing stroke rehabilitation programs and intervention studies.

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Data sharing: Data presented in this study were obtained from Danish registries. Owing to data protection rules, we are not allowed to share individual level data. Other researchers who fulfil the requirements set by the data providers could obtain similar data.

The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

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Web appendix: Supplementary material