Trends in Diagnosis-Specific Work Disability Before and After Stroke: A Longitudinal Population-Based Study in Sweden

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Background—Although a stroke event often leads to work disability, diagnoses behind work disability before and after stroke are largely unknown. We examined the pre-event and postevent trends in diagnosis-specific work disability among patients of working age.

Methods and Results—We included all new nonfatal stroke events in 2006–2008 from population-based hospital registers in Sweden among women and men aged 25 to 60 years (n=12 972). Annual days of diagnosis-specific work disability were followed for 4 years before and after stroke. Repeated measures negative binomial regression models using the generalized estimating equations method were fitted to examine trends in diagnosis-specific work disability before and after the event. Already during the 4 pre-event years, work disability attributed to circulatory diseases increased among women (rate ratio, 1.99; 95% confidence interval, 1.68–2.36) and men (rate ratio, 2.20; 95% confidence interval, 1.88–2.57). Increasing trends before stroke were also found for work disability attributed to mental disorders, musculoskeletal diseases, neoplasms, diseases of the nervous, respiratory, and digestive systems, injuries, and diabetes mellitus. As expected, a sharp increase in work disability days attributed to circulatory diseases was found during the first year after the event among both sexes. Overall, during 4 years after the stroke, there was a decreasing trend for circulatory diseases and injuries, whereas the trend was increasing for nervous diseases and diabetes mellitus.

Conclusions—Work disability attributed to several mental and somatic diagnoses is higher already before a stroke event. (***J Am Heart Assoc***. 2018;7:e006991. DOI: 10.1161/JAHA.117.006991.)

According to global estimates, stroke and ischemic heart disease are 2 leading causes of premature mortality and years of life lost.[1] In Sweden, incidence of stroke increased in 1989–2000 among the working-aged, and the increase was most pronounced among people aged <60 years and among women.[2]

Whereas the incidence of stroke is higher in elderly population, around one fifth or even one fourth of strokes are estimated to occur during working age, making stroke a costly public health and societal issue.[3,4] Further knowledge about stroke in working age, and trends in work disability diagnoses both before and after the event, could help identify risk groups and reduce burden of stroke and comorbid conditions as well as later work disability.

A previous case-control study found that sickness absence accumulates both among women and men already before their first stroke, which indicates that such information might help to identify people with a higher risk of stroke event.[5] The study was conducted in the Swedish county of Östergötland, and because the number of cases was relatively low (n=212), information on sickness absence diagnoses could not be included. Additionally, in our recent study, excluding pre-event work disability, all-cause work disability days increased after stroke.[6] However, information on work disability diagnoses was not examined. Thus, it is not known whether people who are diagnosed with stroke have an increased risk of work disability attributed to circulatory diagnoses or attributed to some other diagnoses *before* the stroke. A recent Swedish register-based study among mid-life people showed that whereas circulatory and endocrine diseases have the

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Clinical Perspective

What Is New?

- Work disability is at a higher level both before and after stroke and not only attributed to circulatory diseases, but also attributed to other diagnoses.

What Are the Clinical Implications?

- Clinicians should consider comorbidity when treating working-aged patients with their first stroke and, moreover, take special care regarding work disability diagnoses shown to be increased already before stroke among people who have not had a stroke before.

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strongest association with the onset of stroke, also several other health conditions are common before their first stroke, and may contribute to their risk of stroke.[7] Another study in Canada showed likewise results among older adults: Comorbid conditions were common before the stroke event, and, moreover, healthcare use was largely attributable to *other* diagnosis than stroke, such as diabetes mellitus, neoplasms, or chronic obstructive pulmonary disease.[8] In addition to somatic conditions, depression, particularly persistent depression, has been shown to predict the risk of first stroke.[9,10]

Furthermore, previous studies have not considered to what extent work disability *after* the stroke is attributed to circulatory diseases and to what extent to other diagnoses. Having a stroke event could increase disability attributed to other conditions such as mental disorders or somatic diseases. Comorbidity could also increase the risk of more-serious stroke events and prolonged work disability, based on the strong evidence about the contribution of comorbid conditions to short- and long-term stroke mortality.[11] Given that most people typically have not 1 but several other chronic conditions before stroke,[8] this highlights the need to investigate the trends in diagnosis-specific work disability before and after stroke.

Finally, in addition to stroke being more prevalent among people with chronic diseases, need of sex-specific studies has been emphasized, attributed to the different incidence of stroke between women and men.[2] Stroke is also known to disproportionally affect people in socioeconomically disadvantaged situations, even in high-income countries.[12] Furthermore, although stroke incidence has been decreasing in Sweden, particularly in men, a register-based study of more than 3 million residents in Sweden showed that inequalities in stroke persist and have even widened.[13] Similarly, in large Danish register-based studies, low socioeconomic position has been linked to both the risk of stroke[14] and poorer stroke survival.[15] Given these previous results, and also attributed to the socioeconomic patterning of work disability,[16,17]

socioeconomic factors need to be considered when focusing on trends in diagnosis-specific work disability among stroke patients.

To fill the current knowledge gaps, we aimed to examine trends in diagnosis-specific work disability 4 years before and 4 years after the diagnosis of stroke among people during working age. More specifically, we examined these trends separately for women and men, and took into account sociodemographic and socioeconomic factors, and examined whether the work disability diagnoses differed before and after the stroke diagnosis.

Methods

The data and study materials will not be made available to other researchers for purposes of reproducing the results or replicating the procedure. According to the Swedish Ethical Review Act, the Personal Data Act, and the Administrative Procedure Act, data can be made available after a legal review only. More details about analytical methods are available from the corresponding author upon request.

All people living in Sweden, who had a stroke diagnosis in 2006–2008, based on hospital records, and were aged 25 to 60 years at the time of the event, were included in the study cohort. We excluded people who were older than 60 in order for all participants to be eligible for sick leave or disability pension benefits during the follow-up after the stroke. An additional prerequisite was that they had lived in Sweden 5 years before the event and had no indication of stroke in the included registers during that time. Major types of strokes are ischemic stroke, primary intracerebral hemorrhage, subarachnoid hemorrhage, and undetermined stroke.[18] Of these types, ischemic stroke is the largest one, and also can be further divided into several subtypes. The event was defined based on hospitalization attributed to stroke (*International Classification of Diseases* [*ICD*] codes: I60, I61, I63, and I64). Although inclusion of subarachnoid hemorrhage (I60) could be questioned here, attributed to different etiology and treatment, it comprises a small part (5%) of all stroke events typically among younger people. Following previous procedures,[18] we only included people with stroke who survived the first 30 days following the event. Thus, the study cohort altogether consisted of 12 972 people who were hospitalized because of a stroke diagnosis in 2006–2008. We included data on work disability diagnoses 4 years before and 4 years after the event date. Participants were followed until the year of death, emigration, or the end of the follow-up, which ever occurred first.

We combined data from several administrative nation-wide registers. First, Statistics Sweden provided data about sex, age, education, family situation, country of birth, living area, and economic activity, and year of emigration (Longitudinal

Integration Database for Health Insurance and Labour Market Studies). Second, the National Board of Health and Welfare holds patient register data regarding cause-specific hospitalizations and specialized outpatient care (dates and *ICD* codes) and the date of death. Third, information on compensated annual days of diagnosis-specific sickness absence and disability pension was obtained from the National Social Insurance Agency. From 16 years of age, people with income from work or unemployment benefits can be granted sickness absence benefits, if their work capacity is reduced because of illness or injury. For most employees, benefits are paid by the employer for the first 14 days. All aged 19 to 64 years can be granted disability pension, if their morbidity has led to long-term or permanent work incapacity.

Because this is a fully register-based study, informed consent was not required. The project was approved by the Regional Ethical Review Board, Stockholm, Sweden.

Work Disability

Information on diagnosis-specific work disability was based on *ICD-10* codes.[19] Main diagnosis was used, because the Social Insurance Agency register data only include the main diagnosis that the physician assessed as leading to the work disability. In addition to work disability attributed to any circulatory diseases (I00-I99), we focused on mental disorders (F00-F99) and musculoskeletal diseases (M00-M99), which are the 2 leading work disability diagnostic groups. Furthermore, the following diagnostic groups were included: neoplasms (C00-D48), diseases of the nervous system (G00-G99), diseases of the respiratory system (J00-J99), diseases of the digestive system (K00-K93), injuries (S00-T35, T66-T78, and T79), and diabetes mellitus (E10-E14). Incidence of first stroke has been found to be higher among young people with these chronic diseases.[7] Other *ICD-10* chapters were too rare for separate more-detailed modeling. However, descriptive statistics, that is, mean number of work disability days per year before and after stroke are reported for all diagnostic groups both for all stroke patients and for stroke patients without work disability pension 2 years before their event.

Covariates

We included key covariates related to circulatory diseases and work disability that were available from the national registers. All covariates were drawn from the event year for each stroke survivor. Covariates used were age, sex, education, economic activity, living area, birth country, and family situation.

Age was used as a continuous measure. Education was based on completed years of education, and it was classified into 3 groups: low education (less than 10 years; elementary school), intermediate education (10–12 years; high school),

and high education (more than 12 years; college or university). For economic activity, we compared people in paid work with people not in paid work (economically active or inactive, eg, studying or on parental leave) for the previous year before stroke event. Family situation was defined based on marital/cohabiting status and living with children. It was classified into 3 groups: single without children living at home, married/cohabiting, and single with children living at home (single parent). Type of living area was classified into 3 groups based on being urban/rural: large city, medium-sized town, and small town/village. Country of birth was either Sweden or other country.

Statistical Analysis

We first examined sex differences in covariates using chi-square tests. Next, we computed mean annual work disability

Table 1. Distribution of Covariates and Sex Difference in Covariates at the Year of the Stroke Diagnosis in 2006–2008 Among People Aged 25 to 60 Years and Living in Sweden (n=12 972)

	All	Men (n=7769), %	Women (n=5203), %	*P* Value (Chi-Square)*
Country of birth				
Born in Sweden	10 940	85	83	0.009
Outside Sweden	2032	15	17	
Living area				
Large city	4508	35	34	
Medium-sized town	4523	35	35	
Small town/village	3941	30	31	0.549
Family situation				
Married or cohabiting	6889	52	55	
Single	5084	44	32	
Single parent†	999	5	12	<0.001
Economic activity				
Active	9193	73	68	
Inactive	3779	27	32	<0.001
Education				
Less than 10 y	3343	27	23	
10 to 12 y	6508	50	51	
More than 12 y	3121	23	26	<0.001

*For sex difference.
†With children living at home.

Table 2. Annual Mean Diagnosis-Specific Work Disability Days 4 Years Before and 4 Years After the Date of the Stroke Among Men (n=7769)

	Before the Event (Y)				After the Event (Y)			
	−4	−3	−2	−1	1	2	3	4
Circulatory diseases (I00-I99)	5.2	6.4	7.3	9.4	111.1	55.1	68.6	66.4
Mental disorders (F00-F99)	15.3	16.9	18.6	20.6	22.2	21.1	22.5	23.0
Musculoskeletal diseases (M00-M99)	15.0	17.0	17.8	18.9	19.8	18.4	18.5	18.1
Neoplasms (C00-D48)	1.1	1.4	2.0	2.7	3.3	2.1	2.1	2.1
Diseases of the nervous system (G00-G99)	3.2	3.4	3.9	4.6	7.1	6.3	7.8	8.4
Diseases of the respiratory system (J00-J99	0.8	0.8	1.0	1.2	2.0	1.9	1.9	1.9
Diseases of the digestive system (K00-K93)	0.8	0.9	0.9	1.1	1.3	1.1	1.0	1.1
Injuries (S00-T35, T66-T78, T79)	3.1	3.6	4.4	5.0	7.6	5.5	5.3	4.7
Diabetes mellitus (E10-E14)	2.5	2.8	3.2	3.6	4.1	4.9	5.6	5.8
Other endocrine, nutritional, and metabolic diseases (E00-E09, E15-E90)	0.6	0.8	1.1	1.2	1.4	1.6	1.8	1.9
Infectious and parasitic diseases (A00-B99)	0.5	0.6	0.6	0.7	1.1	0.8	0.8	0.7
Diseases of the skin and subcutaneous tissue (L00-L99)	0.3	0.4	0.4	0.6	0.6	0.5	0.7	0.6
Diseases of the eye and adnexa (H00-H59)	0.7	0.7	0.8	0.9	1.0	1.0	1.1	1.3
Adverse effects, poisoning, toxic effects (T36-T65)	0.1	0.0	0.0	0.0	0.2	0.2	0.2	0.3
Other diagnoses	39.9	40.1	41.4	43.6	50.9	61.3	76.4	80.6

days for each main work disability diagnoses, 4 years before and 4 years after the stroke event, respectively. Repeated-measures negative binomial regression models using the

generalized estimating equations method were fitted to examine trends in diagnosis-specific work disability 4 years before and after the event (rate ratios [RRs] and their 95%

Table 3. Annual Mean Diagnosis-Specific Work Disability Days 4 Years Before and 4 Years After the Stroke Date Among Women (n=5203)

	Before the Event (Y)				After the Event (Y)			
	−4	−3	−2	−1	1	2	3	4
Circulatory diseases (I00-I99)	5.8	6.7	7.8	9.6	108.3	56.0	73.2	70.8
Mental disorders (F00-F99)	27.2	30.1	31.3	32.6	34.2	33.1	34.0	34.1
Musculoskeletal diseases (M00-M99)	27.4	30.5	32.3	34.7	35.1	32.9	33.2	32.3
Neoplasms (C00-D48)	2.0	2.5	3.0	4.2	5.5	3.9	4.3	4.1
Diseases of the nervous system (G00-G99)	4.3	4.5	4.9	5.7	9.0	7.7	9.5	10.2
Diseases of the respiratory system (J00-J99	1.9	2.3	2.3	2.5	3.2	2.8	3.3	3.1
Diseases of the digestive system (K00-K93)	1.7	1.8	2.0	2.1	2.2	1.9	1.8	1.7
Injuries (S00-T35, T66-T78, T79)	3.2	3.6	4.2	4.7	6.6	4.8	4.5	4.6
Diabetes mellitus (E10-E14)	2.1	2.7	3.2	3.4	4.1	3.8	4.3	4.6
Other endocrine, nutritional, and metabolic diseases (E00-E09, E15-E90)	1.2	1.6	1.7	1.8	2.1	2.3	2.5	2.7
Infectious and parasitic diseases (A00-B99)	0.7	0.6	0.6	1.0	1.7	1.0	1.0	0.9
Diseases of the skin and subcutaneous tissue (L00-L99)	1.1	1.3	1.5	1.7	1.7	1.3	1.5	1.3
Diseases of the eye and adnexa (H00-H59)	0.7	0.7	0.7	0.8	0.9	0.9	1.1	1.2
Adverse effects, poisoning, toxic effects (T36-T65)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Other diagnoses	59.4	59.2	60.1	62.1	69.8	78.7	94.0	100.1
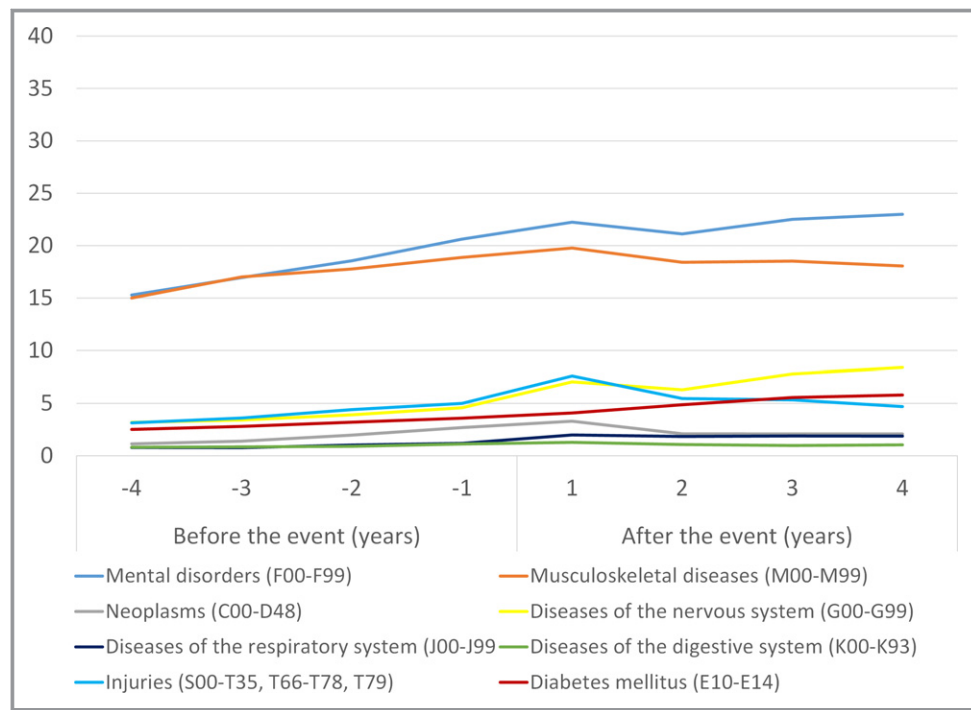
Figure 1. Mean annual days of work disability attributed to key diagnoses other than stroke (*y*-axis) among men (n=7769) 4 years before and after date of their stroke event.

confidence intervals). If the RR is more than 1.00 and statistically significant, this suggests an increasing trend, and if it is below 1.00 and statistically significant, this suggests a decreasing trend in the number of work disability days over the 4-year period before and after the event. In other words, if mean annual days increase, the RRs help confirm whether the
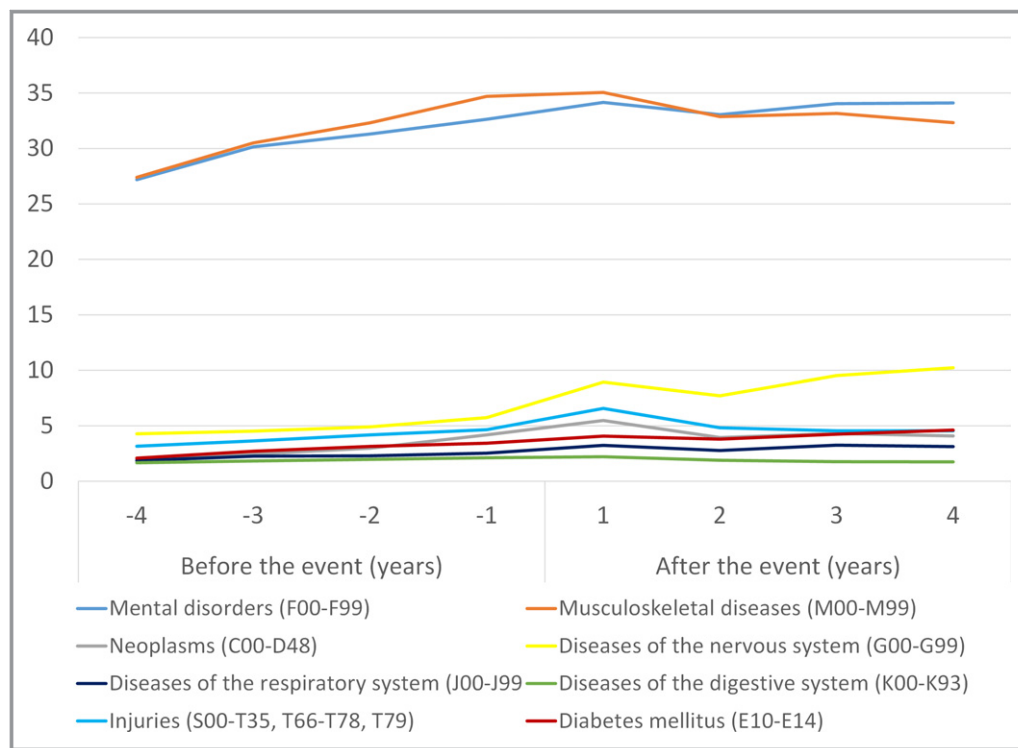
Figure 2. Mean annual days of work disability attributed to key diagnoses other than stroke (*y*-axis) among women (n=5203) 4 years before and after date of their stroke event.
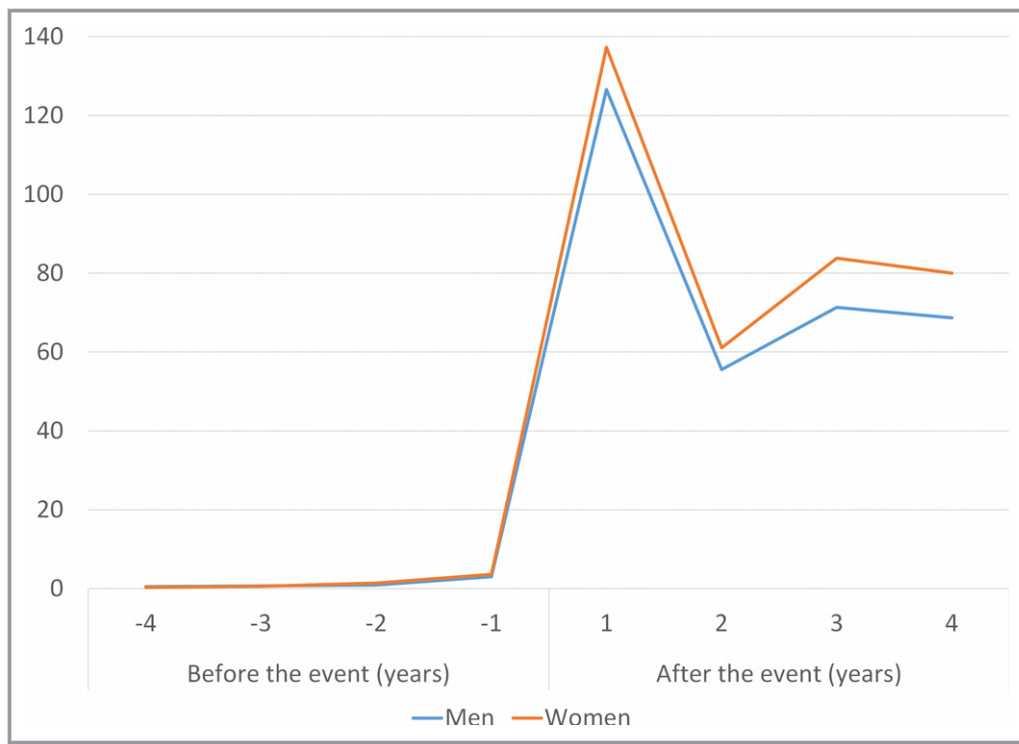
Figure 3. Mean annual days of work disability attributed to circulatory diseases (*y*-axis) 4 years before and 4 years after diagnosis of stroke among men (n=6077) and women (n=3516) not on full disability pension or sickness absence during the 2 years before the event date.

increase is statistically significant, indicated by a statistically significant positive RR. Thus, the RRs show the slope separately for the period 4 years before and 4 years after the event. The method generalized estimating equations further allowed considering intraindividual correlations between repeated measurements. Poisson distribution was applied in the generalized estimating equations models for work disability attributed to circulatory diseases, where negative binomial models did not converge. Poisson models were also fitted for interaction tests between sex and time, when contrasting the years after the stroke to the years before the stroke, examining difference in rates of work disability. Sensitivity analyses were conducted excluding people who were on full-time disability pension or with long-term (2 years) sickness absence for the 2 years before the event, to assess the effect of stroke on new work disability. We used SAS (version 9.4) statistical software to conduct all the analyses (SAS Institute Inc, Cary, NC).

Results

A new stroke diagnosis during working age was more prevalent among men (60%) than women (40%) in 2006–2008 (Table 1). Mean age at baseline was 51.5 years (SD, 7.8). There were no differences by type of living area or unemployment between women and men, but as compared with men, women with stroke were more often economically inactive, single, and had higher education.

Mean annual days of work disability attributed to circulatory diseases 4 years before and after stroke diagnosis are displayed in Tables 2 and 3 for men and women, respectively. The patterns were very similar, showing a sharp increase in work disability days during the first year after the event among both sexes. Thus, 1 year before the event, mean annual number of work disability days attributed to circulatory diagnoses was 9.4 days for men and 9.6 days for women. During the first year after the event, the mean annual number increased to 111 days for men and 108 days for women. The mean number roughly halved during the second year after the event, but remained at a high level throughout the follow-up among both sexes.

The most common other diagnoses for work disability during the entire follow-up were musculoskeletal diseases and mental disorders for both men (Figure 1 and Table II) and women (Figure 2 and Table III). For men, mean annual days ranged between 15.3 and 23.0 days for mental disorders and 15.0 to 19.8 days for musculoskeletal disorders, whereas the corresponding figures for women where 27.2 to 34.2 and 27.4 to 35.1, respectively. Furthermore, work disability was relatively often attributed to diseases of the nervous system, injury, or diabetes mellitus. Other diagnoses were rare, with a

mean annual number of work disability days typically around 1 to 2 days per year or less (Tables 2 and 3).

Figures 3 through 5 and Tables 4 and 5 show the corresponding results for men and women after excluding people on full-time disability pension or long sickness absence (2 years or more) during 2 years before their event. Postevent level of work disability attributed to circulatory diagnoses was similar to the main analysis reported in earlier Tables 2 and 3. For mental disorders and musculoskeletal diseases, mean annual number of work disability days ranged between 4.4 and 6.7 for men and 2.1 and 11.7 for women.

Diagnosis-specific work disability before and after stroke was further addressed by examining whether the trend for increase or decrease in work disability could be statistically confirmed (Tables 6 and 7). There was a clear increasing trend in annual days of work disability attributed to circulatory diseases during 4 years before stroke event, whereas during the 4 years after the event the trend was decreasing among both men and women.

With respect to other diagnoses of work disability, there was a weaker, but similarly increasing, trend for mental disorders among men and women before the event. The pre-event trends were similarly increasing for musculoskeletal diseases before stroke for men and women. For neoplasms, we observed a particularly strong increasing trend in work disability before stroke among both women and men. There was an increasing trend in work disability before the stroke among both men and women also for diseases of the nervous, respiratory, and digestive systems, injuries, and diabetes mellitus.

After the stroke, work disability attributed to mental disorders was slightly increasing among men but not women, and there were decreasing trends for musculoskeletal diseases for both men and women. For neoplasms, a decreasing trend in work disability after the stroke was observed for men. Decreasing trends after the stroke were further found for work disability days attributed to injuries among men and women. For diseases of the nervous system, trends continued to increase after the stroke, although the changes appeared somewhat weaker after the event. Trends in work disability attributed to diabetes mellitus were also increasing after the stroke among both sexes. All the reported trends were statistically significant (Tables 6 and 7).

After adjusting for potential confounders, the trends, particularly the pre-event trends, were strengthened for most work disability diagnoses. Adjustments also somewhat affected the trends after the stroke diagnosis. However, for some rarer diagnoses with a low annual number of work disability days, such as diseases of the respiratory system and
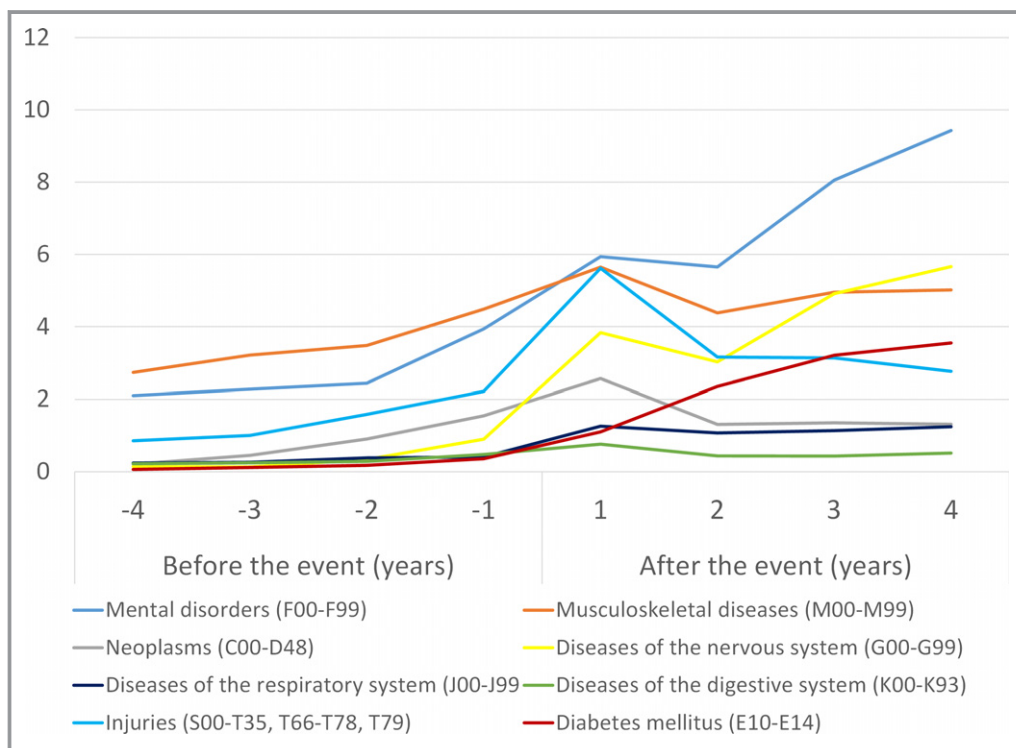
Figure 4. Mean annual days of work disability attributed to key diagnoses other than stroke (*y*-axis) 4 years before and 4 years after the stroke among men (n=6077) not on full disability pension or sickness absence during the 2 years before the event date.
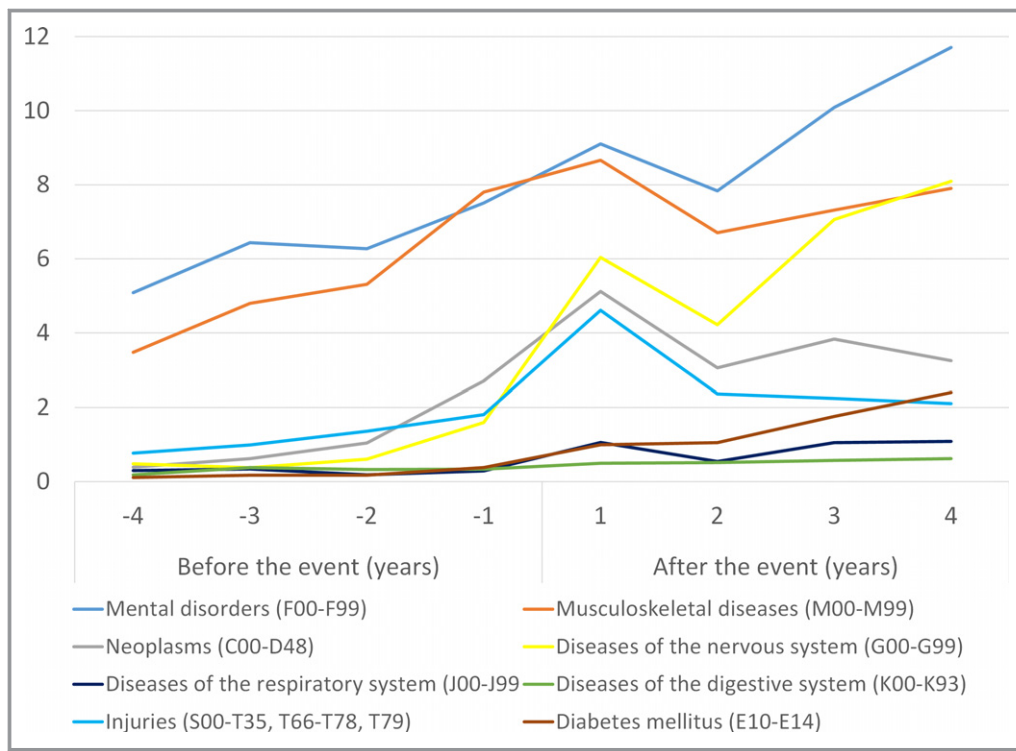
Figure 5. Mean annual days of work disability attributred to key diagnoses other than stroke (*y*-axis) 4 years before and 4 years after the stroke among women (n=3516) not on full disability pension or sickness absence during the 2 years before the event date.

diseases of the digestive system, the trends before the event were no longer statistically significant after full adjustments, although estimates (RRs) pointed to the same direction.

Finally, we examined whether there was an interaction over time with sex, that is, whether the increase or decrease over time was similar or different between men and women (Table 8). There was a notable difference in annual days of work disability attributed to circulatory diseases after versus before stroke among both men (RR, 10.49; 95% confidence interval, 9.22–11.94) and women (RR, 10.30; 95% confidence interval, 8.82–12.02), and the interaction (sex×time) was significant (*P*=0.011), suggesting that the poststroke increase was slightly stronger among men than women. Similarly, for work disability attributed to mental disorders, the results suggest a larger change for men than for women after versus before the stroke (*P* value, 0.008). The RRs were, however, clearly lower as compared with circulatory diseases (RR for men 1.58 and for women 1.25). With respect to musculoskeletal diseases, there was a slight increase among both men and women in work disability after the stroke as compared with before the stroke, but no indication of an interaction was found (*P* value, 0.276). For neoplasms, diseases of the nervous system, diseases of the respiratory system, diseases of the digestive system, injuries, or diabetes mellitus, results also suggest increased work disability after

the stroke as compared with before event levels, but no statistically significant interactions were found between sex and time.

Discussion

This longitudinal, population-based study showed that stroke survivors had high levels of work disability attributed to various diagnoses already before, but particularly after, their stroke event. Trends in work disability attributed to circulatory diseases increased 4 years before the event, peaked during the first postevent year, and decreased after the second postevent year. Similar, but weaker, trends were observed for work disability attributed to musculoskeletal diseases, whereas for mental disorders the trends were increasing before and after the stroke among men and before the stroke event among women. Furthermore, work disability trends were increasing both before and after the stroke for diseases of the nervous system and diabetes mellitus, but decreased after the event for injuries. For other diagnostic groups, the before-stroke increase leveled off after the stroke. Whereas the trends were relatively similar between sexes, socioeconomic factors strongly affected the trends of work disability in the fully adjusted models.

Table 4. Annual Mean Diagnosis–Specific Work Disability Days 4 Years Before and 4 Years After the Stroke Among Men Not on Full Disability Pension or Sickness Absence During the 2 Years Before the Event Date (n=6077)

	Before the Event (Y)				After the Event (Y)			
	−4	−3	−2	−1	1	2	3	4
Circulatory diseases (I00-I99)	0.5	0.7	0.9	3.0	126.6	55.5	71.3	68.7
Mental disorders (F00-F99)	2.1	2.3	2.4	3.9	5.9	5.7	8.1	9.4
Musculoskeletal diseases (M00-M99)	2.7	3.2	3.5	4.5	5.6	4.4	5.0	5.0
Neoplasms (C00-D48)	0.2	0.5	0.9	1.5	2.6	1.3	1.4	1.3
Diseases of the nervous system (G00-G99)	0.1	0.1	0.3	0.9	3.8	3.0	4.9	5.7
Diseases of the respiratory system (J00-J99	0.2	0.3	0.4	0.4	1.3	1.1	1.1	1.2
Diseases of the digestive system (K00-K93)	0.2	0.2	0.3	0.5	0.8	0.4	0.4	0.5
Injuries (S00-T35, T66-T78, T79)	0.9	1.0	1.6	2.2	5.6	3.2	3.1	2.8
Diabetes mellitus (E10-E14)	0.1	0.1	0.2	0.4	1.1	2.4	3.2	3.5
Other endocrine, nutritional and metabolic diseases (E00-E09, E15-E90)	0.1	0.1	0.2	0.3	0.5	0.8	0.9	1.1
Infectious and parasitic diseases (A00-B99)	0.1	0.1	0.1	0.1	0.6	0.3	0.4	0.4
Diseases of the skin and subcutaneous tissue (L00-L99)	0.1	0.2	0.1	0.2	0.3	0.2	0.3	0.2
Diseases of the eye and adnexa (H00-H59)	0.0	0.1	0.0	0.2	0.4	0.3	0.5	0.7
Adverse effects, poisoning, toxic effects (T36-T65)	0.1	0.0	0	82E-5	0.2	0.2	0.2	0.3
Other diagnoses	3.2	1.9	1.8	2.9	12.2	26.1	46.1	54.0

Interpretation

Although comorbidity before and after stroke has been previously studied in young and particularly in older people,[7–10] these previous studies have not addressed trends in diagnosis–specific work disability among stroke survivors. Although a disease or impairment is a prerequisite to be granted work disability, it is not a sufficient reason, given that

Table 5. Annual Mean Diagnosis–Specific Work Disability Days 4 Years Before and 4 Years After the Event Among Women Not on Full Disability Pension or Sickness Absence During the 2 Years Before the Event Date (n=3516)

	Before the Event (Y)				After the Event (Y)			
	−4	−3	−2	−1	1	2	3	4
Circulatory diseases (I00-I99)	0.3	0.6	1.4	3.6	137.3	61.1	83.8	80.0
Mental disorders (F00-F99)	5.1	6.4	6.3	7.5	9.1	7.8	10.1	11.7
Musculoskeletal diseases (M00-M99)	3.5	4.8	5.3	7.8	8.7	6.7	7.3	7.9
Neoplasms (C00-D48)	0.4	0.6	1.0	2.7	5.1	3.1	3.8	3.3
Diseases of the nervous system (G00-G99)	0.5	0.4	0.6	1.6	6.0	4.2	7.1	8.1
Diseases of the respiratory system (J00-J99	0.3	0.3	0.2	0.3	1.1	0.5	1.1	1.1
Diseases of the digestive system (K00-K93)	0.2	0.4	0.3	0.3	0.5	0.5	0.6	0.6
Injuries (S00-T35, T66-T78, T79)	0.8	1.0	1.4	1.8	4.6	2.4	2.2	2.1
Diabetes mellitus (E10-E14)	0.1	0.2	0.2	0.4	1.0	1.1	1.8	2.4
Other endocrine, nutritional, and metabolic diseases (E00-E09, E15-E90)	0.1	0.1	0.1	0.2	0.4	0.8	1.1	1.4
Infectious and parasitic diseases (A00-B99)	0.1	0.1	0.1	0.3	1.3	0.6	0.7	0.5
Diseases of the skin and subcutaneous tissue (L00-L99)	0.1	0.1	0.2	0.2	0.4	0.1	0.3	0.3
Diseases of the eye and adnexa (H00-H59)	0.1	0.0	0.0	0.1	0.4	0.3	0.6	0.9
Adverse effects, poisoning, toxic effects (T36-T65)	57E-5	0.0	0.0	0.0	0.1	0.0	0.1	0.0
Other diagnoses	5.5	3.6	2.6	3.4	13.9	28.9	53.8	65.2

Table 6. Trends in Diagnosis-Specific Work Disability Before and After Date of Stroke Among Men (n=7769)

Diagnostic Categories (*ICD*-10 Codes)*	Crude Model				Fully Adjusted Model[†]			
	Before (4-Y Trend)		After (4-Y Trend)		Before (4-Y Trend)		After (4-Y Trend)	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Circulatory diseases (I00-I99)	2.20	1.88 to 2.57	0.51	0.48 to 0.53	3.47	2.68 to 4.50	0.52	0.50 to 0.55
P value for trend	<0.0001		<0.0001		<0.0001		<0.0001	
Mental disorders (F00-F99)	1.49	1.37 to 1.62	1.08	1.00 to 1.17	1.68	1.36 to 2.07	1.38	1.16 to 1.64
P value for trend	<0.0001		0.045		<0.0001		0.0003	
Musculoskeletal diseases (M00-M99)	1.36	1.25 to 1.48	0.89	0.83 to 0.96	1.34	1.08 to 1.65	0.87	0.72 to 1.06
P value for trend	<0.0001		0.0026		0.0069		0.1643	
Neoplasms (C00-D48)	3.13	2.08 to 4.70	0.66	0.50 to 0.88	5.09	3.02 to 8.60	0.61	0.43 to 0.87
P value for trend	<0.0001		0.004		<0.0001		0.0065	
Diseases of the nervous system (G00-G99)	1.62	1.35 to 1.94	1.29	1.08 to 1.54	2.30	1.50 to 3.52	1.33	1.03 to 1.71
P value for trend	<0.0001		0.0043		0.0001		0.0276	
Diseases of the respiratory system (J00-J99)	1.73	1.08 to 2.77	1.00	0.71 to 1.40	1.67	0.90 to 3.09	0.63	0.37 to 1.07
P value for trend	0.0218		0.9982		0.1025		0.0878	
Diseases of the digestive system (K00-K93)	1.52	1.04 to 2.23	0.82	0.55 to 1.24	1.36	0.66 to 2.79	0.87	0.42 to 1.80
P value for trend	0.03		0.35		0.41		0.70	
Injuries (S00-T35, T66-T78, T79)	1.86	1.51 to 2.30	0.53	0.43 to 0.65	2.71	1.96 to 3.75	0.50	0.39 to 0.65
P value for trend	<0.0001		<0.0001		<0.0001		<0.0001	
Diabetes mellitus (E10-E14)	1.61	1.34 to 1.92	1.68	1.41 to 2.01	1.91	1.21 to 3.04	2.27	1.69 to 3.06
P value for trend	<0.0001		<0.0001		0.0058		<0.0001	

CI indicates confidence interval; RR, rate ratio.

*International Classification of Diseases version 10.

[†]Adjusted for age, country of birth, family situation, type of living area, economic activity, and education.

also other factors such as an individual's work ability and working conditions affect whether a person with a chronic disease can continue working. Thus, previous results on comorbidity are not fully comparable to the current ones. Given that it is important to promote work participation among people with ill health, these findings can be used to prevent work disability attributed to comorbid conditions among stroke survivors by, for example, earlier detection of potential risk of developing mental disorder after the event.

We focused on work disability attributed to circulatory diagnoses before and after diagnosis of stroke, in addition to all other key work disability diagnoses. From a clinical point of view, although we excluded all people with any indication of previous stroke in the registers, we still found an increase in work disability attributed to circulatory diagnoses before, a strong increase during the first postevent year, and a decreasing trend from the second year after the event. The patients were relatively young at the time of their event, and if they recovered and were rehabilitated, they could have been more likely to return to economic activity as judged based on the decreasing trend in work disability. This is line with a recent study.[20] However, the absolute level of work disability

attributed to circulatory diagnoses still remained high after the event, and circulatory diseases remained the key work disability diagnoses, with the largest number of work disability days each year after the event (55–111 days per year among men and 56–108 days per year among women). The before-stroke levels are comparable to those of the general population 4 years before the event, whereas after the stroke the number of work disability days per year is at a much higher level as compared with the general population during the same time period.[6] One might also assume that age could affect the increasing trends; however, our previous study further showed that there are no notable differences between unadjusted and age- or education-adjusted mean annual number of work disability days.[6]

In addition to circulatory diseases, there were also clear increasing and decreasing trends regarding work disability attributed to other diagnoses. Given that the level of work disability attributed to mental disorders was already relatively high before the event, this suggests that these people had comorbid mental disorders that could also have increased their risk of stroke.[9,10] As that the level tended to slightly increase after the stroke, this suggests that stroke diagnosis could

Table 7. Trends in Diagnosis-Specific Work Disability Before and After Date of Stroke Among Women (n=5203)

Diagnostic Categories (*ICD*-10 Codes)*	Crude Model				Fully Adjusted Model[†]			
	Before (4-Y Trend)		After (4-Y Trend)		Before (4 Y Trend)		After (4-Y Trend)	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Circulatory diseases (I00-I99)	1.99	1.68 to 2.36	0.57	0.54 to 0.61	4.27	3.18 to 5.73	0.62	0.59 to 0.67
P value for trend	<0.0001		<0.0001		<0.0001		<0.0001	
Mental disorders (F00-F99)	1.28	1.19 to 1.37	1.01	0.94 to 1.08	1.32	1.14 to 1.52	1.14	0.98 to 1.33
P value for trend	<0.0001		0.8562		0.0003		0.0916	
Musculoskeletal diseases (M00-M99)	1.37	1.28 to 1.47	0.90	0.84 to 0.95	1.55	1.36 to 1.78	0.93	0.81 to 1.07
P value for trend	<0.0001		0.0006		<0.0001		0.2883	
Neoplasms (C00-D48)	2.75	1.99 to 3.80	0.80	0.62 to 1.04	5.39	3.33 to 8.74	0.76	0.57 to 1.02
P value for trend	<0.0001		0.095		<0.0001		0.0694	
Diseases of the nervous system (G00-G99)	1.48	1.19 to 1.83	1.21	0.99 to 1.47	2.55	1.68 to 3.89	1.30	1.03 to 1.64
P value for trend	0.0004		0.0618		<0.0001		0.0251	
Diseases of the respiratory system (J00-J99)	1.50	1.13 to 1.99	1.04	0.83 to 1.30	1.59	0.79 to 3.19	0.89	0.49 to 1.62
P value for trend	0.005		0.7648		0.1928		0.7017	
Diseases of the digestive system (K00-K93)	1.37	1.00 to 1.87	0.92	0.68 to 1.23	1.14	0.53 to 2.48	1.61	0.92 to 2.83
P value for trend	0.0472		0.5754		0.736		0.098	
Injuries (S00-T35, T66-T78, T79)	1.67	1.31 to 2.13	0.62	0.48 to 0.80	1.94	1.41 to 2.68	0.58	0.43 to 0.79
P value for trend	<0.0001		0.0002		<0.0001		0.0006	
Diabetes mellitus (E10-E14)	1.95	1.47 to 2.58	1.26	1.01 to 1.58	2.10	1.46 to 3.03	1.50	1.02 to 2.19
P value for trend	<0.0001		0.0397		<0.0001		0.0388	

CI indicates confidence interval; RR, rate ratio.

*International Classification of Diseases version 10.

[†]Adjusted for age, country of birth, family situation, type of living area, economic activity, and education.

additionally increase the risk of disability attributed to mental disorders such as depression. Indeed, depression is known to be a key consequence of stroke.[21] Our sensitivity analysis excluding past long-term work disability further supports the latter interpretation, given that work disability was increased because of non-stroke-related reasons, including mental disorders, also among those without sickness absence or full disability pension 2 years before their event. Given that an earlier study has already shown that stroke survivors have high use of healthcare services attributed to reasons that are largely unrelated to stroke,[8] this suggests that our findings are plausible and the risk of work disability could correspondingly increase after a stroke diagnosis attributed to, for example, mental disorders but also to comorbid somatic diagnoses. One could also assume that there could be a common disease process behind the findings, but such specific underlying pathological mechanisms or other diseases processes remain speculative in these data.

The strong contribution of socioeconomic confounders to the work disability trends, particularly before the stroke, was expected given the strong evidence on socioeconomic patterning of stroke and work disability.[12–15] An explanation for the strengthening of the associations could be related to differences in access to treatment or variation in timing of treatment between socioeconomic groups. Thus, groups with a lower absolute level of stroke and work disability could be more likely to be hospitalized earlier and to survive after their stroke and also differ with respect to the likelihood of work disability, for example, attributed to different social and material circumstances and working conditions. Confirming the actual mechanisms is, however, beyond the scope of this study. These findings, nonetheless, suggest that although inequalities in stroke persist, prevention of work disability attributed to different diagnoses is to be targeted across socioeconomic strata. Although level of permanent work disability is high after stroke,[20] many people are able to return to work after stroke.[22] It is thus important to pinpoint particular risk groups, for example, for depression and aim to address their modifiable risk factors, to reduce the risk of prolonged work disability after the stroke diagnosis.

Methodological Considerations

This study has several strengths. First, the cohort is large and population based, including all people with strokes during

Table 8. Diagnosis-Specific Work Disability (RR and Their 95% CI) Among Men and Women After the Stroke Event Versus Before the Event*

	RR	Lower 95% CI	Upper 95% CI	Interaction (Sex×Time) P Value
Circulatory diseases (I00-I99)				
Men (after vs before)	10.49	9.22	11.94	0.0111
Women (after vs before)	10.30	8.82	12.02	
Musculoskeletal diseases (M00-M99)				
Men (after vs before)	1.16	1.05	1.27	0.2759
Women (after vs before)	1.09	1.01	1.19	
Mental disorders (F00-F99)				
Men (after vs before)	1.58	1.43	1.76	0.0076
Women (after vs before)	1.25	1.13	1.37	
Neoplasms (C00-D48)				
Men (after vs before)	1.99	1.64	2.41	0.6882
Women (after vs before)	2.55	2.07	3.14	
Diseases of the nervous system (G00-G99)				
Men (after vs before)	3.32	2.71	4.08	0.9928
Women (after vs before)	3.23	2.58	4.05	
Diseases of the respiratory system (J00-J99)				
Men (after vs before)	2.25	1.52	3.33	0.3433
Women (after vs before)	1.61	1.20	2.16	
Diseases of the digestive system (K00-K93)				
Men (after vs before)	1.46	1.08	1.97	0.4340
Women (after vs before)	1.73	1.19	2.51	
Injuries (S00-T35, T66-T78, T79)				
Men (after vs before)	1.84	1.56	2.16	0.5196
Women (after vs before)	1.41	1.16	1.71	
Diabetes mellitus (E10-E14)				
Men (after vs before)	2.62	2.08	3.31	0.5550
Women (after vs before)	2.16	1.68	2.77	

CI indicates confidence interval; RR, rate ratio.

*Four years before stroke are contrasted to 4 years after stroke. Fully adjusted rate ratios (age, birth country, living area, family situation, economic activity, education, sex, year, and sex×year interaction term).

working age. Furthermore, there is practically no loss to follow-up, except that we do not know work disability trends for those who moved out of Sweden and were censored. Emigration was, however, very rare after a stroke (data not shown). Moreover, this study included all stroke events during the study years, focused on work disability diagnoses already 4 years before the diagnosis, and followed up the survivors up to 4 years after their event, showing the trends and changes in diagnosis-specific work disability before and after the diagnosis of stroke. Stroke was defined from hospital records of high validity[23] and based on *ICD*-10 classification. Because no information was self-reported, recall bias is not an issue in this study. Using several linked register-based data sources,

we were further able to consider all strokes before our baseline, to be able to better include only people without previous stroke in this cohort. However, it is possible that some previous stroke events were missed, especially if the previous event had occurred more than 5 years before our index event. Another advantage is that a physician assessed all work disability diagnoses as having led to functional limitations and also as affecting the work capacity of the patient. For patients who are granted disability pension, those assessments are particularly thorough. An issue often discussed, however hardly ever studied, is the validity of the work disability diagnoses. We found only 1 study about this, comparing sick leave diagnoses to the information in the

patient's medical files.[24] The study found the diagnoses to have a high validity, especially at a 3-digit level, which we also used. Attributed to the possible stigma of mental disorders,[25] one could consider those diagnoses to be of higher validity, given that it is unlikely to receive such a diagnosis without an actual disorder. A limitation of the study is the fact that we only had information about the main diagnosis behind the work incapacity, although it is possible that there were also other diagnoses stated on the certificate to contribute to the work incapacity. We were, nonetheless, able to include detailed information about all key diagnoses of work disability during several years both before and after stroke.

It is of note that data on job content are unavailable in the registers, although one might assume differences in return to work by the type of work, for example. However, we adjusted for education, which could act as a proxy for, for example, the spectrum of jobs available, type of work, and work-related demands, among other things. Although we were able to cover, in addition to education, a variety of key socioeconomic and sociodemographic correlates of stroke,[12–15,26] we acknowledge that register-based information remains limited with residual confounding likely present, given that, for example, modifiable risk factors and health behaviors or further patient-level factors could not be included. Additionally, the data lack information on stroke severity or poststroke functional limitation. This is a major limitation. Exclusion of deaths in 30 days, nonetheless, means that the most severe events were not included. Finally, it needs to be noted that because our data are large, statistical significance can be reached more easily, even if the actual differences are small and may have little clinical significance. The same applies to testing of the interactions about sex differences: It cannot be ruled out that they may have emerged by chance. Because this is a population-level study, implications and significance need to be addressed at population level. This means that although, for example,, a 1- or 2-day difference may appear small regarding an individual patient, if this figure is multiplied by the number of absence days among all stroke patients, societal significance can be notable. Nonetheless, the results should be interpreted with some caution and further research is needed to corroborate whether there is a difference between women and men, and what clinical significance the results may have. Despite limitations, the findings of this exploratory study show the overall trends in work disability and highlight that work disability is increased not only because of obvious circulatory diseases, but also because of other diseases, even before stroke.

Conclusions

There was a sharp increase in work disability attributed to circulatory diseases during the first postevent year after stroke. Although the trend in work disability attributed to circulatory diseases decreased after the second year onward, the absolute levels remained high. Work disability was also at a high level for several other diagnoses, including mental and musculoskeletal disorders as well as diabetes mellitus, diseases of the nervous system, and also injuries. This highlights the need to consider comorbidity among working-aged stroke survivors, to prevent loss of work capacity.

Given that the rates of work disability were high after stroke as compared with before stroke among both women and men, this strengthens the importance of considering both sexes when aiming to promote work participation after stroke and reduce the burden and risk of comorbid conditions. The associations remained after considering socioeconomic factors, suggesting that issues of higher work disability and comorbidity do not merely concern specific population groups, such as those economically inactive, with low socioeconomic position or immigrants. Preventive actions need to be targeted to all stroke patients to improve prognosis and sustained return to work after stroke, and to prevent long-term work disability attributed to comorbid conditions. Further studies could address whether early detection and intervention could help reduce the risk of stroke occurrence in the identified high-risk groups and decrease work disability and other consequences of stroke.

Disclosures

None.

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