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Post-injury long-term sickness absence and risk of disability pension: The role of socioeconomic status

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ABSTRACT

Introduction: Previous research has identified low socioeconomic status (SES) as a risk factor for long-term sickness absence (LTSA) and disability pension (DP) following trauma. However, most studies lack information on medical diagnoses, limiting our understanding of the underlying factors. To address this gap, we retrieved information about diagnostic causes for receipt of welfare benefits to explore the role of SES in the transition from post-injury LTSA to permanent DP among the working population in Norway.
Materials and methods: We conducted a population-based cohort study of all Norwegian residents aged 25–59 years registered with a spell of LTSA due to injury commencing in the period 2000–2003. This cohort was followed through 2014 by linking information on receipt of welfare benefits with sociodemographic data from administrative registers. SES was defined as a composite measure of educational attainment and income level. We used flexible parametric survival models to estimate hazard ratios (HR) with 95 % confidence intervals (CI) for all-cause and diagnosis-specific DP according to SES, adjusting for sex, age, marital status, immigrant status and healthcare region of residence.
Results: Of 53,937 adults with post-injury LTSA, 9,665 (18 %) transferred to DP during follow-up. The crude risk of DP was highest for LTSA spells due to poisoning and head injuries. Overall, individuals in the lowest SES category had twice the risk of DP compared to those in the highest SES category (HR = 2.25, 95 % CI 2.13–2.38). The difference by SES was greatest for LTSA due to poisoning and smallest for LTSA due to head injuries. A majority (75 %) of DP recipients had a non-injury diagnosis as the primary cause of DP. The socioeconomic gradient was more pronounced for non-injury causes of DP (HR = 2.47, 95 % CI 2.31–2.63) than for injury causes (HR = 1.73, 95 % CI 1.56–1.92) and was especially steep for DP due to musculoskeletal diseases and mental and behavioural disorders.
Conclusions: The relationship between SES and DP varied by both the type of injury that caused LTSA and the diagnosis used to grant DP, highlighting the importance of taking diagnostic information into account when investigating long-term consequences of injuries.

Introduction

In recent decades, improvements in injury prevention and trauma care have contributed to a global reduction in injury mortality rates [1]. As the likelihood of surviving serious injury has increased, attention has shifted towards exploring the burden of non-fatal injury. This research effort has established that non-fatal injuries can have adverse effects on health-related quality of life and other functional outcomes [2–6], while also documenting substantial economic costs to society [7–8]. Of particular concern are long-term or lifelong consequences of injury, including the inability to return to work and subsequent reliance on welfare benefits to compensate for loss of income. Addressing the latter

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outcome, several studies have explored the prevalence of sickness absence (SA) and disability pension (DP) among injured patients, in the process identifying a variety of injury-related and sociodemographic risk factors [9–14]. One such factor is low socioeconomic status (SES), which has been found to increase the risk of both long-term sickness absence (LTSA) [14] and permanent DP [9] following trauma.

A limitation in this literature, however, is that studies often lack information on diagnoses, which specify the medical reason(s) for granting welfare benefits. Due to confidentiality issues, such details are seldom available. In the absence of diagnostic information, it can be difficult to attribute the need for such benefits to the effects of a particular injury, as individuals may suffer from comorbid disorders or develop additional conditions over time, thus potentially receiving benefits for reasons unrelated to that injury. Misclassification errors are particularly likely to occur for DP, which is often granted many years after an injury event [12]. In support of this claim, a recent Finnish study investigating risk of DP after LTSA due to different diagnostic causes (musculoskeletal, mental, respiratory, and circulatory diseases) found that a high proportion of individuals transferring to DP were registered with a DP diagnosis from another diagnostic group than that which was used to code the preceding LTSA spell [15]. Whether this finding extends to LTSA due to injury is, however, unknown. A further concern is that this source of misclassification may differ systematically according to SES, as low SES is associated with a range of poor health outcomes [16–18] and multimorbidity [19–22]. Yet, to our knowledge, no studies have explored the role of SES in risk of diagnosis-specific DP following injury. Likewise, few studies have assessed whether the association between SES and DP is modified by injury type.

To address these gaps, we retrieved information about diagnostic causes for receipt of welfare benefits to explore socioeconomic differences in the transition from post-injury LTSA to permanent DP among the working population in Norway, a Nordic country where all citizens of working age are covered by national tax-based programs of income maintenance, including SA benefits ensuring 100 % wage compensation for up to 52 weeks. If still unable to return to full employment, individuals can then apply for other temporary benefits and ultimately DP (corresponding to approximately 66 % of previous income with a preset ceiling for high-income earners), provided that relevant attempts at rehabilitation and vocational training have been exhausted. The main aims of this study were to investigate whether the association between DP and SES among individuals with post-injury LTSA varied according to 1) the type of injury that caused LTSA and 2) the diagnosis used to grant DP.

Materials and methods

Study design and data sources

In this nationwide population-based cohort study, we linked information on receipt of welfare benefits with sociodemographic data from administrative registers at the individual level using the unique personal identification numbers given to all Norwegian residents. Information on SA spells and DP status was obtained from Statistics Norway's historical events database (Norwegian acronym: FD-Trygd), which links basic demographic data with employment records and information on social security benefits administered by the Norwegian Labour and Welfare Administration. Statistics Norway also supplied census data (obtained from the National Population Register) and socioeconomic information in the form of educational attainment (obtained from the National Education Database) and income (obtained from tax returns and other administrative data sources). Information about diagnostic causes for receipt of SA and DP was obtained directly from the Norwegian Labour and Welfare Administration.

Study population

We established a closed cohort of all Norwegian residents aged 25–59 years registered with a spell of LTSA due to injury commencing in the period 2000–2003. Individuals below the age of 25 years were not included as many have not yet finished their education and obtained a stable income. Individuals 60 years and older were excluded because they would soon reach an age where several retirement schemes other than DP are available. We further excluded individuals who were granted DP prior to the SA spell ($N = 2929$), of whom almost all received partial DP at the time they were granted SA, thus combining DP and part-time work. Following the convention in previous Scandinavian studies [23–24] and administrative procedures in Norwegian Social Security, we defined LTSA as a sick leave spell lasting 8 weeks or longer (i.e., 56 days or more), leaving a study population of 53,937 individuals (see flowchart, Fig. 1). Individuals with more than one LTSA spell ($N = 3371$) were included with their longest SA spell.

Identification of post-injury SA

Most SA certificates are issued by general practitioners and diagnoses are thus coded according to the second edition of the *International Classification of Primary Care* (ICPC-2). We used the following ICPC-2 codes to identify post-injury SA: L72-L76 (fractures), L77-L81, L96 (dislocations/sprains/strains), N79-N80 (head injuries), S14 (burns), A84, A86 (poisoning, including toxic effects due to overdoses of both medicinal and non-medicinal substances), F75-F76, H76, H78, S12-S13, S15-S18 (superficial injuries, including open wounds) and A80-A82, A87-A88, B76-B77, D79-D80, F79, H77, H79, N81, R87-R88, S19, U80, X82, Y80 (miscellaneous injuries).

Outcome: risk of DP

The study outcomes were all-cause and diagnosis-specific DP in the period 2000–2014. Diagnoses for DP in this period were coded in accordance with either the ninth or tenth edition of the *International Statistical Classification of Diseases and Related Health Problems* (ICD-9 and ICD-10). Recipients of DP were in all cases assigned a principal diagnosis, and in many cases also a secondary diagnosis. To measure risk of diagnosis-specific DP, we first categorised recipients of DP into two main groups: 1) DP due to injury, defined as a principal diagnosis from either chapter XVII in ICD-9 (codes 800–999) or chapter XIX in ICD-10 (codes S00-T98), regardless of any secondary diagnoses; 2) DP due to all other causes than injury, defined as a principal diagnosis from any other ICD chapter, regardless of whether an injury was registered as a secondary diagnosis. This latter group was further categorised into the following five subgroups: mental and behavioural disorders (ICD-9: 290–319; ICD-10: F00-F99), diseases of the nervous system (ICD-9: 320–359; ICD-10: G00-G99), diseases of the circulatory system (ICD-9: 390–459; ICD-10: I00-I99), diseases of the musculoskeletal system and connective tissue (ICD-9: 710–739; ICD-10: M00-M99) and other diseases (i.e., all remaining non-injury codes). While we restricted our main analyses of DP to the principal diagnosis, for a complete picture we also tallied the number of individuals granted DP with an injury registered exclusively as a secondary diagnosis.

Main exposure: composite measure of SES

To capture multiple aspects of SES [25], we defined SES as a composite measure of educational attainment and income level. We first grouped highest educational attainment as of October 1st the year in which the SA spell commenced (or the year nearest in time for individuals missing information on education that year) in nine categories according to the Norwegian Standard Classification of Education [26], ranging from no education/preschool education to postgraduate education. We likewise divided pensionable income earned in the year prior

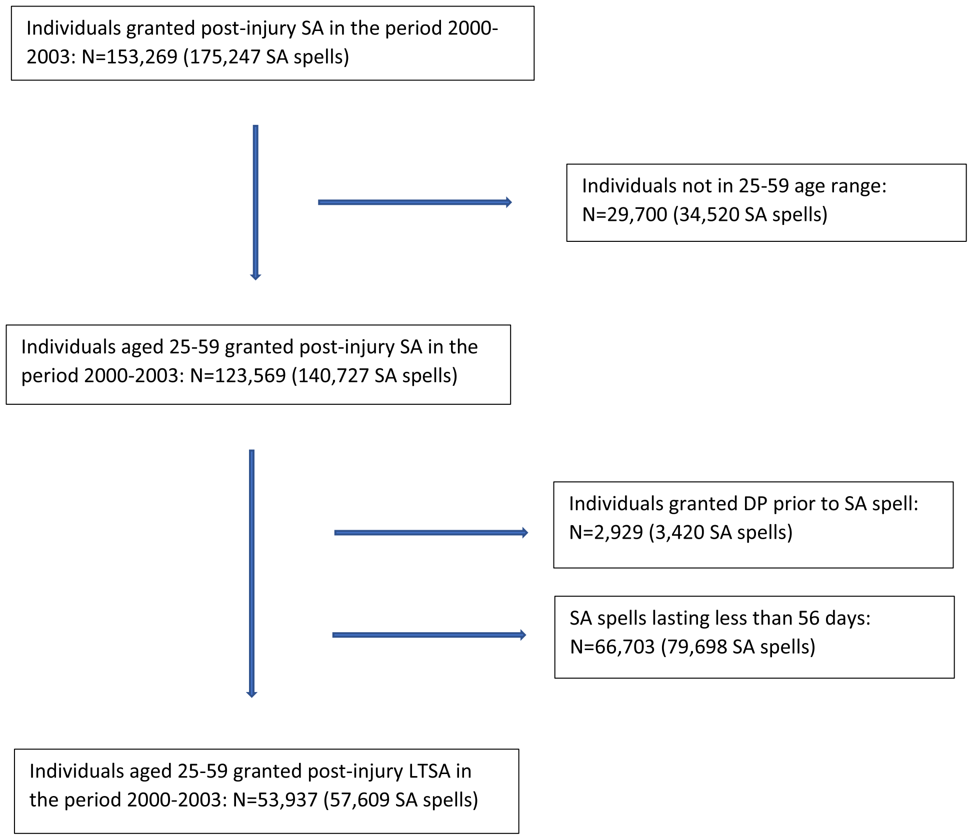

Fig. 1. Flowchart of inclusion process.

to the SA spell into nine quantiles. We then summed these two scores for each individual, yielding a composite score with values ranging from 2 to 18. For individuals with missing information on education during the entire period ($N = 548$), we computed a composite score by multiplying their income score by two, adopting a formula used previously to estimate SES in case of missing data [27–28]. No individuals had missing data for pensionable income. We finally divided this composite score into tertiles, corresponding to “low SES”, “medium SES” and “high SES”. For further details on how this composite measure was calculated, see Supplementary Tables S1-S3.

Covariates

We included the following covariates (all based on information at the start of the SA spell): sex, age, marital status, immigrant status and healthcare region of residence. Age was categorised into 5-year age groups (ranging from 25 to 29 through 55–59 years). Marital status was dichotomised as either married or unmarried, where the latter included divorced, separated, and widowed. Immigrant status was dichotomised as either immigrants (defined as individuals born abroad by two foreign-born parents) or non-immigrants (all other residents). To account for potential geographical variations in demographic composition and other risk factors correlated with SES, individuals were assigned to one of four healthcare regions based on their residential municipality: South-East, West, Central and North.

Statistical analysis

Statistical analyses were conducted in Stata 17.0. To obtain person-time at risk, each individual was followed from the start of their LTSA spell until receipt of DP or censoring at either 62 years of age (at which age many individuals are entitled to early retirement pension), date of emigration, date of death or December 31st, 2014 (end of follow-up), whichever occurred first. We performed descriptive analyses for our cohort of sickness absentees and used Chi-squared tests to compare crude proportions granted DP according to sociodemographic variables and injury type. We also estimated age-adjusted DP incidence rates within socioeconomic strata, where incidence rates were calculated as the number of individuals on LTSA granted DP divided by the sum of person-years at risk.

As preliminary analyses revealed time-dependent effects of SES on risk of DP (i.e., non-proportional hazards), we used flexible parametric survival models [29] (*stpm2* command with *tvc* option in Stata) with cubic splines ($N= 2$) as smoothers to estimate hazard ratios (HR) with 95 % confidence intervals (CI) for the outcome measures according to SES, using the highest SES tertile as reference category and adjusting for sex, age group, marital status, immigrant status and healthcare region of residence. This model allows for time-varying effects of SES on the risk of transferring to DP. We first estimated HRs with 95 % CIs for all-cause DP by SES overall, and then separately for fractures, dislocations/-sprains/strains, head injuries, burns, poisoning, superficial injuries, and miscellaneous injuries. We then estimated HRs with 95 % CIs by SES separately for DP due to injuries, all non-injury diagnoses, mental and behavioural disorders, diseases of the nervous system, diseases of the circulatory system, diseases of the musculoskeletal system, and all remaining non-injury diagnoses. We present sex-combined results, as likelihood ratio tests revealed no statistical interactions between sex and SES.

Following the definition of long-term recipients of sickness benefit used by Statistics Norway [30], we also performed a sensitivity analysis using 180 (rather than 56) days as a cut-off for LTSA. The composite measure of SES was calculated anew for this subsample, resulting in a slightly different distribution of composite scores, but the cut-off values for each SES tertile remained the same (see Supplementary Tables S4-S6).

Ethical approval

The Regional Committees for Medical and Health Research Ethics in Norway (region South-East) provided advance approval for this study (REC approval number: 2014/1945).

Results

Cohort characteristics

The study population comprised 53,937 adults aged 25–59 years with LTSA due to injury commencing in the period 2000–2003, of whom 9665 (18 %) transferred to DP during follow-up. Median follow-up time was 11.8 years. Median time from start of LTSA to DP was 6.6 years.

Crude cohort characteristics are presented in Table 1. Risk of DP

Table 1
Crude characteristics of individuals aged 25–59 years with post-injury long-term sickness absence (LTSA) during 2000–2003 in Norway, and proportion granted disability pension (DP) during follow-up between 2000 and 2014.

	Sickness absentees			Granted DP		
	N	%	Person-years	DP	%	P-value
Total	53,937	100.0	560,248	9665	17.9	
Sex						<0.001
Men	33,366	61.9	356,949	5256	15.8	
Women	20,571	38.1	203,298	4409	21.4	
Age group						<0.001
25–29	6935	12.9	87,223	445	6.4	
30–34	8061	15.0	100,612	761	9.4	
35–39	8127	15.1	99,093	1067	13.1	
40–44	7808	14.5	93,085	1416	18.1	
45–49	7633	14.2	85,220	1932	25.3	
50–54	7981	14.8	64,545	2301	28.8	
55–59	7392	13.7	30,468	1743	23.6	
Marital status [a]						<0.001
Married	27,626	51.3	269,558	5307	19.2	
Unmarried	26,182	48.7	289,414	4351	16.6	
Immigrant status						0.331
Non-immigrants	49,779	92.3	517,670	8943	18.0	
Immigrants	4158	7.7	42,578	722	17.4	
Healthcare region of residence [b]						<0.001
South-East	30,107	56.0	312,891	5335	17.7	
West	9308	17.3	96,922	1584	17.0	
Central	8256	15.3	85,609	1442	17.5	
North	6140	11.4	63,589	1297	21.1	
Injury type						<0.001
Fractures [c]	22,918	42.5	232,748	3634	15.9	
Dislocations/sprains/strains [d]	21,423	39.7	230,943	3726	17.4	
Head injuries [e]	1868	3.5	18,537	516	27.6	
Burns [f]	285	0.5	2875	41	14.4	
Poisoning [g]	84	0.2	806	31	36.9	
Superficial injuries [h]	1592	3.0	16,643	280	17.6	
Miscellaneous injuries [i]	5767	10.7	57,695	1437	24.9	
SES						<0.001
1st tertile (lowest)	21,211	39.3	213,592	4973	23.5	
2nd tertile	15,849	29.4	168,078	2721	17.2	
3rd tertile (highest)	16,877	31.3	178,577	1971	11.7	

[a] Marital status was missing for 129 individuals.
[b] Healthcare region of residence was missing for 126 individuals.
[c] ICPC-2 codes L72-L76.
[d] ICPC-2 codes L77-L81, L96.
[e] ICPC-2 codes N79-N80.
[f] ICPC-2 code S14.
[g] ICPC-2 codes A84, A86.
[h] ICPC-2 codes F75-F76, H76, H78, S12-S13, S15-S18.
[i] ICPC-2 codes A80-A82, A87-A88, B76-B77, D79-D80, F79, H77, H79, N81, R87-R88, S19, U80, X82, Y80.

Table 2
Incidence rates[a] (IR) and hazard ratios[b] (HR) for all-cause DP by SES and injury type.

	Overall		Fractures [c]		Dislocations/sprains/strains [d]		Head injuries [e]		Burns [f]		Poisoning [g]		Superficial injuries [h]		Miscellaneous injuries [i]	
N at risk	53,937		22,918		21,423		1868		285		84		1592		5767	
Number of DPs granted	9665		3634		3726		516		41		31		280		1437	
SES	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**
1st tertile (lowest)	29.8 (28.9 – 30.6)	2.25 (2.13 – 2.38)	27.5 (26.3 – 28.8)	2.57 (2.34 – 2.81)	29.0 (27.6 – 30.3)	2.32 (2.12 – 2.53)	44.6 (37.8 – 51.3)	1.82 (1.47 – 2.26)	25.0 (12.9 – 37.1)	3.44 (1.29 – 9.20)	86.8 (36.2 – 137.5)	4.31 (1.38 – 13.45)	29.3 (24.4 – 34.1)	2.47 (1.76 – 3.48)	40.6 (37.3 – 43.8)	1.89 (1.65 – 2.17)
2nd tertile	21.2 (20.4 – 22.1)	1.60 (1.51 – 1.69)	19.7 (18.4 – 21.0)	1.76 (1.60 – 1.94)	19.2 (18.0 – 20.4)	1.59 (1.44 – 1.75)	38.6 (32.2 – 45.1)	1.53 (1.22 – 1.90)	23.1 (11.5 – 34.6)	3.30 (1.27 – 8.58)	42.1 (12.8 – 71.4)	1.70 (0.57 – 5.11)	19.0 (14.6 – 23.3)	1.60 (1.10 – 2.31)	30.9 (27.9 – 33.9)	1.46 (1.26 – 1.68)
3rd tertile (highest)	13.4 (12.8 – 14.0)	1.00 (ref)	11.3 (10.5 – 12.2)	1.00 (ref)	12.2 (11.3 – 13.1)	1.00 (ref)	26.2 (22.2 – 30.1)	1.00 (ref)	7.9 (1.4 – 14.4)	1.00 (ref)	27.8 (5.1 – 50.5)	1.00 (ref)	12.5 (8.8 – 16.2)	1.00 (ref)	21.1 (18.7 – 23.4)	1.00 (ref)

[a] Number of new cases per 1000 person-years at risk, adjusted for age.
[b] Adjusted for sex, age group, marital status, immigrant status and healthcare region of residence.
[c] ICPC-2 codes L72-L76.
[d] ICPC-2 codes L77-L81, L96.
[e] ICPC-2 codes N79-N80.
[f] ICPC-2 code S14.
[g] ICPC-2 codes A84, A86.
[h] ICPC-2 codes F75-F76, H76, H78, S12-S13, S15-S18.
[i] ICPC-2 codes A80-A82, A87-A88, B76-B77, D79-D80, F79, H77, H79, N81, R87-R88, S19, U80, X82, Y80.

increased strongly with increasing age and was highest for individuals aged 50–54 years. While the cohort overall consisted of more men, a higher proportion of women transferred to DP. Risk of DP was also higher among married than unmarried individuals. These differences were partly explained by differences in age distribution, as median age was lower for men (40 years vs. 45 years for women) and unmarried individuals (37 years vs. 46 years for married individuals). Risk of transferring to DP did not differ according to immigrant status but was higher among individuals residing in the north of Norway than in other regions, which was partly explained by regional differences in SES (data not shown). The most common diagnostic categories used to classify LTSA were fractures and dislocations/sprains/strains, which together comprised more than 80 % of all SA spells. Among these injury types, additional analyses indicated that lower limb injuries were more frequent than upper limb injuries, but they did not incur a greater risk of DP (data not shown). The proportions transferring to DP were highest for LTSA spells caused by poisoning and head injuries (Table 1).

Socioeconomic differences in risk of all-cause DP

Overall, we observed an inverse relationship between SES and DP, where the crude risk of DP was highest for individuals in the lowest SES category and decreased with increasing SES (Table 1). After adjusting for sex, age group, marital status, immigrant status and healthcare region of residence, people in the lowest SES category had approximately twice the risk of all-cause DP compared to people in the highest SES category (HR = 2.25, 95 % CI 2.13–2.38) (Table 2).

Table 2 also shows that an inverse socioeconomic gradient was observed for all injury types. The absolute and relative difference by SES was greatest for LTSA due to poisoning, where individuals in the lowest SES category had a fourfold risk of all-cause DP than individuals in the highest SES category (HR = 4.31, 95 % CI 1.38–13.45). The relative difference by SES was also strong for LTSA due to burns (HR = 3.44, 95 % CI 1.29–9.20). However, these estimates had large uncertainty due to few DP cases in these groups. The relative difference by SES was smallest for LTSA due to head injuries, where individuals in the lowest SES category had an 82 % higher risk of all-cause DP compared to individuals in the highest SES category (HR = 1.82, 95 % CI 1.47–2.26, Table 2). Still, compared to most other injury types, the absolute risk of DP for LTSA due to head injuries was high, also for the highest SES category.

Socioeconomic differences in risk of diagnosis-specific DP

Of individuals with post-injury LTSA who were later granted DP, a majority (75 %) had a non-injury diagnosis registered as the primary cause of DP (Table 3). The most common diagnostic subgroup used to grant DP was diseases of the musculoskeletal system (33 % of all DP cases). While 2379 DP recipients (25 %) had an injury as the principal diagnosis, a further 385 individuals (4 %) were granted DP with an injury registered exclusively as the secondary diagnosis.

Table 3 shows that the socioeconomic gradient in risk of DP varied by the diagnosis used to grant DP. Compared to people in the highest SES category, those in the lowest SES category had more than twice the risk of DP due to non-injury causes (HR = 2.47, 95 % CI 2.31–2.63), but only a 73 % increased risk of DP due to injury (HR = 1.73, 95 % CI 1.56–1.92). Comparing the non-injury subgroups, the absolute and relative difference by SES was especially strong for DP due to diseases of the musculoskeletal system and mental and behavioural disorders, with HRs for the lowest vs. highest SES category of 3.12 and 2.68 respectively. The socioeconomic gradient was smaller for diseases of the nervous system, where individuals in the lowest SES category had a 73 % increased risk of DP compared to those in the highest SES category (HR = 1.73, 95 % CI 1.40–2.14).

Sensitivity analysis

The sensitivity analysis revealed some differences from the main analysis but did not change the overall pattern of results. Defining LTSA as a sick leave spell lasting 180 (rather than 56) days or longer reduced the sample size to 17,341 individuals (32 % of the original study population), of which 30 % were later granted DP (main analysis: 18 %). Median time from start of LTSA to DP was 5.4 years (main analysis: 6.6 years). A majority (64 %) of individuals granted DP had a non-injury diagnosis as the primary cause of DP (main analysis: 75 %) (see Supplementary Table S9). Descriptive statistics of this subsample revealed

Table 3
Incidence rates[a] (IR) and hazard ratios[b] (HR) for diagnosis-specific DP by SES.

	Injury [c]		Non-injury DP All non-injury diagnoses [d]		Mental and behavioural disorders [e]		Diseases of the nervous system [f]		Diseases of the circulatory system [g]		Diseases of the musculoskeletal system [h]		Remaining non-injury diagnoses [i]	
Number of DPs granted	2379		7286		1559		575		590		3214		1348	
SES	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**	**IR (95 % CI)**	**HR (95 % CI)**
1st tertile (lowest)	6.7 (6.3 – 7.2)	1.73 (1.56 – 1.92)	23.0 (22.2 – 23.7)	2.47 (2.31 – 2.63)	4.5 (4.2 – 4.9)	2.68 (2.32 – 3.09)	1.5 (1.3 – 1.7)	1.73 (1.40 – 2.14)	1.6 (1.4 – 1.8)	1.91 (1.54 – 2.37)	11.3 (10.8 – 11.9)	3.12 (2.81 – 3.45)	3.9 (3.6 – 4.2)	1.73 (1.50 – 1.99)
2nd tertile	5.7 (5.2 – 6.1)	1.38 (1.24 – 1.54)	15.6 (14.9 – 16.3)	1.69 (1.58 – 1.81)	2.6 (2.3 – 2.9)	1.58 (1.36 – 1.85)	1.1 (0.9 – 1.3)	1.26 (1.00 – 1.59)	1.7 (1.5 – 2.0)	1.70 (1.37 – 2.11)	7.1 (6.6 – 7.6)	2.03 (1.82 – 2.26)	3.1 (2.8 – 3.5)	1.43 (1.24 – 1.66)
3rd tertile (highest)	4.2 (3.8 – 4.5)	1.00 (ref)	9.2 (8.7 – 9.7)	1.00 (ref)	1.6 (1.4 – 1.8)	1.00 (ref)	0.9 (0.7 – 1.0)	1.00 (ref)	1.1 (0.9 – 1.2)	1.00 (ref)	3.5 (3.2 – 3.8)	1.00 (ref)	2.2 (1.9 – 2.4)	1.00 (ref)

[a] Number of new cases per 1000 person-years at risk, adjusted for age.
[b] Adjusted for sex, age, marital status, immigrant status and healthcare region of residence.
[c] Defined as DP with a principal diagnosis from either chapter XVII in ICD-9 (codes 800–999) or chapter XIX in ICD-10 (codes S00-T98).
[d] Defined as DP with a principal diagnosis from all non-injury chapters in ICD-9 or ICD-10.
[e] Defined as DP with a principal diagnosis from chapter V in either ICD-9 (codes 290–319) or ICD-10 (codes F00-F99).
[f] Defined as DP with codes 320–359 (ICD-9) or codes G00-G99 (chapter VI in ICD-10) as principal diagnosis.
[g] Defined as DP with a principal diagnosis from either chapter VII in ICD-9 (codes 390–459) or chapter IX in ICD-10 (codes I00-I99).
[h] Defined as DP with a principal diagnosis from chapter VIII in either ICD-9 (codes 710–739) or ICD-10 (codes M00-M99).
[i] Defined as DP with a principal diagnosis from all other non-injury chapters in ICD-9 or ICD-10 not specified in e-h.

the same patterns as in the main analysis, except that crude risk of DP was found to be higher among non-immigrants than immigrants (see Supplementary Table S7). This subsample also had a slightly lower socioeconomic profile than the entire cohort (see Supplementary Tables S4-S6). Furthermore, this sensitivity analysis consistently produced a weaker socioeconomic gradient in the regression analyses. With this cut-off, people in the lowest SES category had a 71 % increased risk of all-cause DP compared to people in the highest SES category (main analysis: HR = 2.25) (see Supplementary Table S8). However, as in the main analysis, the socioeconomic gradient in risk of all-cause DP was observed to be largest for LTSA due to poisoning and burns (see Supplementary Table S8). In addition, the socioeconomic differences in risk of diagnosis-specific DP remained largely unchanged, with the effect of SES stronger for DP due to non-injury causes (especially diseases of the musculoskeletal system and mental and behavioural disorders) than for DP due to injury (see Supplementary Table S9).

Discussion

In this nationwide registry study covering all post-injury LTSA spells over a four-year period among the working population in Norway, we revealed socioeconomic inequalities in the transition to permanent DP. Overall, our results showed an inverse social gradient, with risk of DP consistently observed to be highest for individuals with low SES and to decrease with increasing SES. Furthermore, although the strength of the association between SES and DP varied to some extent both by the type of injury that caused LTSA and by the diagnosis used to grant DP, we observed an inverse social gradient in risk of DP for all injury types examined and across all major causes of DP. These findings add to a large body of research that has established SES as an important determinant for many health-related outcomes [16-18,31-33], including reliance on DP to compensate for permanent loss of earning ability [9, 24, 34-37].

A novel finding in our study was that the socioeconomic gradient among this cohort of sickness absentees was more pronounced for cases where DP was granted due to non-injury causes than due to injury. In explaining this finding, it seems plausible to tie this difference to a greater prevalence of multimorbidity among individuals with low SES [19–22]. Thus, in addition to dealing with the impact of an injury, these individuals may to a larger degree also suffer from comorbid conditions, either present at the time of the injury or developed subsequently (e.g., as complications to the injury), resulting in a greater risk of transferring to DP even if the injury were to heal or, by itself, not be severe enough to cause medical disability.

It is also worth noting that among those with post-injury LTSA later granted DP, a clear majority (75 %) received a non-injury diagnosis as the primary cause of DP. A similar pattern has recently been observed for other medical conditions, with a change in diagnostic categories for individuals transferring to DP especially likely for those with LTSA due to respiratory diseases and circulatory diseases [15]. These findings may suggest that multimorbidity is the norm for recipients of DP, with multiple causes “competing” for diagnostic ascendency. However, we cannot rule out other explanations for our finding. Since DP often is granted many years after a spell of LTSA (in our data, median time to DP was 6.6 years), some individuals may fully heal from the injury and return to normal functioning before developing a new medical condition, triggering a new SA spell unrelated to the previous injury. In such cases, the most recent medical condition would represent the actual, and sole, cause for subsequent DP. Alternatively, some injuries may heal physically but give rise to mental health problems such as post-traumatic stress disorder (PTSD) or depression, disorders which have been found to independently predict long-term functional disability following major trauma [38–40]. Another possibility is that even in cases where an injury is the only medical condition causing long-term disability, this injury may with the passing of time be re-classified as a chronic health condition (i.e., a disease). This type of re-classification may be especially likely for injuries that often result in permanent medical impairment and consequently managed as chronic conditions, such as traumatic brain injury [5,41-45], joint injuries [46], and burns [47], which over time may evolve into diseases like encephalopathy, arthrosis, and hypertrophic scar, respectively.

We further found that the effect of SES varied between the non-injury subgroups. Consistent with previous studies examining socioeconomic differences in cause-specific DP in the general population [48–51], the socioeconomic gradient was especially steep for DP due to diseases of the musculoskeletal system. We also observed large socioeconomic differences for DP due to mental and behavioural disorders. In contrast, the differences by SES were less pronounced for DP due to diseases of the nervous system and DP due to diseases of the circulatory system. In the absence of information on potential explanatory factors, we can only speculate on the reasons for these cause-specific differences. Conceivably, these findings may simply reflect socioeconomic inequalities in the overall prevalence of these diseases (i.e., independently of whether they result in DP or were preceded by post-injury LTSA), with socioeconomic gradients in disease prevalence reproduced in our estimates of cause-specific DP. Alternatively, these differences may be specific to our study, instead reflecting the composition of our cohort. More than 80 % of all LTSA spells included were due to injuries to the musculoskeletal system (i.e., fractures and dislocations/sprains/strains), raising the possibility that risk factors which contribute particularly to socioeconomic differences in musculoskeletal complaints (e.g., physically demanding work [50,52]) may exert a greater influence in our study than other risk factors more important in generating socioeconomic differences in other diseases, such as nutrition, smoking and alcohol consumption in the case of cardiovascular diseases [53–54].

We also observed some interesting differences when comparing the types of injuries causing LTSA. Risk of transferring to DP was especially high for LTSA due to poisoning and head injuries, and lower for fractures, dislocations/sprains/strains, burns and superficial injuries. A similar pattern has previously been reported in a study from Denmark [55]. While it seems plausible to partly attribute these findings to differences in injury severity, our injury categories are likely too broad to draw any firm conclusions. When exploring differences by SES in risk of DP, however, a different picture emerged. Specifically, the socioeconomic gradient was strongest for LTSA due to poisoning and burns and weakest for head injuries, with the other injury types in between. While we can only speculate as to why socioeconomic deprivation seems to be a stronger risk factor for subsequent DP for some injury types than others, the greater prevalence of multimorbidity among individuals with low SES [19–22] may feasibly also apply here, with comorbid conditions particularly likely to co-occur in cases of poisoning and burns, thereby contributing to stronger socioeconomic inequalities for these injury types. For instance, poisoning may result from unintentional overdoses in patients with substance use disorders, or intentional overdoses in patients with depression or other mental health disorders. However, there are surely other mechanisms mediating socioeconomic inequalities in risk of DP between these injury types that await further examination.

Strengths and limitations

Strengths of this study include the population-based design with up to 15 years of follow-up and the ability to link individual-level data from mandatory national registers. Using both income and educational level to measure SES may also give more reliable estimates of SES than either of these dimensions alone [25]. Moreover, unlike many studies exploring the prevalence of SA and DP, we had access to diagnostic information. While including such data should provide more reliable estimates when investigating long-term consequences of injuries, the validity of these diagnoses may still be a concern. In cases of multimorbidity, it may be difficult to reduce a complex medical condition to a single diagnosis, as additional conditions can develop over time and interact with pre-existing conditions. Likewise, some patients may develop sequelae resulting from side effects of treatment or polypharmacy, further complicating the diagnostic process. There is also reason to suspect that diagnostic validity may differ systematically by SES, arising for instance from social inequalities in physician-patient communication [56–57].

Another shortcoming is that we lacked information about the external circumstances that contribute to injuries, as injury data in this study were restricted to diagnostic codes in ICPC-2 (for SA spells) and nature of injury codes in ICD (for DP). These classification systems provide mainly a medical/anatomical description of the injury, which is less useful for prevention purposes. For instance, we lacked information about the intent of injury and were thus unable to separate intentional from unintentional poisoning. The lack of details in ICPC-2 also prevented us from investigating certain kinds of injuries, such as spinal injuries. Furthermore, our study did not have sufficient data on occupational class [15] and work environment, factors which likely mediate the relationship between SES and DP. Finally, granting of DP and other welfare benefits is highly dependent on contextual factors such as legislation, religion and other cultural aspects, and traditions. Consequently, our findings will not necessarily generalise to other countries. Likewise, as data were available only until 2014, we were unable to explore more recent trends.

Conclusions

We showed an inverse socioeconomic gradient in the transition from post-injury LTSA to permanent DP, suggesting that treatment and rehabilitation efforts following trauma need to be particularly directed towards individuals with low SES. We further found that the association between SES and DP varied both by the type of injury that caused LTSA and the diagnosis used to grant DP. These findings highlight the importance of taking diagnostic information into account when examining long-term consequences of injuries.

CRediT authorship contribution statement

Eyvind Ohm: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. **Christian Madsen:** Conceptualization, Formal analysis, Methodology, Validation, Writing – review & editing. **Hans Magne Gravseth:** Validation, Writing – review & editing. **Søren Brage:** Validation, Writing – review & editing. **Else Karin Grøholt:** Validation, Writing – review & editing. **Kari Alver:** Writing – review & editing, Conceptualization. **Kristin Holvik:** Investigation, Methodology, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2024.111480.

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