Sickness absence, disability pension and permanent medical impairment among 64 000 injured car occupants of working ages: A two-year prospective cohort study

Rasmus Elrud[a,*], Emilie Friberg[a], Kristina Alexanderson[a], Helena Stigson[a,b]

[a] Division of Insurance Medicine, Department of Clinical Neuroscience, Karolinska Institutet, SE-17177 Stockholm, Sweden
[b] Folksam Research, Stockholm, Sweden

ABSTRACT

Objective: There is a lack of knowledge regarding sickness absence (SA) and disability pension (DP) as consequences of road traffic injuries, and on the association between DP and permanent medical impairment (PMI). Therefore, the aim of this study was to investigate SA, DP, and PMI among injured passenger car occupants two years after a crash, and how they are associated, accounting for sociodemographics, crash-related factors, and previous SA/DP.

Methods: This prospective cohort study included 64 007 injured car occupants aged 17–62 years at the time of a crash occurring in 2001–2013, involving a car insured at Folksam Insurance Group in Sweden. Information on sociodemographics, crash-related factors, SA (in SA spells > 14 days) and DP status at inclusion and at two-year follow-up, and PMI assessed by the insurance company was used. PMI grades were categorized as 1–4, 5–9, 10–19, or > 19%. Logistic regression was performed to calculate odds ratios (OR) with 95% confidence intervals (CI) for DP at follow-up and for PMI, respectively.

Results: At the time of the crash 13% were already on SA or DP. At follow-up two years after the crash, 6% among those not already on SA/DP at the time of the crash were on SA and 2% on DP. Furthermore, 8% of the total cohort had a determined PMI. Among those not already on DP at the crash, 3% with no PMI had DP at follow-up. This proportion was higher the higher PMI grade. Among individuals without already ongoing DP at the crash date, 10% of those with a PMI 1–4 ha d DP, compared to 76% among PMI ≥ 20. Already ongoing SA at the time of the crash (OR = 39.16, 95% CI 34.89–43.95) and PMI grade (PMI ≥ 5 OR = 27.44, 95% CI 23.88–31.52, reference group PMI 0) were found to be associated with DP at two years after crash. The factor most strongly associated with PMI was the model year of the car. The older the car, the higher the risk of PMI (Model year ≤ 1990 OR = 3.36, 95% CI 2.67–4.23, reference group model year 2006–2010). An association with the same direction was also found between the model year of the car and DP at follow-up.

Conclusions: The association between PMI grade and DP status at follow-up among occupants not on DP at the crash date indicates that both could be used to measure long-term consequences of road traffic injury. In this cohort, already ongoing SA at the crash date was associated with DP at the two-year follow-up, emphasizing the importance of accounting for this factor in future research.

1. Introduction

Road traffic injuries constitute a major public health problem in most countries, including Sweden, in terms of morbidity, mortality, incapacity, costs, and individual suffering (Peden et al., 2004). During the last decades, significant improvements in road infrastructure and vehicle safety have been achieved in many countries (Strandroth, 2015; Stigson, 2009; Farmer and Lund, 2006; Kullgren et al., 2002; Lie and Tingvall, 2002; Kullgren et al., 2013; Lie et al., 2006; Ferguson, 2007; Erke, 2008). Although the number of cars in road traffic have increased much worldwide; in Sweden from approximately 4.0 million to 4.6 million (15% increase) between the years 2000 and 2015 (The Swedish Road Traffic Register, 2017), the numbers of road traffic fatalities have decreased, in Sweden by 56% during the same years (ITF, 2017). The

* Corresponding author.
E-mail addresses: rasmus.elrud@ki.se (R. Elrud), emilie.friberg@ki.se (E. Friberg), kristina.alexanderson@ki.se (K. Alexanderson),
helena.stigson@folksam.se (H. Stigson).

reduction in road-traffic crashes resulting in injuries have in the same years, however, been more modest; 7% (ITF, 2017). As fatalities decrease, the consequences of non-fatal injuries are brought into focus. Road traffic crashes are one of the leading causes of disability and reduction of productive years in the population (Peden et al., 2004).

In 2008, the Swedish Transport Administration broadened the definition of serious injuries to include also injuries leading to permanent medical impairment (PMI). Such impairments are covered by the Swedish Road Traffic Insurance (mandatory for all motor vehicles in road traffic). In insurance medicine two types of insurances are of interest; those covering loss of earnings due to reduced work capacity and those with compensations due to permanent medical impairment. Regarding medical impairment, specific types of medical conditions are graded on a scale based on a pre-determined ruleset, such as in the case with PMI, and compensated accordingly (Insurance Sweden, Permanent medical impairment -injuries, 2013). Loss of earnings due to disease or injury are covered by different types of public insurances providing sickness absence (SA) and disability pension (DP) benefits (OECD, 2010; Alexanderson and Norlund, 2004). The scientific knowledge is very limited regarding the association between these two types of benefits, that is, between PMI and SA/DP, as well as regarding SA/DP following road traffic injuries.

Few studies of injuries sustained in car crashes have investigated SA in populations of working ages, encompassing all injury types or diagnoses and severity grades. We have found two studies that investigated the incidence of granted SA among passenger car occupants who were treated at a hospital for injuries sustained in a crash. The first includes individuals aged 16–64 injured in 1990–1991 (Bylund and Bjornstig, 1998) and the second includes individuals 16–66 years old, injured in 1970 (Hansson, 1976), both reported high proportions, 40–66%, of SA of any length. It is, however, not clear how many of those already were on SA before the crash. In a population-based study of all individuals aged 16–64, who in 2010 received in- or specialized outpatient healthcare for injuries sustained as passenger car occupants in a crash, we found that 9% were on already ongoing SA spells > 14 days at the time of the healthcare visit, while 10% among those at risk, i.e., not already on SA or DP, had a new SA spell > 14 days (Elrud et al., 2017). In another study, of individuals in ages 18–65 and including all types of injuries, and their incidence of self-reported lost working days due to injury from a motor vehicle crash, found that among individuals working prior to the crash, 30% reported missing days of work after the crash (Ebel et al., 2004). Diagnosis-specific studies have reported work disability among individuals with whiplash, in terms of working fewer hours 12 months after a car crash (Buitenhuis et al., 2009), or having self-reported SA or DP due to the injury at some point during the past year at a follow-up 17 years after a car crash occurring in 1983 (Bunketorp et al., 2002).

There are few studies on incidence of DP after a car crash and in those published, DP is often not well defined. Following injured car occupants over time, one study found 7% to either be granted DP or being on long-term SA 4–6 years after a crash occurring in 1990–1991 (Bylund and Bjornstig, 1998). A cross-sectional study comprising all individuals in Sweden with a road traffic injury assessed with a more severe PMI (≥ 10%) in 1994 found that 33% had partial or full-time DP determined the same year (Holm et al., 1999). These previous findings are important, however, of older date, and there are many differences with the present day in terms of changes in car and road safety (Strandroth, 2015; Stigson, 2009; Farmer and Lund, 2006; Kullgren et al., 2002; Lie and Tingvall, 2002; Kullgren et al., 2013; Krafft et al., 2006).

To the best of our knowledge, no study has investigated DP over time in larger study populations, that also is representative of all passenger car occupants injured in road traffic car crashes.

Previous general studies on SA and DP in general have found that several sociodemographic factors are associated with the risk of SA/DP, such as sex, age, country of birth, educational level, previous SA/DP,

and marital status (Allebeck and Mastekaasa, 2004; Samuelsson et al., 2012). It has also been shown that previous SA is associated with SA/DP in trauma patients at 12 months after the in individuals with whiplash trauma (von Oelreich et al., 2017), and (Carstensen et al., 2015; Myrtveit et al., 2013). The few previous studies on the risk of PMI has found that women generally have a higher risk when injured than men, mainly due to whiplash injuries (Gustafsson et al., 2015). Furthermore, higher age and being injured in a rollover crash are associated with higher risk of PMI (Stigson et al., 2015). Also, the risk of being injured in a car crash has been found to be associated with the model year of the car (MY) (Kullgren et al., 2002; Lie and Tingvall, 2002; Kullgren et al., 2013). Thus, also such factors are important to take into consideration.

The aim of this study was to investigate SA, DP, and PMI among injured passenger car occupants two years after the crash, and how they were associated, accounting for sociodemographic and crash-related factors, and previous SA/DP.

2. Material and methods

2.1. Study design

A prospective cohort study was conducted including all injured passenger car occupants where the car crash was reported to Folksam Insurance Group; one of the largest insurance companies in Sweden, with a market share of approximately 22% (Insurance Sweden, 2017). From all such crashes occurring between 2001 and 2013, all individuals at an eligible age for DP within two years of follow-up (17–62 years old at the year of the crash) were included. We excluded those who died within 30 days or had another crash during the two-year follow-up; leaving 64 007 injured car occupants for analyses. For each individual, information from the Folksam database was obtained regarding: crash date, crash impact direction, car model year (MY), and determined PMI grade. This information was linked at an individual level, through the personal identity number assigned to all Swedish residents (Ludvigsson et al., 2009), to microdata from the following Swedish nationwide registers:

1 The Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA), administrated by Statistics Sweden, regarding sociodemographic factors for the year before the crash for each individual.
2 The MicroData for Analysis of the Social Insurance database (MiDAS) administrated by the Social Insurance Agency, regarding dates and grades of SA and DP at the time of the crash and at two years after the crash.
3 The Cause of Death Register, administrated by the National Board of Health and Welfare, regarding date of death.

2.2. Permanent medical impairment

Insurance companies in Sweden use a set of rules "Grading Medical Impairment" to assess medical impairment resulting from injuries (Insurance Sweden, Permanent medical impairment -injuries, 2013). Most European countries have similar rules. Grading is conducted by consultant physicians, in cases where injured claimants have not recovered within a year. All medical records from before and after the crash are used in the assessment, where a degree of impairment based on the reduction in function caused by the injury is determined. If an injured occupant receives multiple diagnoses that result in medical impairment, a cumulative value of impairment is set. The impairment grade can be between 1 and 99%. Since assessment of PMI is done for individual injuries, the information on PMI grades used in this study were directly related to the injury outcome in the specific car crash.

2.3. Sickness absence and disability pension in Sweden

In the public Swedish sickness absence insurance system, all people from the age of 16 with income from work or unemployment benefits, whose disease or injury result in work incapacity, can be granted SA benefits, paid by the Social Insurance Agency (The Swedish Social Insurance Agency, 2016). Employers generally pay sick pay the first 14 days of a SA spell. From day eight a sickness certificate from a physician is required. All aged 19–64 years with a long-term or permanent work incapacity due to disease or injury can be granted DP. Both SA and DP can be granted for 100, 75, 50, or 25% of ordinary working hours. In this study, only SA spells > 14 days were included. Sickness absence benefits amount to 80% of lost income, DP benefits to 64%, both up to a certain level. In this study, DP was operationalized as granted DP or being on a SA spell > 2 years, to facilitate international comparisons (OECD, 2010).

2.4. Included factors

The following factors were included in the analyses:
Sociodemographic factors, measured 31 December of the year before the crash were: sex (women, men), age (17–24, 25–34, 35–44, 45–54, and 55–62 years), educational level (Elementary school (< 10 years), High school (10–12 years), and College/University (> 12 years)), country of birth (Sweden, Rest of Europe, and Rest of the world), and marital status (married or not). *Crash-related factors* were: crash impact direction (frontal, side, rear, rollover, and other/unknown), MY (1929–1980, 1981–1985, 1986–1990, 1991–1995, 1996–2000, 2001–2005, 2006–2010, and Unknown).

Information about already being on SA or DP at the time of the crash was included, irrespective of grade. As independent variables, DP was defined as already being on DP of any grade, SA as already having an ongoing SA spell, at the date of the crash. When used as outcome variables, SA and DP were measured at two years after the crash. The criteria for being categorised as SA was having a SA spell at the date of follow-up, of any grade that had lasted for > 14 days but < 2 years. The criteria for DP was being on DP or on a SA spell that had been ongoing since the crash date, of any grade; at the date of the follow-up,

2.5. Statistical analysis

Descriptive statistics were used to describe the study population, in total and stratified by sex. We calculated proportions with already ongoing SA and DP at the crash date (inclusion date), and at a follow-up two years after the crash date. Proportions with different grades of determined PMI were also calculated. PMI was here categorised 0, 1–4, 5–9, 10–19, and ≥20, or alternatively yes (PMI ≥ 1%) and no, depending on analyses. Descriptive analyses were also used to investigate SA and DP status at follow-up in relation to status at inclusion, for all and stratified by PMI. Logistic regression analyses were used to calculate crude and adjusted odds ratios (OR) and 95% confidence intervals (CI) for DP at follow-up and for determined PMI, respectively. For each of these two outcomes, a mutually adjusted multivariable model was constructed. Included as independent variables in the adjustment models were the factors found to have an association with the outcome in univariate analysis.

In the regression analysis with DP at follow-up as an outcome, occupants with DP at inclusion were excluded since they were no longer at risk of DP, leaving a total of 58 252 individuals. Here, PMI as an independent variable, was categorised as: no PMI, 1–4%, and ≥5%.

In the regression analysis with PMI as an outcome, the whole cohort (n = 64 007) was included. Permanent medical impairment was here categorised as yes (PMI ≥ 1%) and no.

SPSS for Windows version 24 was used for analyses.

The project was approved of by the Regional Ethical Review Board of Stockholm, Sweden (Dnr 2015/2234-31).

Table 1

Descriptive statistics of the studied cohort of injured passenger car occupants, for all, and for women and men, respectively.

	Total		Women		Men	
	n	%	n	%	n	%
All	64 007		32 781	51.2	31 226	48.8
Age groups, (years)						
17-24	16 446	25.7	7507	22.9	8939	28.6
25-34	14 354	22.4	7264	22.2	7090	22.7
35-44	13 650	21.3	7393	22.6	6257	20.0
45-54	11 875	18.6	6412	19.6	5463	17.5
55-62	7682	12.0	4205	12.8	3477	11.1
Level of education (years)						
Elementary (< 10)	16 175	25.3	6937	21.2	9238	29.6
High school (10-12)	33 955	53.0	17 385	53.0	16 570	53.1
College/University (> 12)	13 877	21.7	8459	25.8	5418	17.4
Country of birth						
Sweden	49 880	77.9	26 921	82.1	22 959	73.5
Rest of Europe	6151	9.6	2877	8.8	3274	10.5
Rest of the world	7976	12.5	2983	9.1	4993	16.0
Married						
Yes	21 289	33.3	11 377	34.7	9912	31.7
No	42 718	66.7	21 404	65.3	21 314	68.3
SA/DP status at date of the crash						
No prevalent SA or DP	55 497	86.7	27 622	84.3	27 875	89.3
Prevalent SA	2755	4.3	1583	4.8	1172	3.8
Prevalent DP	5558	8.7	3416	10.4	2142	6.9
Both SA and DP	197	0.3	160	0.5	37	0.1
Crash impact direction						
Frontal	22 300	34.8	10 804	33.0	11 496	36.8
Rear	23 535	36.8	12 858	39.2	10 677	34.2
Side	11 017	17.2	5830	17.8	5187	16.6
Rollover	3693	5.8	1619	4.9	2074	6.6
Other/Unknown	3462	5.4	1670	5.1	1792	5.7
Car model year						
2006-2010	2161	3.4	1297	4.0	864	2.8
2001-2005	6978	10.9	3993	12.2	2985	9.6
1996-2000	14 539	22.7	7632	23.3	6907	22.1
1991-1995	13 682	21.4	6513	19.9	7169	23.0
1990 or older	16 003	25.0	7608	23.2	8395	26.9
Unknown	10 644	16.6	5738	17.5	4906	15.7
SA/DP status at 2 years after crash date						
No SA or DP	52 845	82.6	26 047	79.5	26 798	85.8
SA	3753	5.9	2300	7.0	1453	4.7
DP	7109	11.1	4229	12.9	2880	9.2
Both SA and DP	300	0.5	205	0.6	95	0.3
PMI grade (%) 2 years after crash date						
0	58 972	92.1	30 030	91.6	28 942	92.7
1-4	3074	4.8	1704	5.2	1370	4.4
5-9	1495	2.3	827	2.5	668	2.1
10-19	363	0.6	190	0.6	173	0.6
≥20	103	0.2	30	0.1	73	0.2

SA: Sickness absence, DP: Disability pension, PMI: Permanent medical impairment.

3. Results

The cohort included 64 007 individuals (51% women) (Table 1). The median age was 35 years.

At the crash, 9% were already on DP and 5% had an already ongoing SA spell, with 0.3% having both partial SA and DP. In total, 8% of the occupants sustained an injury resulting in PMI. At the follow-up two years after the crash date, 7409 (12%) had DP and 4053 (6%) were on SA, 300 of these were on both SA and DP, making up 0.5% of the study population. Generally, the proportions with DP, SA, and PMI were all higher among women than among men.

Among those on DP two years after the crash, 60% were women, and the median age was 49 years. The vast majority of the occupants that were on DP at follow-up, were on SA or DP already at inclusion

Table 2
Descriptive statistics of disability pension (DP) and sickness absence (SA) status at follow-up two years after a passenger car crash date, stratified by already ongoing SA and DP at the time of the crash, for all and for those with no permanent medical impairment (PMI) and PMI ≥ 1%, respectively. Individuals with both partial SA and partial DP are here categorized in the DP category of respective time point.

			Already ongoing SA/DP at the crash		
			No SA or DP	SA	DP
	DP at follow-up				
Total (n = 64 007)	No DP	N	54 398	1689	511
		column %	98.0	61.3	8.9
	DP	N	1099	1066	5244
		column %	2.0	38.7	91.1
No PMI (n = 58 972)	No DP	N	50 891	1566	485
		column %	99.0	64.3	9.4
	DP	N	500	868	4662
		column %	1.0	35.7	90.6
PMI ≥ 1 (n = 5035)	No DP	N	3507	123	26
		column %	85.4	38.3	4.3
	DP	N	599	198	582
		column %	14.6	61.7	95.7
	SA at follow-up				
Total (n = 64 007)	No SA	N	52 235	2375	5644
		column %	94.1	86.2	98.1
	SA	N	3262	380	111
		column %	5.9	13.8	1.9
No PMI (n = 58 972)	No SA	N	48 825	2091	5046
		column %	95.0	85.9	98.0
	SA	N	2566	343	101
		column %	5.0	14.1	2.0
PMI ≥ 1 (n = 5035)	No SA	N	3410	284	598
		column %	83.0	88.5	98.4
	SA	N	696	37	10
		column %	17.0	11.5	1.6

DP: Disability pension, SA: Sickness absence, PMI: Permanent medical impairment.

Fig. 1. Proportions (%) with and without disability pension (DP) (by DP grade) two years after the car crash date, for different permanent medical impairment (PMI) grade categories, among those not on DP at the date of the crash (n = 58 252).

Fig. 2. Proportions (%) with and without disability pension (DP) (by DP grade) two years after the car crash date, for different permanent medical impairment (PMI) grade categories, among those on DP at the date of the crash (n = 5755).

(Table 2). Among the 55 497 occupants not on SA or DP at inclusion, 2% were on DP at follow-up. Similarly, SA at follow-up was more common among individuals on SA at the time of the crash than among those that were not.

Disability pension at follow-up was also associated with PMI; 27% of the occupants with a determined PMI had DP two years after the crash, compared to 10% among those with no PMI. Among the occupants with both PMI and DP at follow-up, 57% were already on SA or DP at the time of the crash. When excluding those with already ongoing SA or DP at the time of the crash, 15% that had a determined PMI due to their injuries also had DP at follow-up, compared to only 1% among those with no PMI (Table 2). A similar difference in proportions with PMI could be seen for SA at follow-up. A high association was also found between PMI grade and DP at follow-up, the percentage with DP was higher in categories with higher PMI grade. When excluding those already on DP at the time of the crash, i.e., those not at risk of new DP, 10% of those with a PMI grade of 1–4% had DP at follow-up, while this proportion was 76% among those with a PMI ≥ 20% (Fig. 1).

Among occupants already on DP at the time of the crash, the proportion with DP at follow-up was 91% among those with no PMI (Fig. 2). Among the 6030 individuals with DP at follow-up who did not sustain a PMI, most were already on DP (77%) or SA (14%) at inclusion. Out of the 1099 occupants who had been granted DP at follow-up and was not already on SA or DP at the time of the crash, 55% also had a determined PMI.

In the regression analyses using PMI at follow-up as outcome, the strongest risk indicator for having a determined PMI was MY (Table 3).
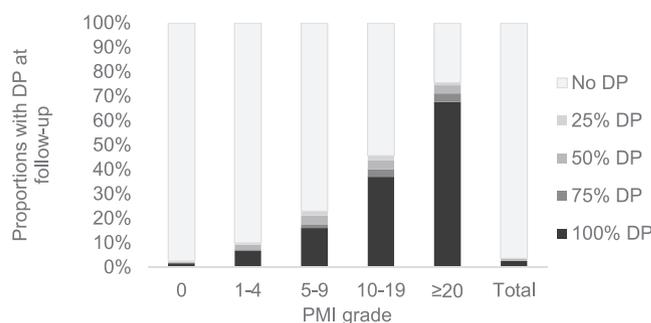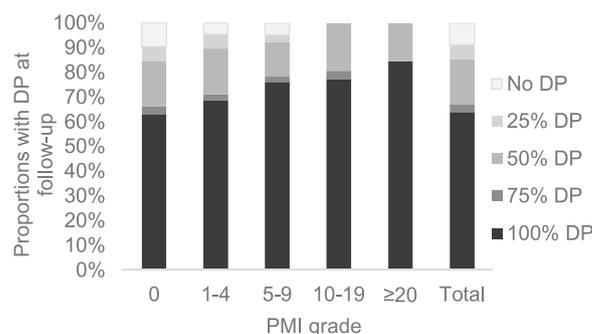
The range of MYs was from 1929 to 2010, with median 1995. In general, older MY resulted in higher ORs for PMI. Occupants injured in a car with MY 1990 or older were over three times more likely to have a PMI than those injured in cars with MY between 2006–2010. In this analysis, PMI was associated with sociodemographic factors; women, those with lower educational level, born outside Sweden, or aged > 24 years were more likely to have PMI. There was no trend with higher ORs with increasing age.

In the regression analyses using DP at follow-up date as outcome, occupants already on DP at inclusion were excluded. The highest OR was found for occupants on SA at inclusion (OR: 39.16; 95% CI: 34.89–43.95), followed by PMI grade ≥5% (Table 4). Occupants injured in older car models were more likely to have DP at follow-up. Associations with sociodemographic factors were also found; those of higher age, low educational level, and born outside Sweden were more likely to have been granted DP at follow-up. A strong association was also found between PMI and DP at follow-up. Occupants with a determined PMI of ≥5% from the crash had an OR of over 27 (OR: 27.44; CI: 23.88–31.52), while occupants with a PMI of 1–4% were four times more likely to have DP at follow-up, compared to those with no PMI (OR: 4.24; CI: 3.57–5.04).

4. Discussion

This large prospective cohort study investigated SA, DP, and PMI and associations between them two years after a car crash among injured passenger car occupants of working ages (17–62). To the best of our knowledge, this is the first study examining future DP and PMI of all grades among injured passenger car occupants, including both sociodemographic and crash-related factors.

Out of the 64 007 injured car occupants, 12% had DP at follow-up. This can be compared to a previous small Swedish study (N = 255), where 7% had DP or long-term SA five to six years later (Bylund and

Table 3
Crude and adjusted odds ratios (OR) with 95% confidence intervals (CI) for determined permanent medical impairment (PMI) at two years after the car crash date (n = 64 007).

	Crude		Adjusted	
	OR	CI	OR	CI
Sex				
Men	Ref		Ref	
Women	1.16	1.10-1.23	1.24	1.17-1.32
Age (years)				
17-24	Ref		Ref	
25-34	1.33	1.22-1.45	1.39	1.27-1.53
35-44	1.46	1.34-1.60	1.48	1.34-1.63
45-54	1.41	1.29-1.55	1.47	1.32-1.63
55-62	1.34	1.21-1.49	1.40	1.25-1.58
Level of education (years)				
College/University (> 12)	Ref		Ref	
High school (10-12)	1.29	1.20-1.40	1.30	1.20-1.40
Elementary (≤9)	1.26	1.16-1.38	1.30	1.19-1.43
Country of birth				
Sweden	Ref		Ref	
Europe other than Sweden	1.34	1.22-1.46	1.29	1.17-1.41
Rest of the world	1.23	1.14-1.34	1.25	1.14-1.36
Married				
No	Ref		Ref	
Yes	1.17	1.10-1.24	1.08	1.01-1.16
SA at inclusion				
No	Ref		Ref	
Yes	1.58	1.40-1.78	1.37	1.22-1.54
DP at inclusion				
No	Ref		Ref	
Yes	1.44	1.31-1.57	1.21	1.10-1.33
Crash impact direction				
Frontal	Ref		Ref	
Rear	0.91	0.85-0.97	0.92	0.85-0.98
Side	0.89	0.82-0.97	0.87	0.79-0.94
Rollover	1.33	1.18-1.49	1.41	1.26-1.59
Unknown	1.10	0.97-1.25	1.04	0.91-1.18
Car model year (MY)				
2006-2010	Ref		Ref	
2001-2005	1.64	1.28-2.09	1.61	1.26-2.06
1996-2000	1.99	1.57-2.50	1.95	1.54-2.46
1991-1995	2.64	2.10-3.33	2.66	2.11-3.35
1990 or older	3.23	2.57-4.06	3.36	2.67-4.23
Unknown	1.23	0.97-1.57	1.27	1.00-1.62

SA: Sickness absence, DP: Disability pension.

Table 4
Crude and adjusted odds ratios (OR) with 95% confidence intervals (CI) for disability pension (DP) at two years after the crash date (n = 58 252. Excluding occupants already on DP at the time of the crash).

	Crude		Adjusted	
	OR	95% CI	OR	95% CI
Sex				
Men	Ref		Ref	
Women	1.17	1.07-1.27	1.11	1.00-1.23
Age (years)				
17-24	Ref		Ref	
25-34	1.97	1.67-2.31	1.29	1.07-1.56
35-44	3.56	3.06-4.14	2.12	1.76-2.54
45-54	3.98	3.41-4.65	2.75	2.28-3.32
55-62	4.89	4.14-5.77	3.82	3.12-4.68
Level of education (years)				
College/University (> 12)	Ref		Ref	
High school (10-12)	1.48	1.31-1.68	1.49	1.30-1.72
Elementary (≤9)	1.64	1.43-1.87	2.09	1.78-2.46
Country of birth				
Sweden	Ref		Ref	
Europe other than Sweden	1.96	1.74-2.22	1.51	1.30-1.76
Rest of the world	1.50	1.33-1.69	1.35	1.16-1.56
Married				
No	Ref		Ref	
Yes	1.66	1.52-1.81	1.10	0.98-1.23
SA at inclusion				
No	Ref		Ref	
Yes	31.24	28.35-34.43	39.16	34.89-43.95
Crash impact direction				
Frontal	Ref		Ref	
Rear	0.83	0.75-0.92	0.86	0.76-0.97
Side	1.00	0.88-1.13	0.99	0.86-1.15
Rollover	0.98	0.81-1.18	1.06	0.85-1.32
Unknown	1.25	1.05-1.49	1.15	0.93-1.42
Car model year				
2006-2010	Ref		Ref	
2001-2005	1.76	1.19-2.61	1.48	0.96-2.29
1996-2000	2.33	1.60-3.38	1.88	1.25-2.85
1991-1995	3.24	2.24-4.69	2.51	1.66-3.79
1990 or older	3.55	2.46-5.13	2.74	1.82-4.13
Unknown	1.21	0.82-1.78	1.25	0.81-1.92
PMI grade (%)				
No PMI	Ref		Ref	
1-4	4.26	3.71-4.88	4.24	3.57-5.04
≥5	16.43	14.64-18.42	27.44	23.88-31.52

SA: Sickness absence, PMI: permanent medical impairment.

Bjornstig, 1998). Although very few, among the individuals with DP (n = 9; 4%), the median age was 45 and five (56%) were women, which is in line with our study.

In the present study, DP and SA status already before the crash corresponded highly with DP at follow-up. Most of those already on DP at inclusion also had DP two years later, which is to be expected since this benefit is designed to compensate loss of income due to long-term or permanent work incapacity. In the adjusted regression analysis including those not on DP at the crash, already being on SA at the crash was also found to be the factor with the highest OR (39.16) for being on DP at follow-up. This could be due to that being granted DP is usually preceded by a long period of SA. It could also be due to existing health vulnerability among occupants with ongoing SA at the time of the crash, also making them more susceptible to DP at the follow-up. An association between prior SA and SA/DP at one year after trauma has been shown in trauma patients admitted with trauma team activation or with injuries more severe than isolated extremity fractures (von Oelreich et al., 2017). However, only a few studies have investigated the association between prior SA or health-related factors with subsequent SA/DP among individuals injured in road traffic crashes. One

study reported that those without self-reported pre-injury chronic disease were more likely of having returned to work two years after the injury, compared to those with chronic disease (Gopinath et al., 2015). We only found two studies on return to work and self-assessed pre-injury health, and the results of them go in different directions (Gopinath et al., 2015; Murgatroyd et al., 2016). Two studies examining the association with prior SA and subsequent whiplash associated disorders were found. In a Danish study (N = 719), history of SA prior to the crash was associated with a negative change in provisional status (OR: 3.8), defined as having gone from being self-supporting or unemployed to temporary or permanent health-related benefits, or from temporary to permanent health-related benefits, one year after the crash (Carstensen et al., 2015). A Norwegian study (N = 20,799) found that in a study population of 20,799 individuals without whiplash, those with self-reported SA at baseline had an OR of 1.92 of subsequent chronic whiplash after a follow-up period of 9–13 years, compared to those with no SA at baseline, while there was no association between self-reported DP and whiplash (Myrtveit et al., 2013). These results suggest that prior SA and DP are important factors to account for when

studying subsequent SA and DP after traffic injury, as failing to do so may result in overestimations of true numbers.

Among car occupants that were not on SA or DP at the time of the crash, 2% were on DP two years later. Previous studies do not present this estimate, as they either do not take into account SA and DP status at the time of the crash (Bylund and Bjornstig, 1998), uses an outcome where DP is mixed with other types of benefits (Carstensen et al., 2015), or are using a study population restricted to individuals with a higher PMI (≥10%) (Holm et al., 1999).

The risk of PMI has been found lower among occupants injured in newer cars (Kullgren et al., 2013; Folksam Insurance Group, 2017). In line with that, we observed that occupants injured in crashes with newer cars were less likely to be on DP two years later and also less likely to sustain PMI. Model year is a proxy for development in the crash safety of cars over time. Thus, our results are in line with the fact that car safety has improved over the years (Farmer and Lund, 2006; Kullgren et al., 2013; Krafft et al., 2006).

In this study, the ORs for DP increased with age, while ORs for PMI was higher for women and for occupants > 25 years compared to those 17–24 years. According to two previous studies, higher age is a risk factor of injury (Augenstein et al., 2005; Braver and Trempel, 2004) and to another study, PMI due to such injuries (Gustafsson et al., 2015). A study of individuals with compensation payments for loss of income due to road traffic injuries (Berecki-Gisolf et al., 2013) found that female sex and higher age was associated with payments after > 18 months, which was also in line with our results.

The majority of the injured occupants were not on DP two years after the crash date. However, the proportion of occupants with DP increased with higher PMI grade, and the regression analysis with DP at follow-up as outcome also found higher ORs for higher PMI. In the study by Holm et al., for PMI assessed in 1994, a grade ≥15% was associated with ORs of around eight of having DP determined the same year, compared to a reference group with PMI 10–14% Holm et al. (1999). In the present study, 473 individuals (< 1% of the study population) got a PMI ≥ 10%. Based on the study population of occupants with injuries encompassing all PMI grades, we observed a strong association between PMI and being on DP at follow-up, as those with PMI ≥ 5% had an OR of 27, compared to those with no PMI. The difference in study populations (all injuries vs. only PMI ≥ 10% as in that of Holm et al) make the ORs hard to compare, however, both studies indicate an association between PMI and DP. In this study we found such an association even for the more common lower grades of PMI. Ongoing SA/DP, PMI, and to a lesser extent MY, age, and other factors were found associated with DP two years after a car crash. More research is, however, needed to learn who with a certain PMI grade do get SA/DP as a result of their injury, and who does not. Future studies should therefore also consider injury, SA/DP diagnosis, and other potentially influential factors, e.g., occupation.

4.1. Strengths and limitations

A strength of this study is the very large cohort, allowing for subgroup analyses, and that it includes linked microdata from several nationwide high-quality registers. This means that all individuals could be followed for two years (i.e., no drop outs) and no self-reported data with risk of recall bias. Furthermore, we had information also on those who were on SA and DP already at the time of the crash, information lacking in other studies. It can be seen as a limitation that we did not have information on SA spells < 15 days, however, the main focus here was on more long-term absences.

The identification of the study population from insurance claims has both advantages and disadvantages. Data from insurance claims could suffer from selection bias to specific insurances. However, the cohort consists of claimants from an insurance company with a 22% market share and which is considered to be representative of the general population (Insurance Sweden, 2017). The baseline distribution of

characteristics of the study population is also similar to that of our previous population-based study of all people living in Sweden, who received in- or specialised outpatient healthcare for injuries sustained as car occupants in crashes in 2010 (Elrud et al., 2017). Furthermore, the Swedish road traffic insurance is compulsory for all cars, and cover all injured individuals, regardless of fault. By using claims data, injured individuals not requiring hospital treatment could be included, allowing examination of the whole spectrum of injuries. It was not in the scope of this study, however, to study specific diagnoses for injury, PMI or SA and DP, whereby conclusions on causal relationships between such cannot be drawn from these results.

To the best of our knowledge, this is the first study investigating the future DP and PMI among passenger car occupants injured in road traffic crashes, including any type of injury, and not restricted to hospital patients or specific injury diagnoses.

In conclusion, in this cohort of injured passenger car occupants with all types of injuries, SA and DP at follow-up two years after the crash were highly associated with already being on SA or DP at the time of the crash, which indicate the importance for future studies to take these factors into account. A quarter of those with PMI were on DP at follow-up. The association between PMI and DP was stronger at higher PMI grades. These results indicate that both DP and PMI could be used to measure long-term effects of road traffic injury. However, more detailed knowledge is needed on how new SA, DP, and PMI are associated with each other and with other factors, e.g., occupation and injury diagnosis, while taking diagnosis of SA, DP, and PMI into consideration.

Authors declaration of interest

Research data for this article

The data used in this study cannot be made publically available. According to the General Data Protection Regulation, the Swedish law SFS 2018:218, the Swedish Data Protection Act, the Swedish Ethical Review Act, and the Public Access to Information and Secrecy Act, these type of sensitive data can only be made available, after legal review, for researchers who meet the criteria for access to this type of sensitive and confidential data. Readers may contact Professor Kristina Alexanderson (kristina.alexanderson@ki.se) regarding the data.

Acknowledgements

References

Alexanderson, K., Norlund, A., 2004. Swedish Council on Technology Assessment in Health Care (SBU). Chapter 2. Methods used for the systematic literature search and for the review of relevance, quality, and evidence of studies. Scand. J. Public Health Suppl. 63, 31–35.

Allebeck, P., Mastekaasa, A., 2004. Swedish Council on Technology Assessment in Health Care (SBU). Chapter 5. Risk factors for sick leave – general studies. Scand. J. Public Health Suppl. 63, 49–108.

Augenstein, J., Digges, K., Bahouth, G., Dalmotas, D., Perdeck, E., Stratton, J., 2005. Investigation of the performance of safety systems for protection of the elderly. Annu. Proc. Assoc. Adv. Automot. Med. 49, 361–369.

Berecki-Gisolf, J., Collie, A., McClure, R., 2013. Work disability after road traffic injury in a mixed population with and without hospitalisation. Accid. Anal. Prev. 51, 129–134.

Braver, E.R., Trempel, R.E., 2004. Are older drivers actually at higher risk of involvement in collisions resulting in deaths or non-fatal injuries among their passengers and other road users? Inj. Prev. 10 (1), 27–32.

Buitenhuis, J., de Jong, P.J., Jaspers, J.P., Groothoff, J.W., 2009. Work disability after whiplash: a prospective cohort study. Spine 34 (3), 262–267.

Bunketorp, L., Nordholm, L., Carlsson, J., 2002. A descriptive analysis of disorders in patients 17 years following motor vehicle accidents. Eur. Spine J. 11 (3), 227–234.

Bylund, P.O., Bjornstig, U., 1998. Sick leave and disability pension among passenger car occupants injured in urban traffic. Spine 23 (9), 1023–1028.

Carstensen, T.B., Fink, P., Oernboel, E., Kasch, H., Jensen, T.S., Frostholm, L., 2015. Sick

leave within 5 years of whiplash trauma predicts recovery: a prospective cohort and register-based study. PLoS One 10 (6), e0130298.

Ebel, B.E., Mack, C., Diehr, P., Rivara, F.P., 2004. Lost working days, productivity, and restraint use among occupants of motor vehicles that crashed in the United States. Inj. Prev. 10 (5), 314–319.

Elrud, R., Stigson, H., Ohlin, M., Alexanderson, K., Kjeldgård, L., Friberg, E., 2017. Sickness absence among passenger car occupants following a crash. International Research Council on Biomechanics of Injury (IRCOBI) Conference. Antwerp, Belgium.

Erke, A., 2008. Effects of electronic stability control (ESC) on accidents: a review of empirical evidence. Accid. Anal. Prev. 40 (1), 167–173.

Farmer, C.M., Lund, A.K., 2006. Trends over time in the risk of driver death: what if vehicle designs had not improved? Traffic Inj. Prev. 7 (4), 335–342.

Ferguson, S.A., 2007. The effectiveness of electronic stability control in reducing real-world crashes: a literature review. Traffic Inj. Prev. 8 (4), 329–338.

Folksam Insurance Group, 2017. How Safe is Your Car 2017 (Hur säker är bilen 2017). Stockholm, Sweden. .

Gopinath, B., Jagnoor, J., Harris, I.A., Nicholas, M., Casey, P., Blyth, F., Maher, C.G., Cameron, I.D., 2015. Prognostic indicators of social outcomes in persons who sustained an injury in a road traffic crash. Injury 46 (5), 909–917.

Gustafsson, M., Stigson, H., Krafft, M., Kullgren, A., 2015. Risk of permanent medical impairment (RPMI) in car crashes correlated to age and gender. Traffic Inj. Prev. 16 (4), 353–361.

Hansson, P.G., 1976. Sick-leave after road trafic accidents. Scand. J. Soc. Med. 4 (2), 103–107.

Holm, L., Cassidy, J.D., Sjogren, Y., Nygren, A., 1999. Impairment and work disability due to whiplash injury following traffic collisions. An analysis of insurance material from the Swedish Road Traffic Injury Commission. Scand. J. Public Health 27 (2), 116–123.

Insurance Sweden, 2017. Insurance Sweden's Statistics for the Insurance Industry - Third Quarter 2017 (In Swedish). Stockholm, Sweden. .

Insurance Sweden, Permanent medical impairment -injuries, 2013. (Medicinsk invaliditet -skador 2013). Insurance Sweden, Stockholm, Sweden 2013.

ITF, 2017. Road Safety Annual Report 2017. Paris, France. .

Krafft, M., Kullgren, A., Lie, A., Tingvall, C., 2006. The use of seat belts in cars with smart seat belt reminders–results of an observational study. Traffic Inj. Prev. 7 (2), 125–129.

Kullgren, A., Krafft, M., Ydenius, A., Lie, A., Tingvall, C., 2002. Developments in car safety with respect to disability – injury distributions for car occupants in cars from the 80's and 90's. International Research Council on Biomechanics of Injury (IRCOBI) Conference. Munich, Germany.

Kullgren, A., Stigson, H., Krafft, M., 2013. Development of whiplash associated disorders for male and female car occupants in cars launched since the 80s in different impact directions. International Research Council on Biomechanics of Injury (IRCOBI) Conference. Gothenburg, Sweden.

Lie, A., Tingvall, C., 2002. How do euro NCAP results correlate with real-life injury risks? A paired comparison study of car-to-car crashes. Traffic Inj. Prev. 3 (4), 288–293.

Lie, A., Tingvall, C., Krafft, M., Kullgren, A., 2006. The effectiveness of electronic stability control (ESC) in reducing real life crashes and injuries. Traffic Inj. Prev. 7 (1), 38–43.

Ludvigsson, J.F., Otterblad-Olausson, P., Pettersson, B.U., Ekbom, A., 2009. The Swedish personal identity number: possibilities and pitfalls in healthcare and medical research. Eur. J. Epidemiol. 24 (11), 659–667.

Murgatroyd, D.F., Harris, I.A., Tran, Y., Cameron, I.D., Murgatroyd, D., 2016. Predictors of return to work following motor vehicle related orthopaedic trauma. BMC Musculoskelet. Disord. 17, 171.

Myrtveit, S.M., Wilhelmsen, I., Petrie, K.J., Skogen, J.C., Sivertsen, B., 2013. What characterizes individuals developing chronic whiplash?: the Nord-Trondelag Health Study (HUNT). J. Psychosom. Res. 74 (5), 393–400.

OECD, 2010. Sickness, Disability and Work: Breaking the Barriers: a Synthesis of Findings across OECD Countries. OECD Publishing, Paris 24 Nov.

Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A.A., Jarawan, E., Mathers, C., 2004. World Report on Road Traffic Injury Prevention. World Health Organization, Geneva, Switzerland.

Samuelsson, A., Alexanderson, K., Ropponen, A., Lichtenstein, P., Svedberg, P., 2012. Incidence of disability pension and associations with socio-demographic factors in a Swedish twin cohort. Soc. Psychiatry Psychiatr. Epidemiol. 47 (12), 1999–2009.

Stigson, H., 2009. Evaluation of safety ratings of roads based on frontal crashes with known crash pulse and injury outcome. Traffic Inj. Prev. 10 (3), 273–278.

Stigson, H., Gustafsson, M., Sunnevang, C., Krafft, M., Kullgren, A., 2015. Differences in long-term medical consequences depending on impact direction involving passenger cars. Traffic Inj. Prev. 16 (Suppl. 1), S133–9.

Strandroth, J., 2015. Validation of a method to evaluate future impact of road safety interventions, a comparison between fatal passenger car crashes in Sweden 2000 and 2010. Accid. Anal. Prev. (76), 133–140.

The Swedish Social Insurance Agency, 2016. Social Insurance in Figures Sweden. The Swedish Social Insurance Agency, 2016.

The Swedish Road Traffic Register, 2017. Statistics Sweden. [cited 2017-09-29]. Available from:. https://www.scb.se/tk1001.

von Oelreich, E., Eriksson, M., Brattstrom, O., Discacciati, A., Strommer, L., Oldner, A., Larsson, E., 2017. Post-trauma morbidity, measured as sick leave, is substantial and influenced by factors unrelated to injury: a retrospective matched observational cohort study. Scand. J. Trauma Resusc. Emerg. Med. 25 (1), 100.