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Childbirth, morbidity, sickness absence, and disability pension: a population-based longitudinal cohort study in Sweden

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ABSTRACT

Objective Studies suggest that childbirth is associated with future sickness absence (SA) and disability pension (DP). Knowledge regarding the role of morbidity in these associations is very limited, but often questioned if exists. We studied the association of morbidity and SA and DP in year 2 and 3 after childbirth (or inclusion year) among women with no, one, or several childbirths.

Design Register-based cohort study.

Setting Sweden.

Participants Women aged 18-39 years and living in Sweden on 31 December 2004 (n=492,504).

Primary and secondary outcome measures Annual mean SA>14 and DP days.

Methods Women were categorised as no childbirth in 2005 nor during follow-up, first childbirth in 2005, and first childbirth in 2005 and at least one more birth within three years. Microdata for three years before and three years after inclusion was obtained regarding SA, DP, and morbidity (i.e., hospitalisation and specialised outpatient healthcare, excluding healthcare for pregnancy, childbirth, and the postpartum period). Hazard ratios and 95% confidence intervals for SA and DP in year 2 and 3 after childbirth were estimated by Cox regression.

Results Women with one childbirth had a lower risk of SA and DP than those who remained nulliparous, while women with more than one childbirth had the lowest DP risk. Morbidity after delivery or 2 July 2005 in the B0 group that was not related to pregnancy, childbirth, or the postpartum period was associated with a higher risk of future SA and DP, regardless of childbirth. Furthermore, morbidity both before and after childbirth showed a strong association with SA and DP (range of hazard ratios: 2.54-13.12).

Conclusions We found a strong positive association between morbidity and both SA and DP among women, regardless of childbirth status. Those who gave birth had lower future SA and DP risk than those who did not give birth.

Keywords: sick leave, disability pension, morbidity, cohort study, childbirth, pregnancy

Strengths and limitations of this study

- Since the study was based on nationwide population-based registers, all women fulfilling our inclusion criteria could be included, not only a sample.
- The large cohort allowed us to perform sub-group analyses and yielded high statistical precision.
- The fact that the study was conducted in Sweden, a country characterised by high employment rate among women, limits health selection into paid work.
- We could not include information on sickness absence shorter than 15 days.

BACKGROUND

A substantial proportion of women suffer from physical and mental distress during pregnancy, delivery, and the postpartum period [1]. Common pregnancy-related symptoms and disorders include fatigue, headache, bowel problems, sleep-related problems, depression, urinary incontinence, back pain, and pelvic pain [2-4]. While most of these pregnancy-related symptoms are temporary, some more severe disorders in pregnancy or postpartum, e.g., hypertension, diabetes, and depression, may be associated with severe disorders several year later [5-8].

The pregnancy-related physical and mental disorders can also lead to temporary and permanent work incapacity in terms of sickness absence (SA) and disability pension (DP). Some studies have found a higher risk of future SA among women after childbirth, as compared to the child's father [9-11]. However, in our previous studies we found that nulliparous women have higher rates of SA/DP than those who give birth and that those having more than one childbirth have the lowest SA/DP levels 3-10 years after the childbirth [12-15]. It is, thus, of interest to study to what extent morbidity in these groups of women is associated with SA. We previously studied this in a cohort of Swedish twin sisters and found strong positive associations with morbidity, measured in terms of hospitalisation [16-18]. This may not seem surprising, however, this association is sometimes questioned and it is argued that women may prefer to be on SA, even in the absence of a limiting condition, in order to meet demands related to domestic work [19 20]. Moreover, SA and DP are not good measures of [21]morbidity in a population: most people with different types of morbidity are not on SA or DP, as their morbidity does not limit their function regarding the work capacities required in their job to such an extent that they require SA/DP [9 22 23]. Nevertheless, knowledge on the link between morbidity and SA also in the general population is limited [21 24-29].

The aim of this study was to investigate in a nationwide population-based cohort the associations of morbidity, assessed in terms of hospitalisation and specialised outpatient care, with subsequent SA and DP among nulliparous women with no, one, or several childbirths during follow-up.

METHODS

This longitudinal population-based cohort study was based on nationwide register microdata, linked by the unique personal identity number assigned to all residents in Sweden. Anonymised data from the following six such registers, kept by the following three authorities, were used:

- From Statistics Sweden: The Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA) regarding information on sociodemographics and year of migration.
- From the National Board of Health and Welfare: 1) The Medical Birth Register to obtain information on date of deliveries and parity. It covers 97-99% of all births in Sweden since 1973; 2) The National In-Patient Register (established in 1964 and nationwide since 1987) to obtain information on childbirths not included in the Medical Birth Register and information on hospitalisations due to other causes (date and diagnoses). If a delivery appeared in both registers, the information from the Medical Birth Register was used; 3) The National Out-Patient Register (established in 2001) for information on specialised outpatient healthcare (date and diagnoses); 4) The Causes of Death Register for date of death.
- From the Swedish Social Insurance Agency, information from the Micro-data for Analyses of Social Insurance (MiDAS) Register, on SA >14 days and DP (dates and extent) for the period 2002-2008.

Study population

All women aged 18-39 years who had not given birth prior to 1 January 2005 and who lived in Sweden during the period 2002-2004 were included. They were categorised according to whether they gave birth in 2005 and during the follow-up for three years (Y_{+1}-Y_{+3}), from date of delivery (T_0). As the outcomes (SA and DP) might be influenced by a new pregnancy, all women were followed up also for 43 weeks after Y_{+3}.

The women were categorised into three groups, according to future childbirth:

• **B0**: Women having no childbirth registered during follow-up (Y_{+1}-Y_{+3}) nor during the subsequent 43 weeks.

• **B1**: Women having their first childbirth in 2005 and no more births during follow-up (Y_{+1}-Y_{+3}) or the subsequent 43 weeks.

• **B1+**: Women having their first childbirth in 2005 and at least one more birth during follow-up (Y_{+1}-Y_{+3}) or the subsequent 43 weeks.

Childbirth in the Patient Register was defined by main or secondary diagnoses according to the International Classification of Disease (ICD-10)[30]: O80-84 delivery, O75.7 vaginal delivery following previous caesarean section, O75.8 other specified complications of labour and delivery, and O75.9 complication of labour and delivery, unspecified.

For the women in B1 and B1+, the date of birth was used for T_0, for the women in B0, T_0 was set to 2 July 2005.

The final cohort included 492,504 women.

Morbidity

We used information on healthcare to operationalise morbidity; we calculated the mean number of hospitalisation days and of specialised outpatient visits per year during the three years prior to and the three years after T_0.

In order to investigate if morbidity in terms of hospitalisation and specialised outpatient healthcare in the year after T_0 increased the risk of future SA and DP, we created a variable for morbidity during Y_{+1}, excluding diagnoses related to pregnancy, childbirth, and the postpartum period (ICD-10: O00-O99 pregnancy, childbirth and the puerperium, and Z30-Z39 health services in circumstances related to reproduction).

In order to examine if morbidity in terms of hospitalisation and specialised outpatient healthcare prior to and/or after childbirth increased the risk of future SA and DP, we created variables, indicating morbidity 1-3 years before T_0 (Y_{-3} -Y_{-1}), and/or 1 year after T_0 (Y_{+1}) (excluding diagnoses related to pregnancy, childbirth and the postpartum period (ICD-10: O00-O99 and Z30-Z39)).

The Swedish sickness absence insurance system

All residents in Sweden aged 16 or older with income from work or unemployment benefits can claim SA benefits in case of reduced work capacity due to disease or injury. For employees, this is paid by the employer during the first 14 days, and thereafter by the Social Insurance Agency [9]. All residents aged 19-65 can be granted DP if their work capacity is long-term or permanently reduced due to disease or injury. The SA benefits cover 80%, DP covers up to 65%, of the lost income up to a certain level. Both SA and DP can be granted for full- or part-time (25%, 50%, or 75%) of ordinary work hours. This means that people can be on part-time SA and DP at the same time. Therefore, we calculated net days, e.g., two days of 50% of SA or DP represent one net day.

All pregnant women can choose to take out parental benefit 60 days before the estimated delivery date. Parental benefit is granted for 480 days for one child. For 390 of these days, the benefit is based on the income, while for the remaining 90 days, the benefit is set to 180 SEK (around 18 Euro) per day.

Outcomes

We used the following measures of sickness absence (SA) and disability pension (DP) as outcomes:

- The mean numbers of SA and DP net days/year were calculated for each of the six years Y_{-3} -Y_{+3}.
- General SA - the first SA spell regardless of duration in year 2-3 after childbirth (Y_{+2} - $Y_{+3)}$.
- Long-term SA - the first SA spell of >90 net days in Y_{+2} -Y_{+3}.
- DP - the first new DP spell in Y_{+2} -Y_{+3}.

Included factors

We included *age* (18-24, 25-29, 30-34, and 35-39 years), *educational level* (elementary (≤9 years + missing), high school (10-12 years), and university/college (>12 years)) in December 2004 and previous *hospitalisation and specialised outpatient healthcare* 1-3 years before T_0 (Y_{-1} -Y_{-3}) as covariates.

Statistical analyses

We performed Cox proportional hazards regression models to investigate the association between childbirth, morbidity and the risks of SA and DP. Hazard ratios (HR) and 95% confidence intervals (CI) for SA and DP were calculated. We tested the assumption of proportional hazards with log negative log curves; there was no indication for non-proportionality. Women with DP before T_0 were excluded from regression analyses of future DP (n=21,848) since they were not at risk of experiencing this outcome. Follow-up started at the beginning of Y_{+2} and ended upon the event, emigration, death, or the end of Y_{+3}, or at 31 December 2008, whichever came first. When performing analyses with SA as the outcome, we censored also for DP since persons with DP are not at risk for SA. We performed crude models and models adjusted for age, educational level, and hospitalisation and specialised outpatient healthcare previous to T_0. Analyses were also performed among parous women only (B1 and B1+; n=38,413) in order to examine the potential differences between women with one childbirth and women who gave birth more than once. All analyses were conducted by SAS Statistical Software, version 9.4.

Patient and public involvement

The study participants or the general public were not involved in decisions about the research question, the design of the study, the outcomes, the conduct of the study, the drafting of the paper, nor in the dissemination of the study results.

RESULTS

Among the 492,504 women, 38,972 (7.9%) had at least one childbirth during the study period (B1 and B1+) (Table 1). Among those who gave birth, the majority were below 30 years and had a somewhat higher educational level than those in the B0 group (no childbirth). Regarding morbidity, when excluding specialized healthcare for pregnancy and childbirth, the proportion of women who had morbidity before and/or after T_0 was similar in the three childbirth groups. Furthermore, a higher proportion of the women who gave birth had had at least one SA spell before and/or after T_0 (delivery date) than women who did not. On the contrary, a higher proportion of the B0 women had DP compared to women with childbirth.

Table 1. Characteristics of the cohort of women[1] by childbirth group (N=492,504)

Factors	B0 (n=453,532) n (%)	B1 (n=14,299) n (%)	B1+ (n=23,673) n (%)
Age in 2004			
18-24	257,219 (56.7)	3688 (25.8)	5284 (21.4)
25-29	92,672 (20.4)	4593 (32.1)	10,354 (42.0)
30-34	56,233 (12.4)	4089 (28.6)	7614 (30.9)
35-39	47,408 (10.5)	1929 (13.5)	1421 (5.8)
Country of birth			
Sweden	397,091 (87.6)	12,388 (86.6)	22,583 (91.5)
Other Northern European	4873 (1.1)	200 (1.4)	237 (1.0)
Other European countries	7432 (1.6)	213 (1.5)	242 (1.0)
Rest of the world	44,136 (9.7)	1498 (10.5)	1611 (6.5)
Type of living area in 2004			
Large cities	196,911 (43.4)	6260 (43.8)	10,882 (44.1)
Medium-sized cities	161,919 (35.7)	4824 (33.7)	8425 (34.2)
Small cities	94,702 (20.9)	3215 (22.5)	5366 (21.8)
Educational attainment in 2004			
Elementary (≤9 years)	90,510 (20.0)	1815 (12.7)	1757 (7.1)
High school (10-12 years)	208,184 (45.9)	6751 (47.2)	9516 (38.6)
University/college (≥13 years)	154,838 (34.1)	5733 (40.1)	13,400 (54.3)
Family situation in 2004			
Married or cohabitant	20,295 (4.5)	3212 (22.5)	6843 (27.7)
Single	433,237 (95.5)	11,087 (77.5)	17,830 (72.3)
Hospitalisation (at least one day during)			
3 years prior to T_0 (Y_{-3} - Y_{-1})	50,184 (11.1)	8074 (56.5)	13,145 (53.3)

excluding ICD-10: O and Z30-Z39	49,040 (10.8)	1726 (12.2)	2210 (9.0)
3 years after T_0 (Y_{+1} - Y_{+3})	49,430 (10.9)	13,975 (97.7)	24,547 (99.5)
excluding ICD-10: O and Z30-Z39	47,892 (10.6)	1691 (11.8)	1924 (7.8)
Both prior to and after T_0 (Y_{-3} - Y_{+3})	14,865 (3.3)	7773 (54.4)	13,024 (52.8)
excluding ICD-10: O and Z30-Z39	14,436 (3.2)	439 (3.1)	372 (1.5)
Specialised outpatient visit (at least one visit during)			
3 years prior to T_0 (Y_{-3} - Y_{-1})	256,677 (56.6)	12,130 (84.8)	19,916 (80.7)
excluding ICD-10: O and Z30-Z39	254,531 (56.1)	10,286 (71.9)	16,323 (66.2)
3 years after T_0 (Y_{+1} - Y_{+3})	264,932 (58.4)	9870 (69.0)	19,625 (79.5)
excluding ICD-10: O and Z30-Z39	261,766 (57.7)	9063 (63.4)	15,489 (62.8)
Both prior to and after T_0 (Y_{-3} - Y_{+3})	180,667 (39.8)	8737 (61.1)	16,520 (67.0)
excluding ICD-10: O and Z30-Z39	177,748 (39.2)	7165 (50.1)	11,376 (46.1)
Sickness absence (SA) (at least one SA spell during)			
3 years prior to T_0 (Y_{-3} - Y_{-1})	54,013 (11.9)	5840 (40.8)	8802 (35.7)
3 years after T_0 (Y_{+1} - Y_{+3})	61,341 (13.5)	2797 (19.6)	7447 (30.2)
3 years prior to or after T_0 (Y_{-3} - Y_{+3})	90,849 (20.0)	6740 (47.1)	11,940 (48.4)
Disability pension (DP) (any time during)			
3 years prior to T_0 (Y_{-3} - Y_{-1})	21,289 (4.7)	351 (2.5)	208 (0.8)
3 years after T_0 (Y_{+1} - Y_{+3})	27,453 (6.1)	438 (3.1)	238 (1.0)
3 years prior to or after T_0 (Y_{-3} - Y_{+3})	28,121 (6.2)	467 (3.3)	256 (1.0)

[1]Nulliparous women aged 18-39 in December 2004 registered as residents in Sweden in 2001-2003.

B0= No childbirth in 2005 nor in the following three years + 43 weeks.

B1= First child in 2005 and no more deliveries in the following three years + 43 weeks.

B1+ = First child in 2005 and at least one more delivery in the following three years + 43 weeks.

T_0= Delivery date or in the B0 group: 2 July 2005.

The mean annual number of hospitalisation days and visits to specialised outpatient healthcare is presented in Figure 1. Figures 1c and 1d show that when healthcare with diagnoses for

pregnancy and childbirth are excluded, women in the B1 and B1+ groups had lower number of hospitalisation days and specialised outpatient visits than women without childbirth (B0), particularly the women with more than one childbirth.

Women who had at least one childbirth had more SA days during the year before T_0, especially in the B1 group (Figure 2). After T_0, the number of SA days for these women dropped rapidly to a lower level than for women without childbirth, that is, in that year most women had parental-leave benefits. However, in all studied years, women who did not give birth (B0) had a higher mean number of DP days/year than women who gave birth. Women in B1+ had the lowest mean number of DP days/year compared to both B0 and B1+.

Table 2 presents crude and multivariate HR and 95% CI for the association between morbidity in Y_{+1} after T_0 and future SA among all not on DP at T_0, for each of the three childbirth groups. First all three groups are compared (B0, B1, and B1+), then the two childbirth groups are compared (B1 and B1+). In the fully adjusted models, the HR of future SA was compared between the groups, using women in the B0 group with no such morbidity as reference group. In the B0 group with such morbidity the risk was around 3-fold higher in Y_{+2}-Y_{+3}. Actually, the women in B1, without morbidity in Y_{+1} had a lower risk of future SA compared to B0 women without such morbidity. Those in B1+, without morbidity at $Y_{+1,}$ had a lower risk of long-term SA (>90 days) in Y_{+2}-Y_{+3}, however, a higher risk for any SA.

Table 2. Association between morbidity[1] and future sickness absence (SA) in year 2-3 after delivery (Y_{+2}-Y_{+3}) among nulliparous women who did not give birth (B0), had one birth (B1), or more than one birth (B1+) during follow-up.

Morbidity [a]	Crude	Model 1[2]	Model 2[3]
	Hazard ratios (HR) and 95% confidence intervals (CI)		
At least one SA spell >14 days in Y_{+2}-Y_{+3}			
All women (n=470 656) [4]			
No childbirth (B0)			
no morbidity	1	1	1
morbidity	3.29 (3.18-3.40)	3.24 (3.14-3.35)	2.56 (2.48-2.65)
1 childbirth (B1)			
no morbidity	1.45 (1.38-1.52)	1.16 (1.10-1.21)	0.82 (0.76-0.86)
morbidity	3.61 (3.08-4.23)	2.93 (2.50-3.43)	1.89 (1.61-2.22)
+ 1 childbirth (B1+)			
no morbidity	3.01 (2.93-3.09)	2.54 (2.47-2.61)	1.85 (1.79-1.90)
morbidity	5.95 (5.23-6.77)	5.09 (4.47-5.78)	3.37 (2.96-3.84)
Women who had at least one childbirth (n=38,413)			
1 childbirth (B1)			
no morbidity	1	1	1
morbidity	2.54 (2.15-3.00)	2.52 (2.14-2.97)	2.38 (2.02-2.81)
+ 1 childbirth (B1+)			
no morbidity	2.10 (2.00-2.22)	2.18 (2.06-2.29)	2.21 (2.10-2.33)
morbidity	4.26 (3.72-4.89)	4.38 (3.82-5.03)	4.18 (3.64-4.79)
At least one long-term SA spell (>90 days) in Y_{+2}-Y_{+3}			
All women (n=470,656) [4]			
No childbirth (B0)			
no morbidity	1	1	1

morbidity	4.61 (4.39-4.84)	4.51 (4.30-4.74)	3.33 (3.16-3.50)
1 childbirth (B1)			
no morbidity	1.46 (1.34-1.58)	1.07 (0.98-1.16)	0.69 (0.63-0.75)
morbidity	5.66 (4.55-7.04)	3.44-5.33)	2.46 (1.98-3.07)
+ 1 childbirth (B1+)			
no morbidity	1.67 (1.58-1.78)	1.29 (1.21-1.37)	0.85 (0.80-0.91)
morbidity	4.48 (3.52-5.70)	3.48 (2.74-4.43)	2.07 (1.62-2.63)
Women who had at least one childbirth (n=38,413)			
1 childbirth (B1)			
no morbidity	1	1	1
morbidity	3.93 (3.12-4.96)	3.83 (3.04-4.83)	3.54 (2.80-4.46)
+ 1 childbirth (B1+)			
no morbidity	1.15 (1.04-1.27)	1.21 (1.09-1.33)	1.23 (1.11-1.36)
morbidity	3.10 (2.41-3.99)	3.18 (2.47-4.09)	2.96 (2.30-3.81)

[1]Morbidity 1 year (Y_{+1}) after delivery date or equivalent (T_0), measured by hospitalisation and specialised outpatient visit (diagnoses O00-O99 and Z30-Z39 excluded).

[2]Model 1: Adjusted for age and educational level.

[3]Model 2: Adjusted for age, educational level, and previous hospitalisation and specialised outpatient visit (Y_{-3}-Y_{-1}).

[4]Women on DP at baseline were excluded.

When restricting those analyses to parous women (n=38,413), those in B1+ with morbidity in Y_{+1} had a particularly higher risk of any SA compared to all others.

When again excluding those on DP at $T_{0,}$ the HR for future DP was highest in the B0 group with morbidity in $Y_{+1,}$ using the women in B0 with no morbidity in Y_{+1} as reference (Table 3). Regardless of morbidity, parous women, particularly those in B1+, had a lower risk of DP than their nulliparous counterparts. When restricting the analyses to parous women only, morbidity was associated with having DP in Y_{+2}-$Y_{+3,}$ especially in the B1 group. That is, multiparity was associated with a lower risk of DP.

Table 3. Association between morbidity and future disability pension (DP) in year 2-3 after delivery (Y_{+2}-Y_{+3}) among nulliparous women who did not give birth (B0), had one birth (B1), or more than one birth (B1+) during follow-up.

Morbidity[1]	Crude	Model 1[2]	Model 2[3]
	Hazard ratios (HR) and 95% confidence intervals (CI)		
Granted DP in Y_{+2}-Y_{+3}			
All women (n=470,656)[4]			
No childbirth (B_0)			
no morbidity	1	1	1
morbidity	7.72 (7.28-8.19)	6.92 (6.52-7.34)	4.12 (3.87-4.38)
1 childbirth (B_1)			
no morbidity	0.52 (0.42-0.64)	0.41 (0.34-0.51)	0.20 (0.16-0.24)
morbidity	3.77 (2.55-5.59)	2.88 (1.94-4.26)	1.17 (0.79-1.74)
+ 1 childbirth (B_{1+})			
no morbidity	0.13 (0.09-0.17)	0.12 (0.09-0.16)	0.06 (0.04-0.08)
morbidity	1.20 (0.60-2.40)	1.04 (0.52-2.08)	0.44 (0.22-0.87)
Women who had at least one childbirth (n=38,413)[4]			
1 childbirth (B_1)			
no morbidity	1	1	1
morbidity	7.32 (4.70-11.40)	6.30 (4.03-9.82)	5.71 (3.65-8.92)
+ 1 childbirth (B_{1+})			
no morbidity	0.24 (0.17-0.35)	0.28 (0.19-0.41)	0.29 (0.20-0.42)
morbidity	2.32 (1.12-4.77)	2.34 (1.13-4.82)	2.10 (1.02-4.34)

[1]Morbidity 1 year (Y_{+1}) after delivery date or equivalent (T_0), measured by hospitalisation and specialised outpatient visit (diagnoses O00-O99 and Z30-Z39 excluded)

[2]Model 1: Adjusted for age and educational level

[3]Model 2: Adjusted for age, educational level and previous hospitalisation and specialised outpatient visit (Y_{-3}-Y_{-1})

[4]Women on DP at baseline were excluded

The associations between morbidity and future SA and DP among women who gave birth were also tested using morbidity (i.e., hospitalisation and specialised outpatient healthcare) before and/or after T_0 as exposure, and SA and DP in $Y_{+(2\text{-}3)}$ as outcomes. The result showed a gradient with a particularly higher risk of future SA and DP among women with morbidity both before and after T_0 (Table 4).

Table 4. Associations (hazard ratios (HR) and 95% confidence intervals (CI)) between morbidity[1] and future sickness absence (SA) and disability pension (DP), respectively, 2-3 year (Y_{+2}-Y_{+3}) after delivery, among women who had at least one childbirth (n=38,413), excluding those on DP when giving birth

	Any SA spell >14 days in Y_{+2}-Y_{+3}		Long-term SA spell (>90 days) in Y_{+2}-Y_{+3}	
	Crude	Model 1[2]	Crude	Model 1[2]
No morbidity	1	1	1	1
Morbidity before[3] delivery	1.33(1.28-1.39)	1.34(1.28-1.40)	1.59(1.44-1.74)	1.57(1.42-1.72)
Morbidity after[3] delivery	1.95(1.63-2.34)	1.95(1.63-2.33)	3.91(2.94-5.19)	3.81(2.87-5.06)
Morbidity before[3] and after[e] delivery	2.50(2.21-2.83)	2.54(2.24-2.88)	4.19(3.39-5.18)	4.06(3.28-5.02)
DP in Y_{+2}-Y_{+3}				
		Crude	Model 1[c]	
No morbidity		1	1	
Morbidity before[3] delivery		2.35(1.62-3.41)	2.12(1.46-3.07)	
Morbidity after[e] delivery		11.70(5.69-24.06)	10.10(4.90-20.79)	
Morbidity before[d] and after[3] delivery		17.45(10.54-28.87)	13.12(7.88-21.85)	

[1]Morbidity: measured by hospitalisation and specialised outpatient visit (diagnoses O00-O99 and Z30-Z39 excluded).

[2]Model 1: Adjusted for age and educational level.

[3]During the period 1-3 years prior to delivery (Y_{-3}-Y_{-1}).

[4]1 year after delivery (Y_{+1}).

DISCUSSION

In this longitudinal, population-based cohort study of 492,504 women in Sweden, we investigated the associations of morbidity (i.e., hospitalisation, specialised outpatient healthcare that is not related to pregnancy, childbirth, or postpartum) with future SA and DP in three groups of nulliparous women: those not giving birth during follow-up (B0), those having one birth (B1), and those with more than one birth (B1+). During the year before date of their first childbirth (T_0) (Y_{-1}), parous women had higher mean number of SA days, that is, during pregnancy. This decreased gradually during the years after T_0. On the other hand, over all the six studied years the women not giving birth (in the B0 group) had a higher number of DP days than parous women. When excluding those on disability pension at T_0, we found that morbidity was strongly associated with a higher risk of future SA and DP, regardless of childbirth status. Giving birth to at least one child was associated with a lower risk of subsequent SA/DP compared to not giving birth, and this was true particularly for DP. Analysis focusing solely on parous women showed that morbidity both before and after the first childbirth was associated with a particularly high risk of future SA and DP.

Research has repeatedly shown that women have a higher probability of having SA or DP than men [31] and pregnancy/childbirth is considered to be one of the reasons behind this difference [10 11 29 32 33]. Our results regarding that SA days increased in the year before T_0, that is, during pregnancy, as well as that the number became much lower in the year after T_0 (when most are on parental leave) are in line with some previous studies [10 12 14-17 34]. The somewhat higher levels of SA in Y_{+3} could be explained by the double-burden hypothesis which suggests that the combination of paid work and parenthood may lead to worse health [35-38]. However, several other studies have suggested that multiple roles are likely to be beneficial to women's health [39-41]. In our study, the SA days/year in women giving birth decreased rapidly in the year after delivery and the higher levels of SA one year before

delivery is most likely to be related to the pregnancies. A Norwegian study also reported a higher level of SA in the years after pregnancy, which disappeared after accounting for SA during subsequent pregnancies [38]. Moreover, women who remained nulliparous had higher levels of DP than those who gave birth. Our findings also showed higher mean number of hospitalisation days among nulliparous women, indicating that there might be a health selection into pregnancy.

Women with morbidity that was not related to pregnancy, childbirth, and the postpartum period after delivery, had an overall higher risk for future SA, regardless of childbirth status. This association persisted even after adjustment for age, education, and previous morbidity. Women with one birth (B1) had a lower risk of any SA and of long-term SA (>90 days), whereas women who had more than one birth had a higher risk of any SA but a lower risk of long-term SA in year 2-3 after delivery (Y_{+2}-Y_{+3}). It is likely that pregnancy during the follow-up time resulted in SA for women in the B1+ group. Our finding regarding an inverse association between the number of births and DP might indicate better health among the women in the B1+ group than in the other two groups. These findings are also in line with two Swedish prospective cohort studies of female twins [16 17]. Comparison of women who gave birth to one child only to those who gave birth to several children, showed similar graded associations between morbidity and future SA/DP as when we compared parous women with nulliparous women.

Morbidity both before and after delivery was the strongest risk factor for SA and DP among women who gave birth. We observed a graded association between morbidity and SA/DP; women with morbidity before *or* after their first childbirth had a higher risk of SA and DP, whereas those with morbidity both before *and* after the first childbirth had even higher risks that reveals the association of more severe morbidity and higher future SA/DP risk among women who gave birth. Also this is in line with the previous studies of Swedish twin sisters

[16 17]. To the best of our knowledge, this is the first study to document associations between morbidity and SA/DP among women in the general population, using data on both hospitalisation and specialised outpatient healthcare as well as on number of childbirths.

Strengths and limitations

Strengths of this study include the population-based longitudinal cohort study design, that all women fulfilling the inclusion criteria could be included (not only a sample) and the large cohort allowing for sub-group analyses. Other strengths are the possibility to use extensive microdata linked from several high-quality nationwide administrative registers [42 43], instead of self-reports that are limited by e.g., recall bias and drop outs. It was also an advantage that all study participants could be followed from date of birth or equivalent. The universal coverage of the Swedish public SA/DP insurance system further reduces selection bias and misclassification of the outcome. Another strength is that we used the National Patient Register to identify also the childbirths not registered in the Medical Birth Register. Additionally, the high employment rates among women on the Swedish labour market minimizes bias due to health selection into paid work [44].

There are, however, some limitations that should be mentioned. First, some immigrant women might only have given birth before coming to Sweden; they would consequently be inappropriately categorised as nulliparous. The Medical Birth Register has information on whether the woman had previous births, also outside of Sweden, however, not the Patient Register. To reduce such misclassification, we only included women who lived in Sweden for at least three years prior to inclusion. If there were any such misclassification it probably led to underestimation of SA and DP in the B0 group and does thus not affect our conclusions. It is important to be aware of that we studied women who gave birth, irrespective of if they

lived with the child or lived with other children. For instance, the child might have died or be adopted, or nulliparous women might live with children they did not give birth to. Another aspect is that SA spells ≤14 days were not included, something that can be seen both as a limitation and a strength. The SA spells ≤14 days only account for a limited number of all SA days and most of them are not verified by a physician certificate [45].

Conclusions

It has been questioned whether sickness absent women with children are actually ill or rather prioritise domestic duties through claiming sick. However, this study showed a strong association between morbidity and both SA and DP among women of child-bearing ages. It has also been suggested that women with more children have more SA. We found the opposite; women with one birth had a lower future SA and DP risk than those who did not give birth, while those who gave birth more than once had the lowest risk of DP.

Contributors MW conducted the analyses, wrote the first draft and revised the paper; KL contributed to interpretation of the findings and revised the paper; PS and KA contributed to the conception and design of the study, interpretation of the findings and revised the paper; LN contribute to the interpretation of the findings, writing and revised the paper. All authors have read and approved the final version of the manuscript.

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Patient consent for publication Not applicable.

Ethics approval The study was approved by the Regional Ethical Review Board of Stockholm.

Data sharing statement No additional data available.

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FIGURE LEGENDS

Figure 1. Mean annual number of hospitalization days and specialized outpatient visits (with 95% CI).

Figure 2. Mean annual number of days on sickness absence (SA) and/or disability pension (DP) (with 95% CI)

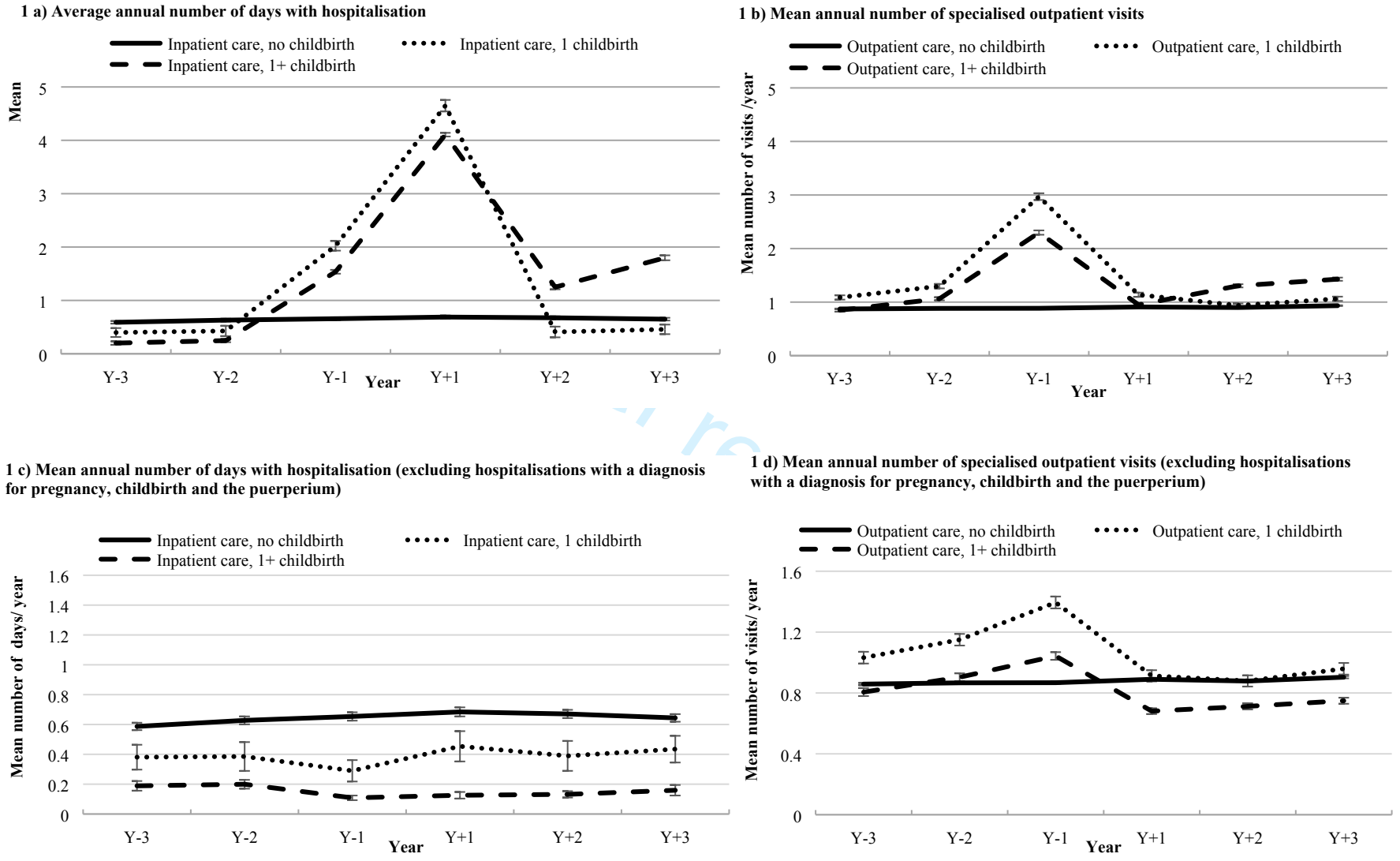
1 a) Average annual number of days with hospitalisation
Inpatient care, no childbirth
Inpatient care, 1 childbirth
Inpatient care, 1+ childbirth
Mean
0
1
2
3
4
5
Y-3
Y-2
Y-1
Year
Y+1
Y+2
Y+3
1 b) Mean annual number of specialised outpatient visits
Outpatient care, no childbirth
Outpatient care, 1 childbirth
Outpatient care, 1+ childbirth
Mean number of visits /year
1 c) Mean annual number of days with hospitalisation (excluding hospitalisations with a diagnosis for pregnancy, childbirth and the puerperium)
Mean number of days/ year
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1 d) Mean annual number of specialised outpatient visits (excluding hospitalisations with a diagnosis for pregnancy, childbirth and the puerperium)
Mean number of visits/ year

Figure 1.

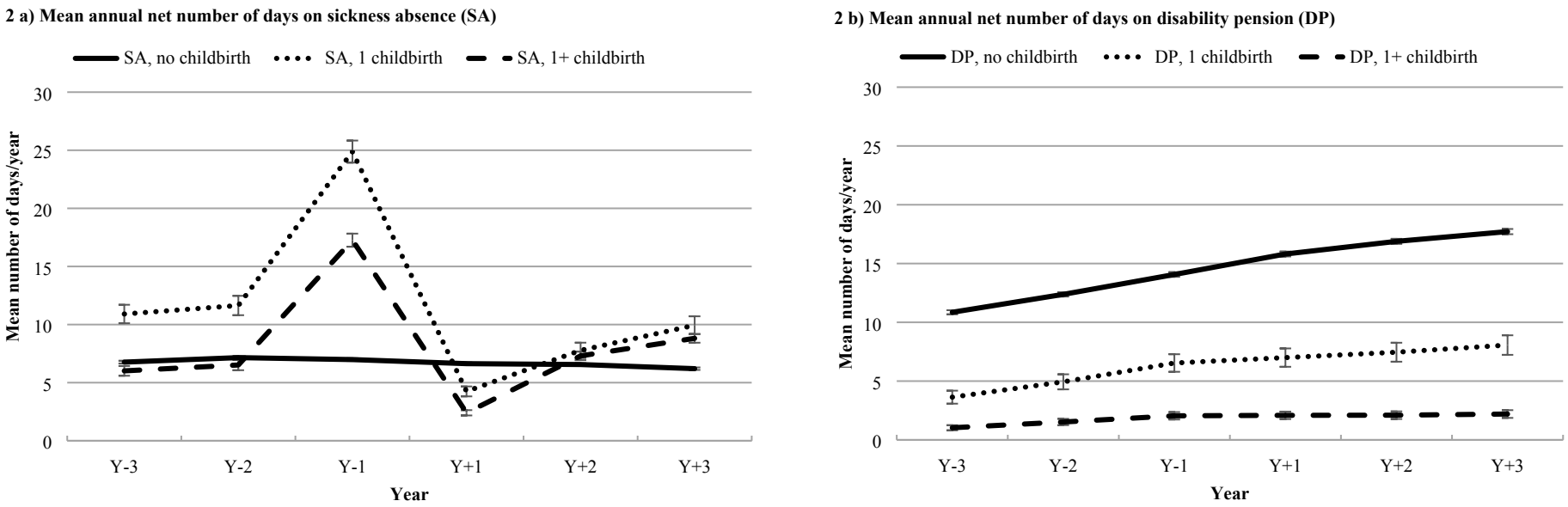

Figure 2.

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	p. 1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p. 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p. 5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	p. 6
Methods			
Study design	4	Present key elements of study design early in the paper	p. 6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p. 6-9
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	p. 6-9
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	-
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p. 7-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p. 7-9
Bias	9	Describe any efforts to address potential sources of bias	p. 9, 10
Study size	10	Explain how the study size was arrived at	p. 7, 12-13
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p. 9, 12-13
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p. 10
		(*b*) Describe any methods used to examine subgroups and interactions	p. 10
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, explain how loss to follow-up was addressed	p. 10
		(*e*) Describe any sensitivity analyses	p. 10
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	p. 7, 12-13
		(b) Give reasons for non-participation at each stage	p. 7, 12-13, 15-16
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p. 12-13
		(b) Indicate number of participants with missing data for each variable of interest	p. 12-13
		(c) Summarise follow-up time (eg, average and total amount)	-
Outcome data	15*	Report numbers of outcome events or summary measures over time	p. 12-13, 15-16, 18, 20,

			Figures 1-2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12-13, 15-16, 18, 20, Figures 1-2
		(*b*) Report category boundaries when continuous variables were categorized	p. 12-13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	p. 10-20
Discussion			
Key results	18	Summarise key results with reference to study objectives	p. 21
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p. 23, 24
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p. 21-24
Generalisability	21	Discuss the generalisability (external validity) of the study results	p. 23, 24
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p. 25

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Childbirth, morbidity, sickness absence, and disability pension: a population-based longitudinal cohort study in Sweden

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Childbirth, morbidity, sickness absence, and disability pension: a population-based longitudinal cohort study in Sweden

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ABSTRACT

Objective To investigate associations of morbidity with subsequent sickness absence (SA) and disability pension (DP) among initially nulliparous women with no, one, or several childbirths during follow-up.

Design Longitudinal register-based cohort study.

Setting Sweden.

Participants Nulliparous women, aged 18-39 years and living in Sweden on 31 December 2004 and the three preceding years (n=492,504).

Outcome measures Annual mean DP and SA days (in SA spells >14 days) in the three years before and after inclusion date in 2005.

Methods Women were categorised into three groups: no childbirth in 2005 nor during the follow-up, a first childbirth in 2005, but not during follow-up, and having a first childbirth in 2005 and at least one more during follow-up. Microdata were obtained for three years before and three years after inclusion regarding SA, DP, mortality, and morbidity (i.e., hospitalisation and specialised outpatient healthcare, excluding healthcare for pregnancy, childbirth, and postpartum period). Hazard ratios and 95% confidence intervals for SA and DP in year 2 and 3 after childbirth were estimated by Cox regression; excluding those on DP at inclusion.

Results After controlling for study participants' prior morbidity and sociodemographic characteristics, women with one childbirth had a lower risk of SA and DP than those who remained nulliparous, while women with more than one childbirth had the lowest DP risk. Morbidity after inclusion that was not related to pregnancy, childbirth, or the postpartum period was associated with a higher risk of future SA and DP, regardless of childbirth group. Furthermore, morbidity both before and after childbirth showed a strong association with SA and DP (hazard ratio range: 2.54-13.12).

Conclusions We found a strong positive association between morbidity and both SA and DP among women, regardless of childbirth status. Those who gave birth had lower future SA and DP risk than those who did not.

Keywords: sick leave, disability pension, morbidity, cohort study, childbirth, pregnancy

Strengths and limitations of this study

- Since the study was based on nationwide population-based registers, all 492,504 women fulfilling our inclusion criteria could be included, not only a sample.
- The large cohort allowed us to perform sub-group analyses and yielded high statistical precision.
- The fact that the study was conducted in Sweden, a country characterised by high employment rate among women, limits health selection into paid work.
- We could not include information on sickness absence spells shorter than 15 days.

BACKGROUND

A substantial proportion of women suffer from physical and mental distress during pregnancy, delivery, and the postpartum period.[1 2] Common pregnancy-related symptoms and disorders include fatigue, headache, bowel problems, sleep-related problems, depression, urinary incontinence, back pain, and pelvic pain.[3-5] While most of these pregnancy-related symptoms are temporary, some more severe disorders in pregnancy or postpartum, e.g., hypertension, diabetes, and depression, may be associated with severe disorders several years later.[2 6-9]

The pregnancy-related physical and mental disorders can also lead to temporary and permanent work incapacity in terms of sickness absence (SA) and disability pension (DP). Some studies have found a higher risk of future SA among women after childbirth, as compared to the child's father[10-12] while others found that women living with children had higher SA than their counterparts not living with children.[13]

However, in our previous studies we found that except for the period around childbirth, women who give birth have lower mean SA/DP days per year than those who remain nulliparous, and that those having more than one childbirth have the lowest SA/DP levels 3-10 years after the childbirth.[14-16] It is, thus, of interest to study to what extent morbidity in these groups of women is associated with SA. We previously studied the link between childbirth and SA/DP in a cohort of Swedish twin sisters (n=5118) and found a strong association between morbidity, measured in terms of hospitalisation, and the risk of SA and DP.[16-18] To what extent findings from this selected and rather small group of twin sisters (n≈5000) are generalizable to the total population is unclear. Also, we wanted to include wider information on morbidity than having been hospitalised.

It is often questioned by mass media, employers, policy makers, and researchers whether the higher SA among women who give birth is indeed due to higher morbidity, or rather to individual choices, related rather to wanting to stay home and handle domestic duties than to be in paid work.[19] Therefore, we wanted to explore if the findings regarding positive associations between morbidity and SA/DP in twin sisters giving and not giving birth could be reproduced in a larger cohort of women in Sweden. Actually, also in the general population knowledge about the link between morbidity and SA or DP is limited.[19-25]

The aim of this study was to investigate in a nationwide population-based cohort the associations of morbidity, assessed in terms of hospitalisation and specialised outpatient healthcare, with subsequent SA and DP among initially nulliparous women with no, one, or several childbirths during follow-up.

METHODS

This longitudinal population-based cohort study was based on nationwide register microdata, linked by the unique personal identity number assigned to all residents in Sweden.[26] Anonymised data from the following six registers, kept by three authorities, were used:

- From Statistics Sweden: The Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA)[27] for information on sociodemographics and year of migration.

- From the National Board of Health and Welfare: 1) The Medical Birth Register to obtain information on date of deliveries and parity. It covers 97-99% of all births in Sweden since 1973; 2) The National In-Patient Register (established in 1964 and nationwide since 1987) for information on childbirths not included in the Medical Birth Register (date and diagnoses) and information on hospitalisations due to other causes (date and main and secondary diagnoses).

If a delivery appeared in both registers, the information from the Medical Birth Register was used; 3) The National Out-Patient Register (established in 2001) for information on specialised outpatient healthcare (date and main diagnoses); 4) The Causes of Death Register for date of death.

- From the Swedish Social Insurance Agency, for information from the Micro-data for Analyses of Social Insurance (MiDAS) Register, on SA spells >14 days and on DP (dates and extent) for the period 2002-2008.

Study population

All women aged 18-39 years who had not given birth prior to 1 January 2005 and who lived in Sweden during the period 2002-2004 were included. The limits were based on the frequency distribution of age among primiparous women in Sweden; very few women had their first child before the age of 18 or after the age of 39 years. The lower age limit of 18 also means that all had at least a chance to have had SA before inclusion (not possible before the age of 16). Women in the extremes were analyzed similarly to women of other ages. Study participants were categorised according to whether they gave birth in 2005 and during the follow-up for three years (Y_{+1} - Y_{+3}), from date of delivery (T_0). As the outcomes (SA and DP) might be influenced by a new pregnancy, all women were followed for an additional 43 weeks after end of Y_{+3}.

The women were categorised into three groups, according to future childbirth:

• **B0**: Women having no childbirth registered during follow-up (Y_{+1} - Y_{+3}) nor during the subsequent 43 weeks.

• **B1**: Women having their first childbirth in 2005 and no more births during follow-up (Y_{+1} - Y_{+3}) or the subsequent 43 weeks.

• **B1+**: Women having their first childbirth in 2005 and at least one more birth during follow-up (Y_{+1} - Y_{+3}) or the subsequent 43 weeks.

Childbirth in the Patient Register was defined by main or secondary diagnoses according to the International Classification of Disease (ICD-10)[28]: O80-84 delivery, O75.7 vaginal delivery following previous caesarean section, O75.8 other specified complications of labour and delivery, and O75.9 complication of labour and delivery, unspecified.

For the women in B1 and B1+, the date of birth was used for T_0, for the women in B0, T_0 was set to 2 July 2005 (i.e., the middle of the year). The final cohort included 492,504 women.

Morbidity

We calculated the mean number of hospitalisation days and of specialised outpatient visits (i.e., morbidity requiring at least secondary healthcare) per year during the three years prior to and the three years after T_0, as a measure of morbidity. In order to investigate if morbidity in terms of hospitalisation and specialised outpatient healthcare in the year after T_0 increased the risk of future SA and DP, we created a variable for morbidity during Y_{+1}, excluding diagnoses related to pregnancy, childbirth, and the postpartum period (ICD-10: O00-O99 pregnancy, childbirth and the puerperium, and Z30-Z39 health services in circumstances related to reproduction). We used information on main diagnoses, i.e., the diagnosis for which the patient was hospitalised or had specialised outpatient healthcare. In order to examine if morbidity in terms of hospitalisation and specialised outpatient healthcare prior to and/or after childbirth increased the risk of future SA and DP, we created variables, indicating morbidity during Y_{-3} - Y_{-1}, and/or Y_{+1} (excluding diagnoses related to pregnancy, childbirth and the postpartum period (ICD-10 codes: O00-O99 and Z30-Z39)).

The Swedish sickness absence insurance system

All residents in Sweden aged 16 or older with income from work or unemployment benefits (of at least ≈900 USD/year) can claim SA benefits in case of reduced work capacity due to disease or injury; students are also included to some extent. For employees, benefits are paid by the employer during the first 14 days, and thereafter by the Social Insurance Agency.[29] A medical certificate is required from the 8th day of the SA spell. All residents aged 19-65 years, irrespective of whether they had income earlier, can be granted DP if their work capacity is long-term or permanently reduced due to disease or injury. The SA benefits cover 80% and the DP benefit 65% of the lost income, up to a certain level. Both SA and DP may be granted for full- or part-time (25%, 50%, or 75%) of ordinary work hours. This means that people can be on part-time SA and DP at the same time. Therefore, we calculated net days, e.g., two days of 50% of SA or DP represent one net day.

All pregnant women can choose to request parental benefit 60 days before the estimated delivery date. Parental benefit is granted for 480 days for one child (in case of singleton births), with 180 additional days per child in case of multiple pregnancies. For 390 of these days, the benefit is based on the income, while for the remaining 90 days, the benefit is set to 180 SEK per day. The parental leave days may be used anytime until the child's eight birthday, by either of the child's parents, except for 60 days that were reserved to the mother and 60 days that were reserved for the father during the years under study.

Outcomes

We used the following measures of SA and DP as outcomes:

- The mean numbers of SA and DP net days/year were calculated for each of the six years Y_{-3} -Y_{+3}.

- General SA, defined as the first SA spell regardless of duration in Y_{+2} -Y_{+3}.
- Long-term SA, defined as the first SA spell of >90 net days in Y_{+2} -Y_{+3}.
- DP, defined as the first new DP spell in Y_{+2} -Y_{+3}.

Nulliparous women with miscarriages, abortions, hysterectomies, stillbirths, unsuccessful fertilization treatments were retained in the analyses and could be in any of the three groups. Women in long-term care facilities were followed with the registers similarly to women in the general population. Women who died or emigrated during the follow-up were censored when these events occurred.

Included factors

We included *age* (18-24, 25-29, 30-34, and 35-39 years), *educational level* (elementary (≤9 years + missing), high school (10-12 years), and university/college (>12 years)) in December 2004, *country of birth* (Sweden, other Northern European country, other European country and rest of the world), and *type of living area* (large city, medium-sized city and small city/rural) and previous *hospitalisation and specialised outpatient healthcare* during Y_{-1} -Y_{-3} as covariates.

Statistical analyses

We compared characteristics of the three childbirth groups by means of chi-square tests in case of categorical variables and Wilcoxon tests in case of continuous/count variables. We performed Cox proportional hazards regression models to investigate the association between childbirth, morbidity and the risks of future SA and DP. Hazard ratios (HR) and 95% confidence intervals (CI) for SA and DP were calculated. We tested the assumption of

proportional hazards with log negative log curves; there was no indication for non-proportionality of hazards. In these analyses we excluded the 21,848 women on DP before T_0 as they were not at risk of future SA or DP. Follow-up started at the beginning of Y_{+2} and ended upon the event, emigration, death, or the end of Y_{+3}, or at 31 December 201<8, whichever came first. When performing analyses with SA as the outcome, we censored also for DP during the follow-up since persons with DP are not at risk for SA. We performed crude models and models adjusted for age, educational level, country of birth, type of living area, hospitalisation and specialised outpatient healthcare before T_0. Analyses were also performed among parous women only (B1 and B1+; n=38,413) in order to examine the potential differences between women in the B1 and B1+ groups, respectively. We performed analysis regarding collinearity diagnostics between morbidity during Y_{-3} - Y_{-1} and $Y_{+1,}$ but found no strong indication for collinearity for these measures.

All analyses were conducted by SAS Statistical Software, version 9.4.

Patient and public involvement

The study participants or the general public were not involved in decisions about the research question, the design of the study, the outcomes, the conduct of the study, the drafting of the paper, nor in the dissemination of the study results.

RESULTS

Among the 492,504 women, 38,972 (7.9%) had at least one childbirth during the study period, i.e., were in the B1 or B1+ groups (Table 1). The majority of the women in B1 or B1+ were younger than 30 years and had a somewhat higher educational level than those in the B0

group. Further characteristics of the three childbirth groups are presented in Table 1. A higher proportion of the women in B1 or B1+ had at least one SA spell before and/or after T_0 than the B0 women. On the contrary, compared to women in B1 or B1+, a higher proportion of the B0 women had DP.

Table 1. Characteristics of the cohort of women[1] by childbirth group (N=492,504)

Factors	**B0** (n=453,532) n (%)	**B1** (n=14,299) n (%)	**B1+** (n=23,673) n (%)	p
Age in 2004				<0.001
18-24	257,219 (56.7)	3688 (25.8)	5284 (21.4)	
25-29	92,672 (20.4)	4593 (32.1)	10,354 (42.0)	
30-34	56,233 (12.4)	4089 (28.6)	7614 (30.9)	
35-39	47,408 (10.5)	1929 (13.5)	1421 (5.8)	
Country of birth				<0.001
Sweden	397,091 (87.6)	12,388 (86.6)	22,583 (91.5)	
Other Northern European	4873 (1.1)	200 (1.4)	237 (1.0)	
Other European countries	7432 (1.6)	213 (1.5)	242 (1.0)	
Rest of the world	44,136 (9.7)	1498 (10.5)	1611 (6.5)	
Type of living area in 2004				<0.001
Large cities	196,911 (43.4)	6260 (43.8)	10,882 (44.1)	
Medium-sized cities	161,919 (35.7)	4824 (33.7)	8425 (34.2)	
Small cities/rural	94,702 (20.9)	3215 (22.5)	5366 (21.8)	
Educational attainment in 2004				<0.001
Elementary (≤9 years)	90,510 (20.0)	1815 (12.7)	1757 (7.1)	
High school (10-12 years)	208,184 (45.9)	6751 (47.2)	9516 (38.6)	
University/college (≥13 years)	154,838 (34.1)	5733 (40.1)	13,400 (54.3)	
Family situation in 2004				<0.001
Married or cohabitant	20,295 (4.5)	3212 (22.5)	6843 (27.7)	
Single	433,237 (95.5)	11,087 (77.5)	17,830 (72.3)	
Hospitalisation (at least one day during):				

Y_{-3} - Y_{-1}	50,184 (11.1)	8074 (56.5)	13,145 (53.3)	<0.001
excluding ICD-10: O and Z30-Z39	49,040 (10.8)	1726 (12.2)	2210 (9.0)	<0.001
Y_{+1} - Y_{+3}	49,430 (10.9)	13,975 (97.7)	24,547 (99.5)	<0.001
excluding ICD-10: O and Z30-Z39	47,892 (10.6)	1691 (11.8)	1924 (7.8)	<0.001
Y_{-3} - Y_{+3}	14,865 (3.3)	7773 (54.4)	13,024 (52.8)	<0.001
excluding ICD-10: O and Z30-Z39	14,436 (3.2)	439 (3.1)	372 (1.5)	<0.001
Specialised outpatient visit (at least one visit during):				
Y_{-3} - Y_{-1}	256,677 (56.6)	12,130 (84.8)	19,916 (80.7)	<0.001
excluding ICD-10: O and Z30-Z39	254,531 (56.1)	10,286 (71.9)	16,323 (66.2)	<0.001
Y_{+1} - Y_{+3}	264,932 (58.4)	9870 (69.0)	19,625 (79.5)	<0.001
excluding ICD-10: O and Z30-Z39	261,766 (57.7)	9063 (63.4)	15,489 (62.8)	<0.001
Y_{-3} - Y_{+3}	180,667 (39.8)	8737 (61.1)	16,520 (67.0)	<0.001
excluding ICD-10: O and Z30-Z39	177,748 (39.2)	7165 (50.1)	11,376 (46.1)	<0.001
At least one sickness absence spell during:				
Y_{-3} - Y_{-1}	54,013 (11.9)	5840 (40.8)	8802 (35.7)	<0.001
Y_{+1} - Y_{+3}	61,341 (13.5)	2797 (19.6)	7447 (30.2)	<0.001
Y_{-3} - Y_{+3}	90,849 (20.0)	6740 (47.1)	11,940 (48.4)	<0.001
Disability pension any time during:				
Y_{-3} - Y_{-1}	21,289 (4.7)	351 (2.5)	208 (0.8)	<0.001
Y_{+1} - Y_{+3}	27,453 (6.1)	438 (3.1)	238 (1.0)	<0.001
Y_{-3} - Y_{+3}	28,121 (6.2)	467 (3.3)	256 (1.0)	<0.001

[1]Nulliparous women aged 18-39 in December 2004 registered as residents in Sweden in 2002-2004.

B0=No childbirth in 2005 nor in the following three years + 43 weeks; B1=First child in 2005 and no more deliveries in the following three years + 43 weeks; B1+=First child in 2005 and at least one more delivery in the following three years + 43 weeks; Y_{-3}=three years before delivery/index date; Y_{-1}=one year before delivery/index date; Y_{+1}=one year after delivery/index date; Y_{+3}=three years after delivery/index date; T_0= Delivery date, or in the B0 group: 2 July 2005.

The mean annual number of hospitalisation days and visits to specialised outpatient healthcare are presented in Figure 1. Figures 1c and 1d show that when healthcare with diagnoses for pregnancy and childbirth are excluded, women in the B1 and B1+ groups had lower number of hospitalisation days and specialised outpatient visits than women in B0, particularly the women in B1+.

Women in B1 or B1+ had more SA days during the year before T_0, especially in the B1 group (Figure 2). After T_0, the number of SA days for these women dropped rapidly to a lower level than for women in B0, that is, in that year most women had parental-leave benefits. However, in all studied years, women in B0 had a higher mean number of DP days/year than women in B1 or B1+. Women in B1+ had the lowest mean number of DP days/year compared to both B0 and B1+.

Table 2 presents crude and multivariate HR and 95% CI for the association between morbidity in Y_{+1} after T_0 and future SA among all not on DP at T_0, for each of the three childbirth groups. Those on DP at T_0 were excluded as they were not at risk of new DP or SA. First all three groups (B0, B1, and B1+) were compared, then the two childbirth groups (B1 and B1+) were compared. In the fully adjusted models, the HR of future SA was compared between the groups, using women in the B0 group with no such morbidity as reference group. In the B0 group with such morbidity, the SA risk was approximately three-fold higher in Y_{+2}-Y_{+3}. Actually, the women in B1, without morbidity in Y_{+1} had a lower risk of future SA compared to B0 women without such morbidity. Those in B1+, without morbidity at $Y_{+1,}$ had a lower risk of long-term SA (>90 days) in Y_{+2}-Y_{+3}, however, a higher risk for any SA.

Table 2. Crude and adjusted hazard ratios and 95% confidence intervals for the association between childbirth, morbidity one year after T_0 and new sickness absence in the second and third year after T_0[1]

Morbidity[2]	SA in Y_{+2}-Y_{+3} (regardless of number of SA days)				Long-term SA (>90 days) in Y_{+2}-Y_{+3}			
	Outcome	Hazard ratios (95% confidence intervals)			Outcome	Hazard ratios (95% confidence intervals)		
		Crude	Model 1[3]	Model 2[4]		Crude	Model 1[3]	Model 2[4]
All women (n=470,656)								
B0, no morbidity in Y_1[5]	39,911	1	1	1	12,614	1	1	1
B0, morbidity in Y_1[5]	3891	3.29 (3.18-3.40)	3.24 (3.14-3.35)	2.56 (2.48-2.65)	1855	4.61 (4.39-4.84)	4.51 (4.30-4.74)	3.33 (3.16-3.50)
B1, no morbidity in Y_1[5]	1837	1.45 (1.38-1.52)	1.14 (1.09-1.20)	0.81 (0.77-0.85)	590	1.46 (1.34-1.58)	1.05 (0.97-1.14)	0.68 (0.62-0.74)
B1, morbidity in Y_1[5]	153	3.61 (3.08-4.23)	2.89 (2.46-3.38)	1.87 (1.59-2.19)	81	5.66 (4.55-7.04)	4.21 (3.38-5.24)	2.43 (1.95-3.02)
B1+, no morbidity in Y_1[5]	6451	3.01 (2.93-3.09)	2.50 (2.43-2.57)	1.82 (1.77-1.87)	1212	1.67 (1.58-1.78)	1.26 (1.18-1.34)	0.84 (0.79-0.89)
B1+, morbidity in Y_1[5]	233	5.95 (5.23-6.77)	5.01 (4.40-5.69)	3.32 (2.92-3.78)	67	4.48 (3.52-5.70)	3.41 (2.68-4.34)	2.03 (1.59-2.58)
Women who had at least one childbirth (n=38,413)								
B1, no morbidity in Y_1[5]	1837	1	1	1	590	1	1	1
B1, morbidity in Y_1[5]	153	2.54 (2.15-3.00)	2.52 (2.14-2.97)	2.38 (2.02-2.81)	81	3.93 (3.12-4.96)	3.85 (3.05-4.85)	3.55 (2.81-4.48)
B1+, no morbidity in Y_1[5]	6451	2.10 (2.00-2.22)	2.17 (2.06-2.29)	2.20 (2.09-2.32)	1212	1.15 (1.04-1.27)	1.21 (1.09-1.33)	1.23 (1.11-1.36)
B1+, morbidity in Y_1[5]	233	4.26 (3.72-4.89)	4.44 (3.87-5.08)	4.23 (3.69-4.85)	67	3.10 (2.41-3.99)	3.21 (2.49-4.13)	2.99 (2.32-3.85)

T_0= Delivery date or equivalent; SA=sickness absence; Y_{+2}=two years after delivery/index date; Y_{+3}=three years after delivery/index date; B0=No childbirth in 2005 nor in the following three years + 43 weeks; B1=First child in 2005 and no more deliveries in the following three years + 43 weeks; Y_{+1}=one year after delivery/index date; B1+=First child in 2005 and at least one more delivery in the following three years + 43 weeks.

[1]Women on DP at baseline were excluded

[2]Morbidity: measured by hospitalisation and specialised outpatient visit

[3]Model 1: Adjusted for age, education, country of birth, and type of living area

[4]Model 2: Adjusted for age, education, country of birth, type of living area, and previous hospitalisation and specialised outpatient visit

[5]Diagnoses O00-O99 and Z30-Z39 were excluded.

When restricting the analyses to women in B1 and B1+ (n=38,413), those in B1+ with morbidity in Y_{+1} had a particularly high risk of any SA compared to all other groups. When again excluding those on DP at $T_{0,}$ the HR for future DP was highest in the B0 group with morbidity in $Y_{+1,}$ using the women in B0 with no morbidity in Y_{+1} as reference group (Table 3). Regardless of morbidity, parous women, particularly those in B1+, had a lower risk of DP than women in B0. When restricting the analyses to only women in B1 and B1+, morbidity was associated with having DP in Y_{+2}-$Y_{+3,}$ especially in the B1 group. That is, those with more than one birth had lower risk of DP.

Table 3. Hazard ratios and 95% confidence intervals for the association between childbirth, morbidity one year after T_0 and new disability pension in the second and third year after T_0 [1]

Morbidity[2]	Outcome	Hazard ratios and 95% confidence intervals for DP in Y_{+2}-Y_{+3}		
		Crude	Model 1[3]	Model 2[4]
All women (n=470,656)				
B0, no morbidity in Y_1[5]	5374	1	1	1
B0, morbidity in Y_1[5]	1391	7.72 (7.28-8.19)	6.88 (6.48-7.30)	4.11 (3.87-4.37)
B1, no morbidity in Y_1[5]	90	0.52 (0.42-0.64)	0.41 (0.33-0.50)	0.20 (0.16-0.24)
B1, morbidity in Y_1[5]	25	3.77 (2.55-5.59)	2.82 (1.90-4.17)	1.17 (0.79-1.73)
B1+, no morbidity in Y_1[5]	39	0.13 (0.09-0.17)	0.11 (0.08-0.16)	0.06 (0.04-0.08)
B1+, morbidity in Y_1[5]	8	1.20 (0.60-2.40)	1.01 (0.50-2.01)	0.43 (0.21-0.85)
Women who had at least one childbirth (n=38,413)				
B1, no morbidity in Y_1[5]	90	1	1	1
B1, morbidity in Y_1[5]	25	7.32 (4.70-11.40)	6.27 (4.02-9.79)	5.68 (3.63-8.87)
B1+, no morbidity in Y_1[5]	39	0.24 (0.17-0.35)	0.28 (0.19-0.41)	0.28 (0.19-0.42)
B1+, morbidity in Y_1[5]	8	2.32 (1.12-4.77)	2.30 (1.12-4.75)	2.07 (1.00-4.27)

T_0= Delivery date or among those in B0: 2 July 2005; DP=disability pension; Y_{+2}=two years after delivery/index date; Y_{+3}=three years after delivery/index date; B0=No childbirth in 2005 nor in the following three years +43 weeks; Y_{+1}=one year after delivery/index date; B1=First child in 2005 and no more deliveries in the following three years + 43 weeks; B1+=First child in 2005 and at least one more delivery in the following three years + 43 weeks.

[1]Women on DP at baseline were excluded

[2]Morbidity: measured by hospitalisation and specialised outpatient visit

[3]Model 1: Adjusted for age, education, country of birth and type of living area

[4]Model 2: Adjusted for age, education, country of birth, type of living area, and previous hospitalisation and specialised outpatient visit

[5]Diagnoses O00-O99 and Z30-Z39 were excluded.

When investigating the associations between the amount of morbidity (classified as no morbidity, morbidity before T_0, morbidity after T_0, and morbidity both before and after T_0, respectively) and the risk of SA and DP in Y_{+2}-Y_{+3} among women who gave birth, we found a gradient across these categories; there was a particularly high risk of future SA and DP among women with morbidity both before and after T_0 (Tables 4 and 5).

Table 4. Hazard ratios and 95% confidence intervals for the association between morbidity before and after the first birth and new sickness absence in the second and third year after T_0 in women who had at least one childbirth (n=38,413)[1]

Morbidity[2]	Hazard ratios and 95% confidence intervals					
	SA in Y_{+2}-Y_{+3} (regardless of the number of days)			Long-term SA (> 90 days) in Y_{+2}-Y_{+3}		
	Outcome	Crude	Model 1[3]	Outcome	Crude	Model 1[3]
No morbidity during Y_{-3}-Y_{-1} or Y_{+1}[4]	3825	1	1	742	1	1
Morbidity during Y_{-3}-Y_{-1} but not during Y_{+1}[4]	4463	1.33 (1.28-1.39)	1.34 (1.28-1.40)	1060	1.59 (1.44-1.74)	1.57 (1.42-1.72)
No morbidity during Y_{-3}-Y_{-1} but during Y_{+1}[4]	123	1.95 (1.63-2.34)	1.96 (1.64-2.35)	51	3.91 (2.94-5.19)	3.84 (2.89-5.09)
Morbidity both during Y_{-3}-Y_{-1} and Y_{+1}[4]	263	2.50 (2.21-2.83)	2.57 (2.27-2.91)	97	4.19 (3.39-5.18)	4.09 (3.31-5.06)

T_0= Delivery date or equivalent; SA=sickness absence; Y_{+2}=two years after delivery; Y_{+3}=three years after delivery; Y_{-3}=three years before delivery; Y_{-1}=one year before delivery; Y_{+1}=one year after delivery.

[1]Women on DP at baseline were excluded

[2]Morbidity: measured by hospitalisation and specialised outpatient visit

[3]Model 1: Adjusted for age, education, country of birth, and type of living area

[4]Diagnoses O00-O99 and Z30-Z39 were excluded.

Table 5. Hazard ratios and 95% confidence intervals for the association between morbidity before and after the first birth and new disability pension in the second and third year after T_0 in women who had at least one childbirth (n=38,413) [1]

Morbidity[2]	Outcome	Hazard ratios and 95% confidence intervals for DP in Y_{+2}-Y_{+3}	
		Crude	Model 1[3]
No morbidity during Y_{-3}-Y_{-1} or Y_{+1}[4]	41	1	1
Morbidity during Y_{-3}-Y_{-1} but not during Y_{+1}[4]	88	2.35 (1.62-3.41)	2.13 (1.47-3.10)
No morbidity during Y_{-3}-Y_{-1} but during Y_{+1}[4]	9	11.70 (5.69-24.06)	9.90 (4.80-20.42)
Morbidity both during Y_{-3}-Y_{-1} and Y_{+1}[4]	24	17.45 (10.54-28.87)	13.20 (7.92-21.98)

T0= Delivery date or equivalent; DP=sickness absence; Y_{+2}=two years after delivery/index date; Y_{+3}=three years after delivery/index date; Y_{-3}=three years before delivery/index date; Y_{-1}=one year before delivery/index date; Y_{+1}=one year after delivery/index date.

[1]Women on DP at baseline were excluded

[2]Model 1: Adjusted for age, education, country of birth, and type of living area

[3]Morbidity: measured by hospitalisation and specialised outpatient visit

[4]Diagnoses O00-O99 and Z30-Z39 excluded.

DISCUSSION

In this longitudinal, population-based cohort study of 492,504 women in Sweden, we investigated the associations of morbidity (i.e., hospitalisation, specialised outpatient healthcare that is not related to pregnancy, childbirth, or postpartum) with future SA and DP in our three groups of initially nulliparous women, i.e., B0, B1, and B1+. During Y_{-1} parous women had higher mean number of SA days than women in B0. This decreased gradually during the years after T_0. On the other hand, over all the six studied years the women in the B0 group had a higher number of DP days than women in B1 and B1+. When excluding those on DP at T_0, we found that morbidity was strongly associated with a higher risk of future SA and DP, regardless of childbirth status. Analyses focusing solely on women who gave birth showed that morbidity both before and after the first childbirth was associated with a particularly high risk of future SA and DP.

Research has repeatedly shown that women have a higher probability of having SA or DP than men[30 31] and pregnancy/childbirth is considered to be one of the reasons behind this difference.[11 12 19 32 33] Our results that SA days increased in Y_{-1}, that is, during pregnancy, as well as that the number became much lower in Y_{+1} (when most are on parental leave) are in line with some previous studies.[11 14 15 17 18 34] The somewhat higher levels of SA in Y_{+3} could be explained by the double-burden hypothesis which suggests that the combination of paid work and parenthood may lead to worse health.[35-38] However, several other studies have suggested that multiple roles are likely to be beneficial to women's health.[39-41] A Norwegian study also reported a higher level of SA in the years after pregnancy, which disappeared after accounting for SA during subsequent pregnancies.[38] Moreover, women who remained nulliparous had higher levels of DP than those who gave birth. Our findings also showed higher mean number of hospitalisation days among nulliparous women, indicating that there might be a health selection into pregnancy.

Women with morbidity that was not related to pregnancy, childbirth, and the postpartum period after delivery, had an overall higher risk for future SA, regardless of childbirth status than the other women. This association persisted even after adjustment for age, education, and previous morbidity. Women in B1 had a lower risk of any SA and of long-term SA than those in B0 (>90 days), whereas women who had more than one birth had a higher risk of any SA but a lower risk of long-term SA in Y_{+2}-Y_{+3}. It is likely that the new pregnancy(ies) during the follow-up time resulted in SA for women in the B1+ group. Our finding regarding an inverse association between the number of births and DP might indicate better health among the women in the B1+ group than in the other two groups. These findings are also in line with two Swedish prospective cohort studies of female twins.[17 42] Comparison of women who gave birth to one child only to those who gave birth to several children, showed similar graded associations between morbidity and future SA/DP as when we compared parous women with nulliparous women.

It has often been questioned by mass media, employers, and policy makers whether the higher SA among women – and in particular among women with small children – is due to really being ill or whether they use SA as a means to ease their "double burden" arising from work and domestic duties.[19] Nevertheless, we found that morbidity both before and after delivery was the strongest risk factor for SA and DP among women who gave birth. We observed a graded association between morbidity and SA/DP; women with morbidity before *or* after their first childbirth had a higher risk of SA and DP than those without morbidity, whereas those with morbidity both before *and* after the first childbirth had even higher risks. This suggests the presence of a dose-response association between morbidity and higher future SA/DP risk. Also this is in line with our previous studies of Swedish twin sisters.[17 42] To the best of our knowledge, this is the first study to document associations between morbidity and SA/DP

among women of childbearing age in the general population, using data on both hospitalisation and specialised outpatient healthcare as well as on number of childbirths.

Strengths and limitations

Strengths of this study include the population-based longitudinal cohort design, that all women fulfilling the inclusion criteria could be included (not only a sample) and the large cohort allowing for sub-group analyses. Other strengths are the possibility to use extensive microdata linked from several high-quality nationwide administrative registers,[43-45] instead of self-reports that are limited by, e.g., recall bias and drop-outs. It was also an advantage that all study participants could be followed from date of birth or equivalent, rather than by calendar years. The universal coverage of the Swedish public SA/DP insurance system further reduces selection bias and misclassification of the outcome. Another strength is that we could use also the National Patient Register to identify the childbirths not registered in the Medical Birth Register. Additionally, the high employment rates among women on the Swedish labour market limits[46] bias due to health selection into paid work, i.e., if a very large proportion of the population is in paid work, more persons with different type of morbidity are in paid work.

There are, however, some limitations that should be mentioned. First, some immigrant women might only have given birth before coming to Sweden; they would consequently be inappropriately categorised as nulliparous. The Medical Birth Register has information on whether the woman had previous births, also outside of Sweden, however, not the Patient Register. To reduce such misclassification, we only included women who lived in Sweden for at least three years prior to inclusion in the study. If there were any such misclassification it probably led to underestimation of SA and DP in the B0 group and does thus not affect our

conclusions. It is important to be aware of that we studied women who gave birth, irrespective of if they lived with the child or lived with other children. For instance, the child might have died or the women given it up for adoption – also, nulliparous women might live with children they did not give birth to. Another aspect is that SA spells ≤14 days were not included, something that can be seen both as a limitation and a strength. The SA spells ≤14 days only account for a limited number of all SA days and most of them are not verified by a physician certificate.[47] Furthermore, since the Patient Register includes only information on in-patient and specialised outpatient healthcare, we could not include in our definition of morbidity information from primary healthcare.

Conclusions

It has been questioned whether sickness absent women with children are actually ill or rather ease their "double burden" through claiming SA.[19] In this study we found a strong association between morbidity and both SA and DP among women of childbearing ages after controlling for morbidity before baseline and for several demographic factors. It has also been suggested that women with more children have more SA. We found the opposite; women with one birth had a lower future SA and DP risk than those who did not give birth, while those who gave birth more than once had the lowest risk of DP. Our findings may inform the debate in welfare states concerning the presence of morbidity in women on SA, in particular among women with small children.

Contributors MW conducted the analyses, wrote the first draft and revised the paper; KL contributed to interpretation of the findings and revised the paper; PS and KA contributed to the conception and design of the study, interpretation of the findings and revised the paper;

LN contribute to the interpretation of the findings, writing and revised the paper. All authors have read and approved the final version of the manuscript.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval The project was approved by the Regional Ethical Review Board of Stockholm.

Data sharing statement No additional data available.

FIGURE LEGENDS

Figure 1. Mean annual number of hospitalization days and specialized outpatient visits (with 95% confidence intervals).

Figure 2. Mean annual number of days on sickness absence and/or disability pension (with 95% confidence intervals)

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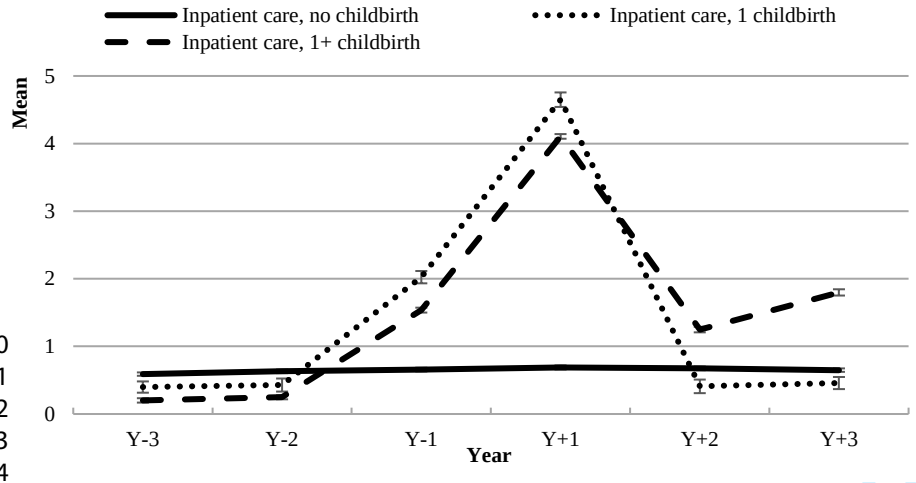
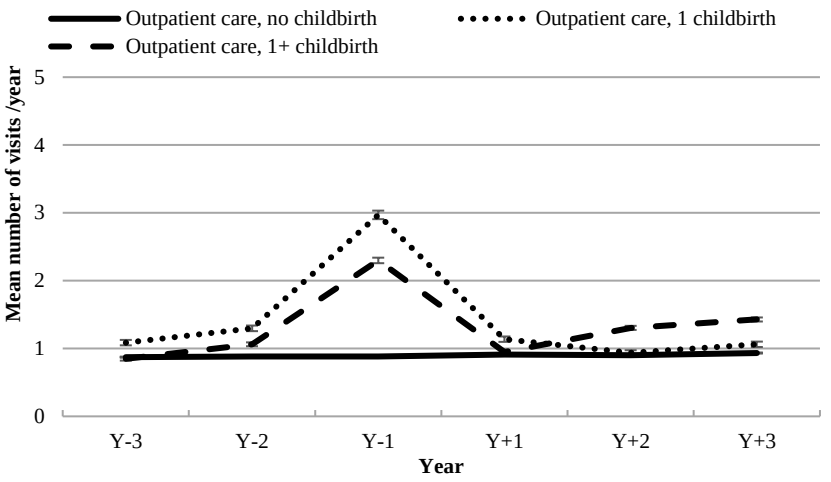
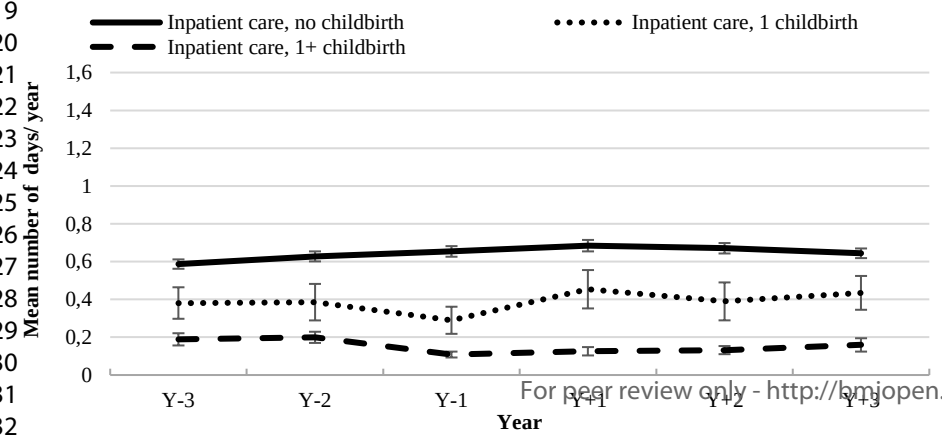
1 a) Average annual number of days with hospitalisation



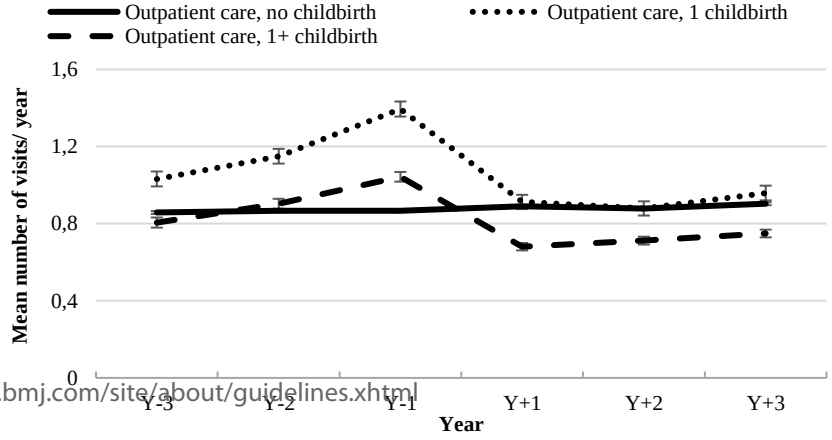
1 b) Mean annual number of specialised outpatient visits



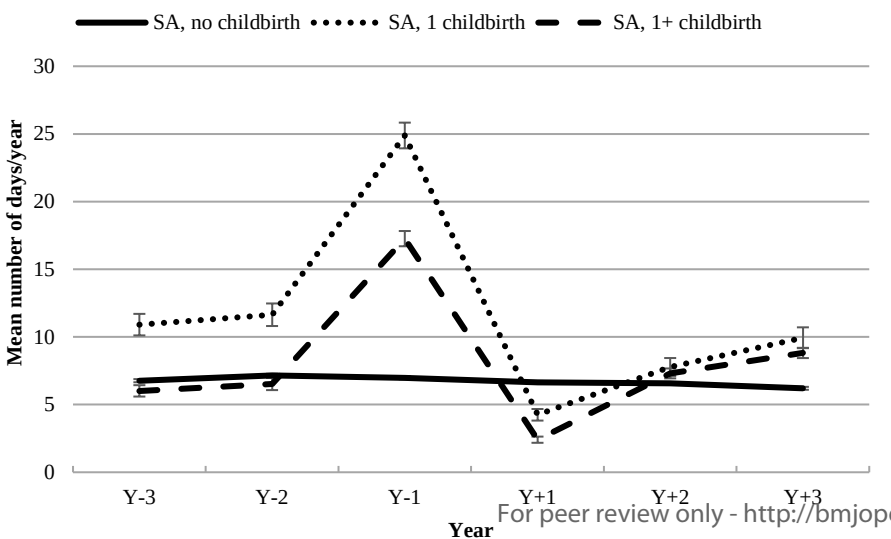
1 c) Mean annual number of days with hospitalisation (excluding hospitalisations with a diagnosis for pregnancy, childbirth and the puerperium)



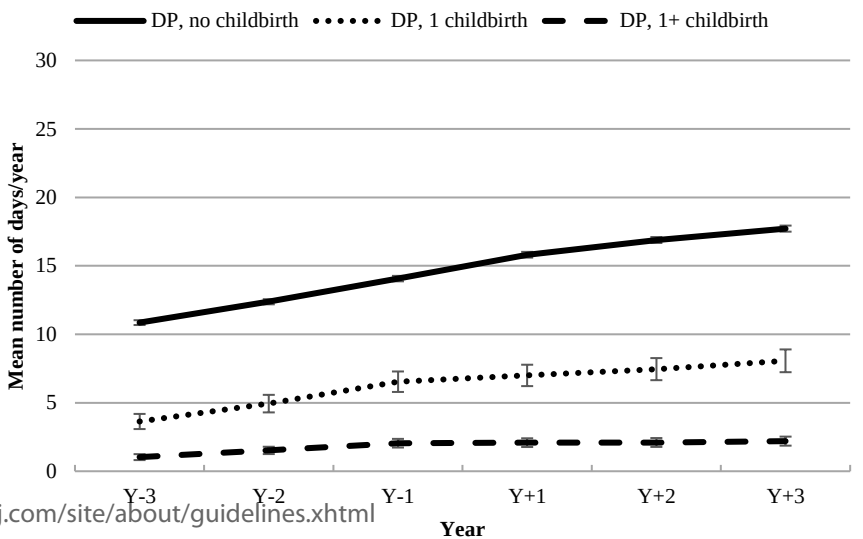
1 d) Mean annual number of specialised outpatient visits (excluding visits with a diagnosis for pregnancy, childbirth and the puerperium)



2 a) Mean annual net number of days on sickness absence (SA)



2 b) Mean annual net number of days on disability pension (DP)



STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	p. 1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p. 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p. 5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	p. 6
Methods			
Study design	4	Present key elements of study design early in the paper	p. 6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p. 6-10
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	p. 6-10
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	-
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p. 7-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p. 6-10
Bias	9	Describe any efforts to address potential sources of bias	p. 11
Study size	10	Explain how the study size was arrived at	p. 7-8, 13-14
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p. 7-10, 13-14
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p. 10-11
		(*b*) Describe any methods used to examine subgroups and interactions	p. 11
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, explain how loss to follow-up was addressed	p. 11
		(*e*) Describe any sensitivity analyses	p. 11
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	p. 7-8, 13-14
		(b) Give reasons for non-participation at each stage	p. 7-8, 13-14
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p. 13-14
		(b) Indicate number of participants with missing data for each variable of interest	p. 13-14
		(c) Summarise follow-up time (eg, average and total amount)	-
Outcome data	15*	Report numbers of outcome events or summary measures over time	Tables 2-5, Figures 1-2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted	Tables 2-5,

		estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Figures 1-2
		(*b*) Report category boundaries when continuous variables were categorized	p. 12-13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	p. 22-24
Discussion			
Key results	18	Summarise key results with reference to study objectives	p. 25
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p. 27, 28
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p. 25-28
Generalisability	21	Discuss the generalisability (external validity) of the study results	p. 27, 28
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p. 29

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Childbirth, morbidity, sickness absence, and disability pension: a population-based longitudinal cohort study in Sweden

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Childbirth, morbidity, sickness absence, and disability pension: a population-based longitudinal cohort study in Sweden

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ABSTRACT

Objective To investigate associations of morbidity with subsequent sickness absence (SA) and disability pension (DP) among initially nulliparous women with no, one, or several childbirths during follow-up.

Design Longitudinal register-based cohort study.

Setting Sweden.

Participants Nulliparous women, aged 18-39 years and living in Sweden on 31 December 2004 and the three preceding years (n=492,504).

Outcome measures Annual mean DP and SA days (in SA spells >14 days) in the three years before and after inclusion date in 2005.

Methods Women were categorised into three groups: no childbirth in 2005 nor during the follow-up, a first childbirth in 2005, but not during follow-up, and having a first childbirth in 2005 and at least one more during follow-up. Microdata were obtained for three years before and three years after inclusion regarding SA, DP, mortality, and morbidity (i.e., hospitalisation and specialised outpatient healthcare, also excluding healthcare for pregnancy, childbirth, and puerperium). Hazard ratios and 95% confidence intervals for SA and DP in year 2 and 3 after childbirth were estimated by Cox regression; excluding those on DP at inclusion.

Results After controlling for study participants' prior morbidity and sociodemographic characteristics, women with one childbirth had a lower risk of SA and DP than those who remained nulliparous, while women with more than one childbirth had the lowest DP risk. Morbidity after inclusion that was not related to pregnancy, childbirth, or the puerperium was associated with a higher risk of future SA and DP, regardless of childbirth group. Furthermore, morbidity both before and after childbirth showed a strong association with SA and DP (hazard ratio range: 2.54-13.12).

Conclusions We found a strong positive association between morbidity and both SA and DP among women, regardless of childbirth status. Those who gave birth had lower future SA and DP risk than those who did not.

Keywords: sick leave, disability pension, morbidity, cohort study, childbirth, pregnancy

Strengths and limitations of this study

- Since the study was based on nationwide population-based registers, all 492,504 women fulfilling our inclusion criteria could be included, not only a sample.
- The large cohort allowed us to perform sub-group analyses and yielded high statistical precision.
- The fact that the study was conducted in Sweden, a country characterised by high employment rate among women, limits health selection into paid work.
- We could not include information on sickness absence spells shorter than 15 days.

BACKGROUND

In societies with a high rate of female employment, women have on average a higher mean number of sickness absence (SA) days than men.[1-4] This gender difference in SA becomes more pronounced with the first pregnancy and childbirth.[5-7] Several studies among women also show a temporary increase in the number of SA days during pregnancy.[8-13] Other authors report that women living with children have higher SA than their counterparts not living with children.[14] In contrast, when including also long-term SA, in terms of disability pension (DP), we in some studies found that except for the period before childbirth, women who give birth have lower mean SA/DP days per year than those who remain nulliparous, and that those having more than one childbirth have the lowest SA/DP levels 3-10 years after the childbirth.[12 15 16]

The increase in SA in relation to pregnancy and childbirth may have several explanations. During pregnancy and the puerperium women experience profound endocrine, immune, metabolic, and cardiovascular changes.[17 18] The pregnancy-related immune changes increase susceptibility to infectious diseases and to more complicated courses in case of common infections. Immune changes affect also the activity of several autoimmune diseases, e.g., in case of some disorders (such as rheumatoid arthritis, multiple sclerosis, Graves disease, Hashimoto thyroiditis) there is an improvement during pregnancy and a worsening postpartum, while for others (such as systemic lupus erythematosus, systemic sclerosis) there is an inverse manifestation.[19] Pregnancy and the postpartum period are considered a "stress test of life", i.e., several diseases presenting first during this period may reveal the individual's susceptibility to later disorders, e.g. diabetes, psychiatric, or cardiovascular diseases.[18 20-23] Furthermore, the antenatal care and the screening for several disorders during pregnancy may increase women's chance to be diagnosed during this period with pre-existing, undetected chronic conditions. A substantial proportion of women suffer from common

pregnancy-related symptoms and disorders[18 24] such as fatigue, headache, bowel problems, sleep-related problems, depression, urinary incontinence, back pain, and pelvic pain,[25-27] which may also contribute to SA during pregnancy.

Mass media, employers, policy makers, and researchers have questioned whether the higher SA among women with children is indeed due to higher morbidity, or rather to individual choices, related to wanting to stay home and handle domestic duties than to be in paid work.[28] To the best of our knowledge, only one previous study investigated associations between morbidity and SA/DP among women giving and not giving birth. In a cohort of Swedish twin sisters (n=5118) they found a strong association between morbidity, measured in terms of hospitalisation, and the risk of SA and DP.[29] To what extent findings from this selected and rather small group of twin sisters are generalizable to the total population is unclear. Also, it would be of interest to include wider information on morbidity than hospitalisation in such analyses. Most people with morbidity are not on SA or DP and knowledge about the associations between morbidity and SA or DP is in general limited.[28 30-35]

Thus, the aim of this study was to investigate, in a nationwide population-based cohort, the associations of morbidity, assessed in terms of hospitalisation and specialised outpatient healthcare, with subsequent SA and DP among initially nulliparous women with no, one, or several childbirths during follow-up.

METHODS

This longitudinal population-based cohort study was based on nationwide register microdata, linked by the unique personal identity number assigned to all residents in Sweden.[36] Anonymised data from the following six registers, kept by three authorities, were used:

- From Statistics Sweden: The Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA)[37] for information on sociodemographics and year of migration.

- From the National Board of Health and Welfare: 1) The Medical Birth Register to obtain information on date of deliveries and parity. It covers 97-99% of all births in Sweden since 1973; 2) The National In-Patient Register (established in 1964 and nationwide since 1987) for information on childbirths not included in the Medical Birth Register (date and diagnoses) and information on hospitalisations due to other causes (date and main and secondary diagnoses). If a delivery appeared in both registers, the information from the Medical Birth Register was used; 3) The National Out-Patient Register (established in 2001) for information on specialised outpatient healthcare (date and main diagnoses); 4) The Causes of Death Register for date of death.

- From the Swedish Social Insurance Agency, for information from the Micro-data for Analyses of Social Insurance (MiDAS) Register, on SA spells >14 days and on DP (dates and extent) for the period 2002-2008.

Study population

All women aged 18-39 years who had not given birth prior to 1 January 2005 and who lived in Sweden during the period 2002-2004 were included. The limits were based on the frequency distribution of age among primiparous women in Sweden; very few women had their first child before the age of 18 or after the age of 39 years. The lower age limit of 18 also means that all had at least a chance to have had SA before inclusion (not possible before the age of 16). Women in the extremes were analyzed similarly to women of other ages. Study participants were categorised according to whether they gave birth in 2005 and during the follow-up for three years (Y_{+1} - Y_{+3}), from date of delivery (T_0). As the outcomes (SA and

DP) might be influenced by a new pregnancy, all women were followed for an additional 43 weeks after end of Y_{+3}.

The women were categorised into three groups, according to future childbirth:

• **B0**: Women having no childbirth registered during follow-up (Y_{+1} - Y_{+3}) nor during the subsequent 43 weeks.

• **B1**: Women having their first childbirth in 2005 and no more births during follow-up (Y_{+1} - Y_{+3}) or the subsequent 43 weeks.

• **B1+**: Women having their first childbirth in 2005 and at least one more birth during follow-up (Y_{+1} - Y_{+3}) or the subsequent 43 weeks.

Childbirth in the Patient Register was defined by main or secondary diagnoses according to the International Classification of Disease (ICD-10)[38]: O80-84 delivery, O75.7 vaginal delivery following previous caesarean section, O75.8 other specified complications of labour and delivery, and O75.9 complication of labour and delivery, unspecified.
For the women in B1 and B1+, the date of birth was used for T_0, for the women in B0, T_0 was set to 2 July 2005 (i.e., the middle of the year). The final cohort included 492,504 women.

Morbidity

We measured morbidity in different ways. One was to calculate the mean number of hospitalisation days and of specialised outpatient visits (i.e., morbidity requiring at least secondary healthcare) per year during the three years prior to and the three years after the date of T_0. Another was the occurrence of any hospitalisation and/or specialised outpatient healthcare in the years before T_0 (Y_{-3}-Y_{-1}), in the year after T_0 (Y_{+1}), and in the three years after T_0 (Y_{+1} - Y_{+3}), respectively. All those measures were calculated for all such secondary

healthcare, excluding visits due to screening for diseases, etc. (ICD-10 codes Z00-2 and Z10-13). The same measures were derived when having excluded such healthcare for diagnoses related to pregnancy, childbirth, and the postpartum period (ICD-10: O00-O99 pregnancy, childbirth and the puerperium, and Z30-Z39 health services in circumstances related to reproduction). For the exclusions we used information on main diagnoses, i.e., the diagnosis for which the patient was hospitalised or had specialised outpatient healthcare.

The Swedish sickness absence insurance system

All residents in Sweden aged 16 or older with income from work or unemployment benefits (of at least ≈900 USD/year) can claim SA benefits in case of reduced work capacity due to disease or injury; students are also included to some extent. For employees, benefits are paid by the employer during the first 14 days, and thereafter by the Social Insurance Agency.[39] A medical certificate is required from the 8th day of the SA spell. All residents aged 19-65 years, irrespective of whether they had income earlier, can be granted DP if their work capacity is long-term or permanently reduced due to disease or injury. The SA benefits cover 80% and the DP benefit 65% of the lost income, up to a certain level. Both SA and DP may be granted for full- or part-time (25%, 50%, or 75%) of ordinary work hours. This means that people can be on part-time SA and DP at the same time. Therefore, we calculated net days, e.g., two days of 50% of SA or DP represent one net day.

All pregnant women can choose to request parental benefit 60 days before the estimated delivery date. Parental benefit is granted for 480 days for one child (in case of singleton births), with 180 additional days per child in case of multiple pregnancies. For 390 of these days, the benefit is based on the income, while for the remaining 90 days, the benefit is set to 180 SEK per day. The parental leave days may be used anytime until the child's eight birthday, by either of the child's parents, except for 60 days that were reserved to the mother

and 60 days that were reserved for the father during the years under study. If a parent on parental leave is too ill to care for the child, he/she may apply for SA, and thus be on SA instead of parental leave while someone else takes care of the child.

Outcomes

We used the following measures of SA and DP as outcomes:

- The mean numbers of SA and DP net days/year were calculated for each of the six years Y_{-3} -Y_{+3}.
- General SA, defined as the first SA spell regardless of duration in Y_{+2} -Y_{+3}.
- Long-term SA, defined as the first SA spell of >90 net days in Y_{+2} -Y_{+3}.
- DP, defined as the first new DP spell in Y_{+2} -Y_{+3}.

Nulliparous women with miscarriages, abortions, hysterectomies, stillbirths, unsuccessful fertilization treatments were retained in the analyses and could be in any of the three groups. Women in long-term care facilities were followed with the registers similarly to women in the general population. Women who died or emigrated during the follow-up were censored when these events occurred.

Included factors

We included *age* (18-24, 25-29, 30-34, and 35-39 years), *educational level* (elementary (≤9 years + missing), high school (10-12 years), and university/college (>12 years)) in December 2004, *country of birth* (Sweden, other Northern European country, other European country and rest of the world), and *type of living area* (large city, medium-sized city, and small

city/rural) and previous *hospitalisation and specialised outpatient healthcare* during Y_{-1} -Y_{-3} as covariates.

Statistical analyses

We compared characteristics of the three childbirth groups by means of chi-square tests in case of categorical variables and Wilcoxon tests in case of continuous/count variables. We performed Cox proportional hazards regression models to investigate associations between the combinations of childbirth, morbidity, and the risks of future SA and DP. Hazard ratios (HR) and 95% confidence intervals (CI) for SA and DP were calculated. We tested the assumption of proportional hazards with log negative log curves; there was no indication for non-proportionality of hazards. In these analyses we excluded the 21,848 women on DP before T_0 as they were not at risk of future SA or DP. Follow-up started at the beginning of Y_{+2} and ended upon the event, emigration, death, or the end of Y_{+3}, or at 31 December 2018, whichever came first. When performing analyses with SA as the outcome, we censored also for DP during the follow-up since persons with DP are not at risk for SA. We performed crude models and models adjusted for age, educational level, country of birth, type of living area, hospitalisation and specialised outpatient healthcare before T_0. Analyses were also performed among parous women only (B1 and B1+; n=38,413) in order to examine the potential differences between women in the B1 and B1+ groups, respectively. We performed analysis regarding collinearity diagnostics between morbidity during Y_{-3} - Y_{-1} and $Y_{+1,}$ but found no strong indication for collinearity for these measures.

All analyses were conducted by SAS Statistical Software, version 9.4.

Patient and public involvement

The study participants or the general public were not involved in decisions about the research question, the design of the study, the outcomes, the conduct of the study, the drafting of the paper, nor in the dissemination of the study results.

RESULTS

Among the 492,504 women, 38,972 (7.9%) had at least one childbirth during the study period, i.e., were in the B1 or B1+ groups (Table 1). The majority of the women in B1 or B1+ were younger than 30 years and had a somewhat higher educational level than those in the B0 group. Further characteristics of the three childbirth groups are presented in Table 1. A higher proportion of the women in B1 or B1+ had at least one SA spell before and/or after T_0 than the B0 women. On the contrary, compared to women in B1 or B1+, a higher proportion of the B0 women had DP.

Table 1. Characteristics of the cohort of women[1] by childbirth group (N=492,504)

Factors	**B0** (n=453,532)	**B1** (n=14,299)	**B1+** (n=23,673)	p-value[2]
	n (%)	n (%)	n (%)	
Age in 2004				<0.001
18-24	257,219 (56.7)	3688 (25.8)	5284 (21.4)	
25-29	92,672 (20.4)	4593 (32.1)	10,354 (42.0)	
30-34	56,233 (12.4)	4089 (28.6)	7614 (30.9)	
35-39	47,408 (10.5)	1929 (13.5)	1421 (5.8)	
Country of birth				<0.001
Sweden	397,091 (87.6)	12,388 (86.6)	22,583 (91.5)	
Other Northern European	4873 (1.1)	200 (1.4)	237 (1.0)	
Other European countries	7432 (1.6)	213 (1.5)	242 (1.0)	
Rest of the world	44,136 (9.7)	1498 (10.5)	1611 (6.5)	
Type of living area in 2004				<0.001
Large cities	196,911 (43.4)	6260 (43.8)	10,882 (44.1)	
Medium-sized cities	161,919 (35.7)	4824 (33.7)	8425 (34.2)	
Small cities/rural	94,702 (20.9)	3215 (22.5)	5366 (21.8)	
Educational attainment in 2004				<0.001
Elementary (≤9 years)	90,510 (20.0)	1815 (12.7)	1757 (7.1)	
High school (10-12 years)	208,184 (45.9)	6751 (47.2)	9516 (38.6)	
University/college (≥13 years)	154,838 (34.1)	5733 (40.1)	13,400 (54.3)	
Family situation in 2004				<0.001
Married or cohabitant	20,295 (4.5)	3212 (22.5)	6843 (27.7)	
Single	433,237 (95.5)	11,087 (77.5)	17,830 (72.3)	
Hospitalisation (at least one day during):				

Y_{-3} - Y_{-1}	50,184 (11.1)	8074 (56.5)	13,145 (53.3)	<0.001
excluding ICD-10: O and Z30-Z39	49,040 (10.8)	1726 (12.2)	2210 (9.0)	<0.001
Y_{+1} - Y_{+3}	49,430 (10.9)	13,975 (97.7)	24,547 (99.5)	<0.001
excluding ICD-10: O and Z30-Z39	47,892 (10.6)	1691 (11.8)	1924 (7.8)	<0.001
Y_{-3} - Y_{+3}	14,865 (3.3)	7773 (54.4)	13,024 (52.8)	<0.001
excluding ICD-10: O and Z30-Z39	14,436 (3.2)	439 (3.1)	372 (1.5)	<0.001
Specialised outpatient visit (at least one visit during):				
Y_{-3} - Y_{-1}	256,677 (56.6)	12,130 (84.8)	19,916 (80.7)	<0.001
excluding ICD-10: O and Z30-Z39	254,531 (56.1)	10,286 (71.9)	16,323 (66.2)	<0.001
Y_{+1} - Y_{+3}	264,932 (58.4)	9870 (69.0)	19,625 (79.5)	<0.001
excluding ICD-10: O and Z30-Z39	261,766 (57.7)	9063 (63.4)	15,489 (62.8)	<0.001
Y_{-3} - Y_{+3}	180,667 (39.8)	8737 (61.1)	16,520 (67.0)	<0.001
excluding ICD-10: O and Z30-Z39	177,748 (39.2)	7165 (50.1)	11,376 (46.1)	<0.001
At least one sickness absence spell during:				
Y_{-3} - Y_{-1}	54,013 (11.9)	5840 (40.8)	8802 (35.7)	<0.001
Y_{+1} - Y_{+3}	61,341 (13.5)	2797 (19.6)	7447 (30.2)	<0.001
Y_{-3} - Y_{+3}	90,849 (20.0)	6740 (47.1)	11,940 (48.4)	<0.001
Disability pension any time during:				
Y_{-3} - Y_{-1}	21,289 (4.7)	351 (2.5)	208 (0.8)	<0.001
Y_{+1} - Y_{+3}	27,453 (6.1)	438 (3.1)	238 (1.0)	<0.001
Y_{-3} - Y_{+3}	28,121 (6.2)	467 (3.3)	256 (1.0)	<0.001

[1]Nulliparous women aged 18-39 in December 2004 registered as residents in Sweden in 2002-2004.

[2]The p-value corresponds to chi-square tests in case of categorical variables and to Wilcoxon tests in case of continuous/count variables.

B0=No childbirth in 2005 nor in the following three years + 43 weeks; B1=First child in 2005 and no more deliveries in the following three years + 43 weeks; B1+=First child in 2005 and at least one more delivery in the following three years + 43 weeks; Y_{-3}=three years before delivery/index date; Y_{-1}=one year before delivery/index date; Y_{+1}=one year after delivery/index date; Y_{+3}=three years after delivery/index date; T_0= Delivery date, or in the B0 group: 2 July 2005.

The mean annual number of hospitalisation days and visits to specialised outpatient healthcare are presented in Figure 1. Figures 1c shows that when healthcare with diagnoses for pregnancy and childbirth are excluded, women in the B1 and B1+ groups had lower number of hospitalisation days than women in B0, particularly the women in B1+; outside the period of pregnancy, women in B1+ had a lower number of specialised outpatient visits than women in B0 (figure 1d).

Women in B1 or B1+ had more SA days during the year before T_0, especially in the B1 group (Figure 2). After T_0, the number of SA days for these women dropped rapidly to a lower level than for women in B0, that is, in that year most women were on parental-leave benefits. However, in all studied years, women in B0 had a higher mean number of DP days/year than women in B1 or B1+. Women in B1+ had the lowest mean number of DP days/year compared to both B0 and B1+.

Table 2 presents crude and multivariate HR and 95% CI for the association between morbidity in Y_{+1} after T_0 and future SA among all not on DP at T_0, for each of the three childbirth groups. Those on DP at T_0 were excluded as they were not at risk of new DP or SA. First all three groups (B0, B1, and B1+) were compared, then the two childbirth groups (B1 and B1+) were compared. In the fully adjusted models, the HR of future SA was compared between the groups, using women in the B0 group with no such morbidity as reference group. In the B0 group with such morbidity, the SA risk was approximately three-fold higher in Y_{+2}-Y_{+3}. Actually, the women in B1, without morbidity in Y_{+1} had a lower risk of future SA compared to B0 women without such morbidity. Those in B1+, without morbidity at $Y_{+1,}$ had a lower risk of long-term SA (>90 days) in Y_{+2}-Y_{+3}, however, a higher risk for any SA.

Table 2. Crude and adjusted hazard ratios and 95% confidence intervals for the association between childbirth, morbidity one year after T_0 and new sickness absence in the second and third year after T_0[1]

Morbidity[2]	SA in Y_{+2}-Y_{+3} (regardless of number of SA days)				Long-term SA (>90 days) in Y_{+2}-Y_{+3}			
	N/Outcome	Hazard ratios (95% confidence intervals)			N/Outcome	Hazard ratios (95% confidence intervals)		
		Crude	Model 1[3]	Model 2[4]		Crude	Model 1[3]	Model 2[4]
All women (n=470,656)								
B0, no morbidity in Y_{+1}[5]	417,592/39,911	1	1	1	417,592/12,614	1	1	1
B0, morbidity in Y_{+1}[5]	14,651/3891	3.29 (3.18-3.40)	3.24 (3.14-3.35)	2.56 (2.48-2.65)	14,651/1855	4.61 (4.39-4.84)	4.51 (4.30-4.74)	3.33 (3.16-3.50)
B1, no morbidity in Y_{+1}[5]	13,425/1837	1.45 (1.38-1.52)	1.14 (1.09-1.20)	0.81 (0.77-0.85)	13,425/590	1.46 (1.34-1.58)	1.05 (0.97-1.14)	0.68 (0.62-0.74)
B1, morbidity in Y_{+1}[5]	523/153	3.61 (3.08-4.23)	2.89 (2.46-3.38)	1.87 (1.59-2.19)	523/81	5.66 (4.55-7.04)	4.21 (3.38-5.24)	2.43 (1.95-3.02)
B1+, no morbidity in Y_{+1}[5]	23,947/6451	3.01 (2.93-3.09)	2.50 (2.43-2.57)	1.82 (1.77-1.87)	23,947/1212	1.67 (1.58-1.78)	1.26 (1.18-1.34)	0.84 (0.79-0.89)
B1+, morbidity in Y_{+1}[5]	518/233	5.95 (5.23-6.77)	5.01 (4.40-5.69)	3.32 (2.92-3.78)	518/67	4.48 (3.52-5.70)	3.41 (2.68-4.34)	2.03 (1.59-2.58)
Women who had at least one childbirth (n=38,413)		§						
B1, no morbidity in Y_{+1}[5]	13,425/1837	1	1	1	13,425/590	1	1	1
B1, morbidity in Y_{+1}[5]	523/153	2.54 (2.15-3.00)	2.52 (2.14-2.97)	2.38 (2.02-2.81)	523/81	3.93 (3.12-4.96)	3.85 (3.05-4.85)	3.55 (2.81-4.48)
B1+, no morbidity in Y_{+1}[5]	23,947/6451	2.10 (2.00-2.22)	2.17 (2.06-2.29)	2.20 (2.09-2.32)	23,947/1212	1.15 (1.04-1.27)	1.21 (1.09-1.33)	1.23 (1.11-1.36)
B1+, morbidity in Y_{+1}[5]	518/233	4.26 (3.72-4.89)	4.44 (3.87-5.08)	4.23 (3.69-4.85)	518/67	3.10 (2.41-3.99)	3.21 (2.49-4.13)	2.99 (2.32-3.85)

T_0= Delivery date or equivalent; SA=sickness absence; Y_{+2}=two years after delivery/index date; Y_{+3}=three years after delivery/index date; B0=No childbirth in 2005 nor in the following three years + 43 weeks; B1=First child in 2005 and no more deliveries in the following three years + 43 weeks; Y_{+1}=one year after delivery/index date; B1+=First child in 2005 and at least one more delivery in the following three years + 43 weeks.

[1]Women on DP at baseline were excluded

[2]Morbidity: measured by hospitalisation and specialised outpatient visit

[3]Model 1: Adjusted for age, education, country of birth, and type of living area

[4]Model 2: Adjusted for age, education, country of birth, type of living area, and previous hospitalisation and specialised outpatient visit

[5]Diagnoses O00-O99 and Z30-Z39 were excluded.

When restricting the analyses to those who had given birth, that is, to the women in B1 and B1+ (n=38,413), those in B1+ with morbidity in Y_{+1} had a particularly high risk of any SA compared to all other groups. When again excluding those on DP at $T_{0,}$ the HR for future DP was highest in the B0 group with morbidity in $Y_{+1,}$ using the women in B0 with no morbidity in Y_{+1} as reference group (Table 3). Regardless of morbidity, parous women, particularly those in B1+, had a lower risk of DP than women in B0. When restricting the analyses to only women in B1 and B1+, morbidity was associated with having DP in Y_{+2}-$Y_{+3,}$ especially in the B1 group. That is, those with more than one birth had lower risk of DP.

Table 3. Hazard ratios and 95% confidence intervals for the association between childbirth, morbidity one year after T_0 and new disability pension in the second and third year after T_0 [1]

Morbidity[2]	N/Outcome	Hazard ratios and 95% confidence intervals for DP in Y_{+2}-Y_{+3}		
		Crude	Model 1[3]	Model 2[4]
All women (n=470,656)				
B0, no morbidity in Y_{+1}[5]	417,592/5374	1	1	1
B0, morbidity in Y_{+1}[5]	14,651/1391	7.72 (7.28-8.19)	6.88 (6.48-7.30)	4.11 (3.87-4.37)
B1, no morbidity in Y_{+1}[5]	13,425/90	0.52 (0.42-0.64)	0.41 (0.33-0.50)	0.20 (0.16-0.24)
B1, morbidity in Y_{+1}[5]	523/25	3.77 (2.55-5.59)	2.82 (1.90-4.17)	1.17 (0.79-1.73)
B1+, no morbidity in $Y+_1$[5]	23,947/39	0.13 (0.09-0.17)	0.11 (0.08-0.16)	0.06 (0.04-0.08)
B1+, morbidity in Y_{+1}[5]	518/8	1.20 (0.60-2.40)	1.01 (0.50-2.01)	0.43 (0.21-0.85)
Women who had at least one childbirth (n=38,413)				
B1, no morbidity in Y_{+1}[5]	13,425/90	1	1	1
B1, morbidity in Y_{+1}[5]	523/25	7.32 (4.70-11.40)	6.27 (4.02-9.79)	5.68 (3.63-8.87)
B1+, no morbidity in Y_{+1}[5]	23,947/39	0.24 (0.17-0.35)	0.28 (0.19-0.41)	0.28 (0.19-0.42)
B1+, morbidity in Y_{+1}[5]	518/8	2.32 (1.12-4.77)	2.30 (1.12-4.75)	2.07 (1.00-4.27)

T_0= Delivery date or among those in B0: 2 July 2005; DP=disability pension; Y_{+2}=two years after delivery/index date; Y_{+3}=three years after delivery/index date; B0=No childbirth in 2005 nor in the following three years +43 weeks; Y_{+1}=one year after delivery/index date; B1=First child in 2005 and no more deliveries in the following three years + 43 weeks; B1+=First child in 2005 and at least one more delivery in the following three years + 43 weeks.

[1]Women on DP at baseline were excluded

[2]Morbidity: measured by hospitalisation and specialised outpatient visit

[3]Model 1: Adjusted for age, education, country of birth and type of living area

[4]Model 2: Adjusted for age, education, country of birth, type of living area, and previous hospitalisation and specialised outpatient visit

[5]Diagnoses O00-O99 and Z30-Z39 were excluded.

When investigating the associations between the amount of morbidity (classified as no morbidity, morbidity before T_0, morbidity after T_0, and morbidity both before and after T_0, respectively) and the risk of SA and DP in Y_{+2}-Y_{+3} among women who gave birth, we found a gradient across these categories; there was a particularly high risk of future SA and DP among women with morbidity both before and after T_0 (Tables 4 and 5).

Table 4. Hazard ratios and 95% confidence intervals for the association between morbidity before and after the first birth and new sickness absence in the second and third year after T_0 in women who had at least one childbirth (n=38,413)[1]

Morbidity[2]	Hazard ratios and 95% confidence intervals					
	SA in Y_{+2}-Y_{+3} (regardless of the number of days)			Long-term SA (> 90 days) in Y_{+2}-Y_{+3}		
	N/Outcome	Crude	Model 1[3]	N/Outcome	Crude	Model 1[3]
No morbidity during Y_{-3}-Y_{-1} or Y_{+1}[4]	19,531/3825	1	1	19,531/742	1	1
Morbidity during Y_{-3}-Y_{-1} but not during Y_{+1}[4]	17,841/4463	1.33 (1.28-1.39)	1.34 (1.28-1.40)	17,841/1060	1.59 (1.44-1.74)	1.57 (1.42-1.72)
No morbidity during Y_{-3}-Y_{-1} but during Y_{+1}[4]	373/123	1.95 (1.63-2.34)	1.96 (1.64-2.35)	373/51	3.91 (2.94-5.19)	3.84 (2.89-5.09)
Morbidity both during Y_{-3}-Y_{-1} and Y_{+1}[4]	668/263	2.50 (2.21-2.83)	2.57 (2.27-2.91)	668/97	4.19 (3.39-5.18)	4.09 (3.31-5.06)

T_0= Delivery date or equivalent; SA=sickness absence; Y_{+2}=two years after delivery; Y_{+3}=three years after delivery; Y_{-3}=three years before delivery; Y_{-1}=one year before delivery; Y_{+1}=one year after delivery.

[1]Women on DP at baseline were excluded

[2]Morbidity: measured by hospitalisation and specialised outpatient visit

[3]Model 1: Adjusted for age, education, country of birth, and type of living area

[4]Diagnoses O00-O99 and Z30-Z39 were excluded.

Table 5. Hazard ratios and 95% confidence intervals for the association between morbidity before and after the first birth and new disability pension in the second and third year after T_0 in women who had at least one childbirth (n=38,413) [1]

Morbidity[2]	N/Outcome	Hazard ratios and 95% confidence intervals for DP in Y_{+2}-Y_{+3}	
		Crude	Model 1[3]
No morbidity during Y_{-3}-Y_{-1} or Y_{+1}[4]	19,531/41	1	1
Morbidity during Y_{-3}-Y_{-1} but not during Y_{+1}[4]	17,841/88	2.35 (1.62-3.41)	2.13 (1.47-3.10)
No morbidity during Y_{-3}-Y_{-1} but during Y_{+1}[4]	373/9	11.70 (5.69-24.06)	9.90 (4.80-20.42)
Morbidity both during Y_{-3}-Y_{-1} and Y_{+1}[4]	668/24	17.45 (10.54-28.87)	13.20 (7.92-21.98)

T0=Delivery date or equivalent; DP=sickness absence; Y_{+2}=two years after delivery/index date; Y_{+3}=three years after delivery/index date; Y_{-3}=three years before delivery/index date; Y_{-1}=one year before delivery/index date; Y_{+1}=one year after delivery/index date.

[1]Women on DP at baseline were excluded

[2]Model 1: Adjusted for age, education, country of birth, and type of living area

[3]Morbidity: measured by hospitalisation and specialised outpatient visit

[4]Diagnoses O00-O99 and Z30-Z39 excluded.

DISCUSSION

In this longitudinal, population-based cohort study of 492,504 women in Sweden, we investigated the associations of morbidity (i.e., hospitalisation, specialised outpatient healthcare that is not related to pregnancy, childbirth, or postpartum) with future SA and DP in our three groups of initially nulliparous women, i.e., B0, B1, and B1+. During Y_{-1} parous women had higher mean number of SA days than women in B0. This decreased gradually during the years after T_0. On the other hand, over all the six studied years the women in the B0 group had a higher number of DP days than women in B1 and B1+. When excluding those on DP at T_0, we found that morbidity was strongly associated with a higher risk of future SA and DP, regardless of childbirth status. Analyses focusing solely on women who gave birth showed that morbidity both before and after the first childbirth was associated with a particularly high risk of future SA and DP.

Research has repeatedly shown that women have a higher probability of having SA or DP than men[40 41] and pregnancy/childbirth is considered to be one of the reasons behind this difference.[6 7 28 42 43] Our results that SA days increased in Y_{-1}, that is, during pregnancy, as well as that the number became much lower in Y_{+1} (when most are on parental leave) are in line with some previous studies.[6 12 15 29 44 45] The somewhat higher levels of SA in Y_{+3} could be explained by the double-burden hypothesis which suggests that the combination of paid work and parenthood may lead to worse health.[46-49] However, several other studies have suggested that multiple roles are likely to be beneficial to women's health.[50-52] A Norwegian study also reported a higher level of SA in the years after pregnancy, which disappeared after accounting for SA during subsequent pregnancies.[49] Moreover, women who remained nulliparous had higher levels of DP than those who gave birth. Our findings also showed higher mean number of hospitalisation days among nulliparous women, indicating that there might be a health selection into pregnancy.

Women with morbidity that was not related to pregnancy, childbirth, and the postpartum period after delivery, had an overall higher risk for future SA, regardless of childbirth status than the other women. This association persisted even after adjustment for age, education, and previous morbidity. Women in B1 had a lower risk of any SA and of long-term SA than those in B0 (>90 days), whereas women who had more than one birth had a higher risk of any SA but a lower risk of long-term SA in Y_{+2}-Y_{+3}. It is likely that the new pregnancy(ies) during the follow-up time resulted in SA for women in the B1+ group. Our finding regarding an inverse association between the number of births and DP might indicate better health among the women in the B1+ group than in the other two groups. These findings are also in line with two Swedish prospective cohort studies of female twins.[11 29] Comparison of women who gave birth to one child only to those who gave birth to several children, showed similar graded associations between morbidity and future SA/DP as when we compared parous women with nulliparous women.

It has often been questioned by mass media, employers, and policy makers whether the higher SA among women – and in particular among women with small children – is due to really being ill or whether they use SA as a means to ease their "double burden" arising from work and domestic duties.[28] Nevertheless, we found that morbidity both before and after delivery was the strongest risk factor for SA and DP among women who gave birth. We observed a graded association between morbidity and SA/DP; women with morbidity before *or* after their first childbirth had a higher risk of SA and DP than those without morbidity, whereas those with morbidity both before *and* after the first childbirth had even higher risks. This suggests the presence of a dose-response association between morbidity and higher future SA/DP risk. Also this is in line with our previous studies of Swedish twin sisters.[11 29] To the best of our knowledge, this is the first study to document associations between morbidity and SA/DP

among women of childbearing age in the general population, using data on both hospitalisation and specialised outpatient healthcare as well as on number of childbirths.

Strengths and limitations

Strengths of this study include the population-based longitudinal cohort design, that all women fulfilling the inclusion criteria could be included (not only a sample), and the large cohort allowing for sub-group analyses. Other strengths are the possibility to use extensive microdata linked from several high-quality nationwide administrative registers,[53-55] instead of self-reports that are limited by, e.g., recall bias and drop-outs. It was also an advantage that all study participants could be followed from date of birth or equivalent, rather than by calendar years. The universal coverage of the Swedish public SA/DP insurance system further reduces selection bias and misclassification of the outcome. Another strength is that we could use also the National Patient Register to identify the childbirths not registered in the Medical Birth Register. Additionally, the high employment rates among women on the Swedish labour market limits[56] bias due to health selection into paid work, i.e., if a very large proportion of the population is in paid work, more persons with different type of morbidity are in paid work.

There are, however, some limitations that should be mentioned. First, some immigrant women might only have given birth before coming to Sweden; they would consequently be inappropriately categorised as nulliparous. The Medical Birth Register has information on whether the woman had previous births, also outside of Sweden, however, not the Patient Register. To reduce such misclassification, we only included women who lived in Sweden for at least three years prior to inclusion in the study. If there were any such misclassification it probably led to underestimation of SA and DP in the B0 group and does thus not affect our

conclusions. It is important to be aware of that we studied women who gave birth, irrespective of if they lived with the child or lived with other children. For instance, the child might have died or the women given it up for adoption – also, nulliparous women might live with children they did not give birth to. Another aspect is that SA spells ≤14 days were not included, something that can be seen both as a limitation and a strength. The SA spells ≤14 days only account for a limited number of all SA days and most of them are not verified by a physician certificate.[57] Furthermore, since the Patient Register includes only information on in-patient and specialised outpatient healthcare, we could not include in our definition of morbidity information from primary healthcare.

Conclusions

It has been questioned whether sickness absent women with children are actually ill or rather ease their "double burden" through claiming SA.[28] In this study we found a strong association between morbidity and both SA and DP among women of childbearing ages after controlling for morbidity before baseline and for several demographic factors. It has also been suggested that women with more children have more SA. We found the opposite; women with one birth had a lower future SA and DP risk than those who did not give birth, while those who gave birth more than once had the lowest risk of DP. Our findings may inform the debate in welfare states concerning the presence of morbidity in women on SA, in particular among women with young children.

Contributors MW conducted the analyses, wrote the first draft and revised the paper; KL contributed to writing, interpretation of the findings and revised the paper; PS and KA contributed to the conception and design of the study, interpretation of the findings and

revised the paper; LN contribute to the interpretation of the findings, writing and revised the paper. All authors have read and approved the final version of the manuscript.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval The project was approved by the Regional Ethical Review Board of Stockholm.

Data sharing statement No additional data available.

FIGURE LEGENDS

Figure 1. Mean annual number of hospitalization days and specialized outpatient visits (with 95% confidence intervals).

Figure 2. Mean annual number of days on sickness absence and/or disability pension (with 95% confidence intervals)

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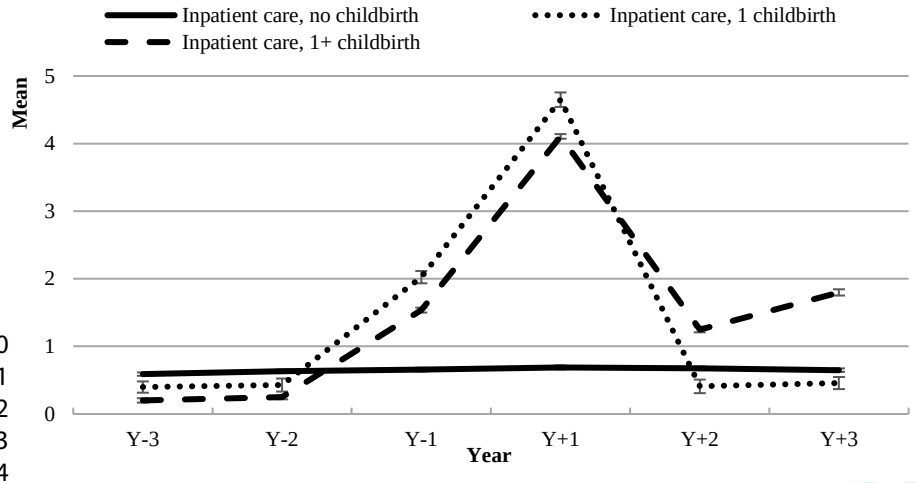
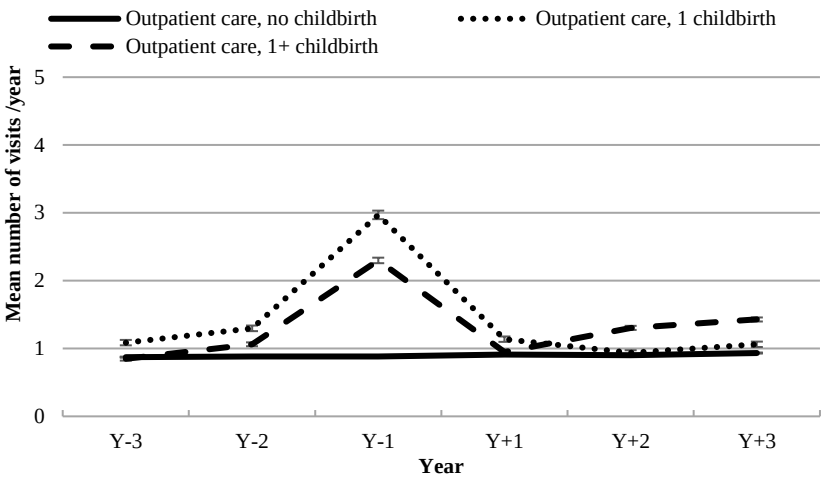
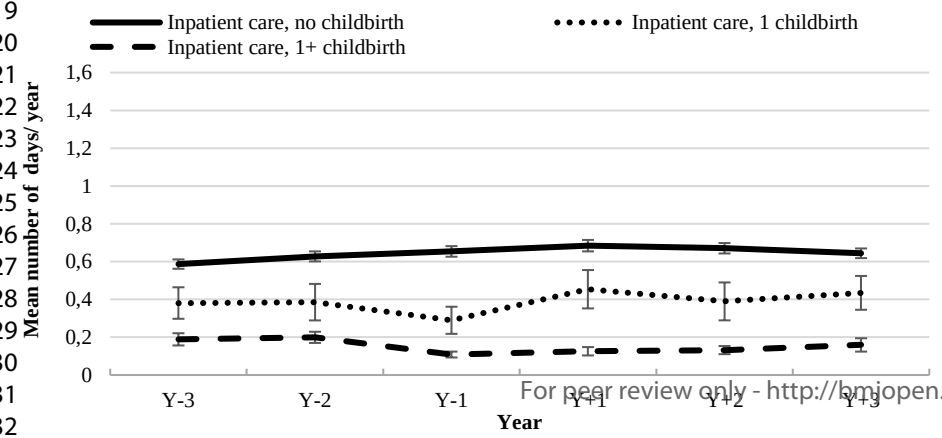
1 a) Average annual number of days with hospitalisation



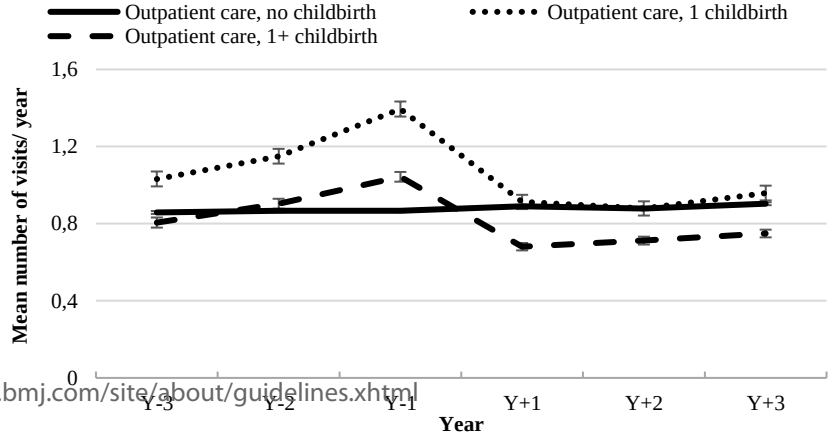
1 b) Mean annual number of specialised outpatient visits



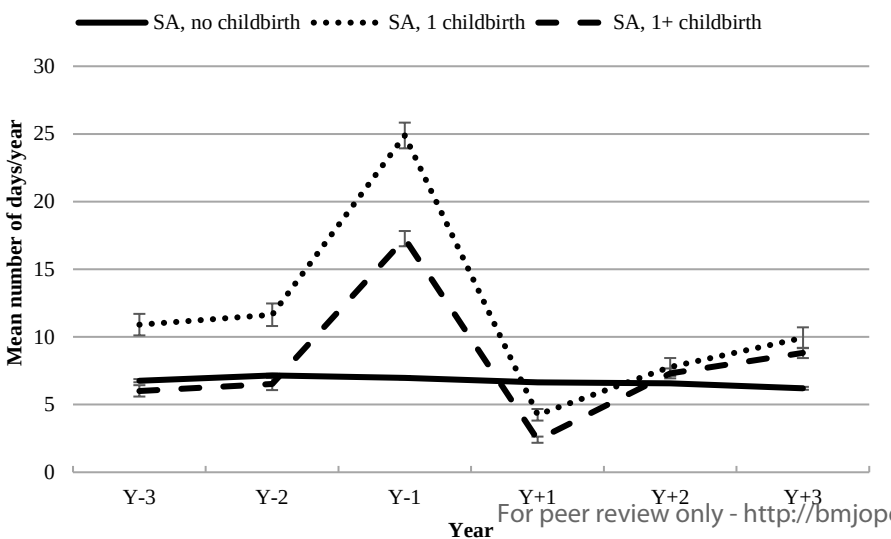
1 c) Mean annual number of days with hospitalisation (excluding hospitalisations with a diagnosis for pregnancy, childbirth and the puerperium)



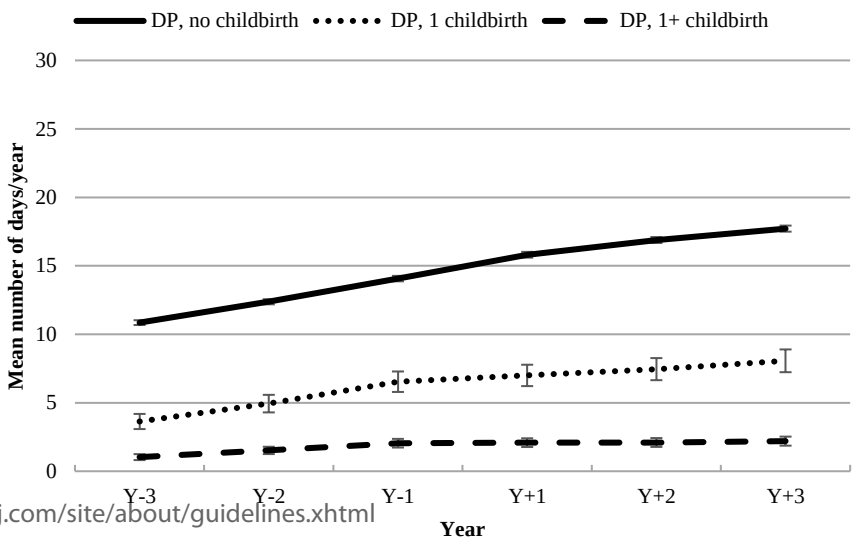
1 d) Mean annual number of specialised outpatient visits (excluding visits with a diagnosis for pregnancy, childbirth and the puerperium)



2 a) Mean annual net number of days on sickness absence (SA)



2 b) Mean annual net number of days on disability pension (DP)



STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	p. 1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p. 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p. 5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	p. 6
Methods			
Study design	4	Present key elements of study design early in the paper	p. 6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p. 6-10
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	p. 6-10
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	-
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p. 7-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p. 6-10
Bias	9	Describe any efforts to address potential sources of bias	p. 11
Study size	10	Explain how the study size was arrived at	p. 7-8, 13-14
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p. 7-10, 13-14
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p. 10-11
		(*b*) Describe any methods used to examine subgroups and interactions	p. 11
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, explain how loss to follow-up was addressed	p. 11
		(*e*) Describe any sensitivity analyses	p. 11
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	p. 7-8, 13-14
		(b) Give reasons for non-participation at each stage	p. 7-8, 13-14
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p. 13-14
		(b) Indicate number of participants with missing data for each variable of interest	p. 13-14
		(c) Summarise follow-up time (eg, average and total amount)	-
Outcome data	15*	Report numbers of outcome events or summary measures over time	Tables 2-5, Figures 1-2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted	Tables 2-5,

		estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Figures 1-2
		(*b*) Report category boundaries when continuous variables were categorized	p. 12-13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	p. 22-24
Discussion			
Key results	18	Summarise key results with reference to study objectives	p. 25
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p. 27, 28
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p. 25-28
Generalisability	21	Discuss the generalisability (external validity) of the study results	p. 27, 28
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p. 29

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.