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Under-reporting of non-fatal occupational injuries among precarious and non-precarious workers in Sweden

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ABSTRACT

Background Under-reporting of occupational injuries (OIs) among precariously employed workers in Sweden challenges effective surveillance of OIs and targeted preventive measures.

Objective To estimate the magnitude of under-reporting of OIs among precarious and non-precarious workers in Sweden in 2013.

Methods Capture–recapture methods were applied using the national OIs register and records from a labour market insurance company. Employed workers 18–65 resident in Sweden in 2013 were included in the study (n=82 949 OIs). Precarious employment was operationalised using the national labour market register, while injury severity was constructed from the National Patient Register. Under-reporting estimates were computed stratifying by OIs severity and by sociodemographic characteristics, occupations and precarious employment.

Results Under-reporting of OIs followed a dose–response pattern according to the levels of precariousness (the higher the precarious level, the higher the under-reporting) being for the precarious group (22.6%, 95% CI 21.3% to 23.8%), followed by the borderline precarious (17.6%, 95% CI 17.1% to 18.2%) and lastly the non-precarious (15.0%, 95% CI 14.7% to 15.3%). Under-reporting of OIs, decreased as the injury severity increased and was higher with highest level of precariousness in all groups of severity. We also observed higher under-reporting estimates among all occupations in the precarious and borderline precarious groups as compared with the non-precarious ones.

Conclusions This is the first register-based study to empirically demonstrate in Sweden that under-reporting of OIs is 50% higher among precariously employed workers. OIs under-reporting may represent unrecognised injuries that especially burden precariously employed workers as financial, health and social consequences shift from the employer to the employee.

INTRODUCTION

Under-reporting of occupational injuries (OIs), illnesses and other safety and health indicators negatively affect surveillance and targeted preventive measures.^{1–3} In the ‘90s, the under-reporting of OIs across all economic sectors in Sweden was estimated to be approximately 50%.⁴ In a recent

Key messages

What is already known about this subject?

► A rich literature indicates a positive association between certain dimensions of precarious employment and occupational injuries (OIs), as well as substantial under-reporting. Qualitative studies have identified the main reasons why precarious workers may decide to not report an injury, but little is known about the extent of under-reporting in this group.

What are the new findings

- Under-reporting of OIs is 50% higher among precariously employed workers as compared with those in standard employment relationships.
- Across all sociodemographic characteristics, there is likely to be more under-reporting of OIs among precariously employed workers.
- Under-reporting remains highest among the most precarious groups irrespectively of injury severity.
- Individual dimensions of precarious employment were associated with highest under-reporting, such as income, workers with unstable employment and multiple job holders with more than three employers.

How might this impact on policy or clinical practice in the foreseeable future?

► By increasing the understanding between precarious employment and under-reporting of OIs, organisations may learn better approaches to improve reporting, address root causes of workplace injuries, and design health and safety programmes aimed at tackling specific component of the workforce—for example, precariously employed workers.

study published by Orellana *et al*, 27% of OIs in Sweden in 2013 were not captured in the official injury register.⁵ This estimate was restricted to the public sector and to private companies with more than 50 employees, thus is a conservative estimate of the overall under-reporting as smaller privately held companies have lower reporting rates.^{6,7} Precarious employment (PE), which is

characterised by employment insecurity, income inadequacy and lack of rights and protection, is a well-known social determinant of health and health inequalities and has been associated in the last decades with several adverse mental and physical health outcomes in workers.^{8,9} Several studies have indicated a positive association between certain dimensions of PE and OIs.^{10–12} A systematic review by Koranyi *et al* found that two aspects of PE provided the strongest evidence for an elevated risk of OIs, namely employees working in multiple jobs and being employed by a temporary agency.^{10,13,14} Few studies have directly examined under-reporting of OIs for precariously employed workers. A Canadian study by Shannon and Lowe found differential levels of under-reporting by injury severity, but no associations between under-reporting levels and temporary employment, multiple job holding nor when looking at occupation.¹ Probst *et al* found in a comparative study between USA and Italy that the tendency to under-report workplace injuries increased with increased perception of job insecurity.¹⁵ Due to their insecure position, precariously employed workers face more complex decisions whether to report OIs and may accept certain injury hazards as the price of employment.^{15,16} Rich evidence from qualitative studies shows that precariously employed workers identify fear of employment reprisal as one of the main reasons for accepting unsafe conditions and OIs.^{16–19} It is also worth noting the tendency towards an enforced work mobility, which suggests that precariously employed workers are likely to have short job tenure, less training about the physical workplace, less acquaintance with other workers and local management, more stressful and heavier work tasks and a higher tendency to work when sick.^{9,20} Not surprisingly they are also likely to be less aware of work hazards since they receive less training and supervision.²¹ Other determinants have been shown to play a role in under-reporting from the employee side such as variation in workers' experience, loss of over-time work, fear of being labelled as 'unable to do their job' or as a 'complainer', lack of proper in-job-training or employment insecurity.^{2,3,16} Other explanations for under-reporting of OIs have been identified in the literature at company level, such as poor employer record-keeping practices, lack of knowledge or understanding of the regulations, lack of health and safety procedures, poor organisational safety climate and differential reporting by company size and sector of economic activity.^{5,22–24}

To the best of our knowledge, no published study to date has examined the magnitude of under-reporting, specifically among precariously employed workers compared with non-precarious workers, using a multidimensional definition of PE.^{15,16} The lack of accurate data on under-reporting of OIs in the Swedish labour market, and more specifically among precariously employed workers, is a concern to workers, employers, occupational health and safety professionals, unions and policy-makers in order to be able to control hazards and prevent workplace injuries.

Aim

The aim of this study was to estimate the magnitude of under-reporting of OIs among employed workers in Sweden in 2013 according to level of employment precariousness. Our hypothesis was that under-reporting of OIs is higher among precariously employed workers as compared to non-precarious workers.

Methods

Data sources

This is a register-based study of OI among individuals aged 18–65 years old residing and working in Sweden in 2013.

Data were extracted from four registers, which are described in greater detail in our published protocol²⁵: (1) the Longitudinal Integration Database for Health Insurance and Labour Market Studies register (LISA) for employment and demographic data and for development of a PE score; (2) the Information System on Occupational Injuries (ISA), a national OIs register held by the Swedish Work Environment Authority; (3) the AFA, a mutual insurance company is owned by employers' organisations and trade unions and provides a separate source of OIs reports and (4) the National Patient Register (NPR) to characterise injury severity.

Exclusion criteria were: (1) incomplete information for measuring the exposure variable (PE level), (2) death, emigration or immigration during the year, (3) OIs occurred during transit to/from work since they are reported to traffic insurance instead, (4) injuries due to accumulated exposure and near injuries were also excluded from this study since they are not included in the definition of OIs required to be reported and (5) <90% probability that the employer of the individual paid occupational pension. This last criterion is because one of the two data sources for injury reports only includes employers that pay insurance fees, which is essentially equivalent to paying occupational pensions. Consequently, all self-employed persons and persons working for small companies (<10 employees) were excluded. See flow chart of the total population in online supplemental figure S1.

Employment and demographic data

Sociodemographic and employment data were collected for the year 2013 from LISA providing individual-level data on sex, age, country of birth, highest completed education, family composition and occupation. Data on individuals' employers were also collected from LISA in order to construct a PE score, including reference employer (largest source of income in November) as well as secondary and tertiary employers, economic sector, number of employees in the company and ownership sector. Reference employer was also retrieved for year 2011 and 2012. We adapted the Jonsson *et al* PE score that was based on a total of five items within three dimensions: employment insecurity, income inadequacy and lack of rights and protection.²⁶ For the purpose of this study, only employment insecurity and income inadequacy were included in the PE score. Lack of rights and protection could not be included directly given the unavailability of the data. Employment scores were categorised in three groups resulting in a score ranging between –7 and +2. The PE score was then categorised as being precarious (–7 to –3), borderline precarious (–2 to –1) and non-precarious (0–2).

Occupational Injuries

Information on all reported non-fatal OIs were retrieved from two data sources: the ISA register and the AFA Insurance records. Both ISA and AFA use the Swedish Legal definition of OIs: 'an OI is an injury due to accident(s), which occurred at the workplace or other place where the injured person had been for work. For an event to be counted as an accident, it is required that the course was relatively short and arose in connection with a particular event'.²⁷

Official ISA statistics covers all employees in Sweden and the employee is responsible for notifying the employer of the OI who is obligated to report it. The AFA register primarily includes workplaces that are covered by a collective bargaining agreement. Employees report directly into AFA through an online form.

Injury severity

Injury severity was operationalised using data from the NPR, which includes all visits to inpatient or specialised outpatient care. OIs in ISA and AFA were linked based on a ± 7 days range, considering injuries reported within a week in either of them as being the same workplace injury. Similarly, information on severity was added from the NPR linking date of admission with injury date on a ± 7 days' range. Finally, OIs severity was operationalised following three levels of increasing OIs severity: no healthcare (no admission in NPR), outpatient care and hospitalisation. Individuals were linked across years with the use of an (anonymised) identification number replacing the unique Swedish personal identification number.

Statistical analysis

We applied a two-source capture–recapture method, estimating the total number of OIs, including those not reported to either source, using the Lincoln–Peterson estimator that assumes source independence.²⁸ Ascertainment for each data source was calculated as the actual number of OIs divided by the capture–recapture estimate. Estimates were computed separately for OI severity, all sociodemographic characteristics, occupations and PE levels. To adjust for predictors (sex, age and country of birth) and make the independence assumption more plausible, we calculated our estimates by means of log-linear regression models.²⁹ Data management was conducted using SAS V.9.4. Capture–recapture estimates were obtained in R (R Foundation for Statistical Computing), including bootstrap to obtain 95% CIs.

Results

After merging datasets from ISA and AFA (70 063 and 44 075 injuries, respectively), a final sample for analysis included 82 949 unique OIs, of which 31 189 (37.6%) overlapped. The capture–recapture analysis resulted in a mean estimate of 13 522 under-reported OIs. The distribution of reported OIs and estimates of under-reporting by sociodemographic factors, severity and level of precariousness are presented in [table 1](#). Under-reporting of OIs was 50% higher ($22.6/15=1.50$) among precariously employed workers as compared with those standardly employed and it followed a dose–response pattern according to the levels of precariousness (the more the precarious, the more the under-reporting) as evidenced by the precarious (22.6%, 95% CI 21.3% to 23.8%), followed by borderline precarious (17.6%, 95% CI 17.1% to 18.2%) and lastly the non-precarious (15.0%, 95% CI 14.7% to 15.3%).

We did not find differential under-reporting associated with country of birth or family composition ([table 1](#)). Non-Swedish born individuals were further merged in one unique group in order to increase statistical power, but results were once again non-significant. Under-reporting was higher among females compared with males (17.8%, 95% CI 17.4% to 18.3% vs 14.4%, 95% CI 14.0% to 14.7%), younger compared with older (19.8%, 95% CI 18.6% to 21.0% vs 15.5%, 95% CI 14.9% to 16.0%) (online supplemental S2). Notably under-reporting increased with increased educational level and this pattern was consistent across all levels of precariousness ([table 1](#)).

Under-reporting estimates by injury severity are presented in [table 2](#). Under-reporting of the OIs decreased as the injury

Table 1 Capture–recapture estimates of under-reported non-fatal occupational injuries by sociodemographic factors, severity and employment relationship in 2013 in Sweden

| | Precarious (7.6%) | | Borderline precarious (27.9%) | | Non-precarious (64.5%) | |
|-----------------------------------|-------------------|-------------------------|-------------------------------|-------------------------|------------------------|-------------------------|
| | Total observed | Under-report % (95% CI) | Total observed | Under-report % (95% CI) | Total observed | Under-report % (95% CI) |
| Total | 6275 | 22.6 (21.3 to 23.8) | 23179 | 17.6 (17.1 to 18.2) | 53495 | 15.0 (14.7 to 15.3) |
| Gender | | | | | | |
| Male | 2757 | 21.6 (20.1 to 23.2) | 9594 | 16.4 (15.6 to 17.1) | 28940 | 13.2 (12.8 to 13.6) |
| Female | 3518 | 22.9 (21.3 to 24.5) | 13585 | 18.0 (17.2 to 18.7) | 24555 | 17.1 (16.5 to 17.6) |
| Age | | | | | | |
| 18–24 | 1746 | 24.0 (21.6 to 26.3) | 2038 | 19.8 (17.9 to 21.8) | 2231 | 16.9 (15.3 to 18.5) |
| 25–34 | 1916 | 23.3 (21.1 to 25.5) | 5338 | 19.0 (17.8 to 20.1) | 9812 | 14.3 (13.5 to 15) |
| 35–54 | 2015 | 21.2 (19.2 to 23.2) | 10803 | 17.1 (16.3 to 17.9) | 28453 | 15.2 (14.7 to 15.6) |
| 55–65 | 598 | 20.6 (17.1 to 24.1) | 5000 | 16.6 (15.4 to 17.7) | 12999 | 14.8 (14.2 to 15.4) |
| Country of birth | | | | | | |
| Sweden | 5224 | 22.3 (21.0 to 23.7) | 18801 | 17.6 (17.0 to 18.2) | 44090 | 14.7 (14.4 to 15.1) |
| Nordic countries | 105 | 24.6 (14.5 to 34.7) | 544 | 16.4 (13.0 to 19.7) | 1449 | 14.2 (12.4 to 16.0) |
| Europe | 370 | 21.9 (17.4 to 26.5) | 1505 | 17.5 (15.5 to 19.5) | 3674 | 16.0 (14.8 to 17.3) |
| Non-Europe | 552 | 24.3 (20.6 to 27.9) | 2225 | 17.9 (16.1 to 19.7) | 4062 | 17.5 (16.2 to 18.8) |
| Missing | 348 | – | – | – | – | – |
| Highest educational level | | | | | | |
| Primary school | 640 | 20.4 (17.2 to 23.6) | 2915 | 16.5 (15.2 to 17.9) | 6114 | 13.3 (12.4 to 14.2) |
| Secondary school | 4089 | 22.0 (20.6 to 23.4) | 14630 | 17.0 (16.4 to 17.7) | 32099 | 15.5 (15.1 to 15.9) |
| Tertiary education <3 years | 847 | 23.8 (20.7 to 26.9) | 2610 | 17.9 (16.3 to 19.5) | 7505 | 10.2 (9.5 to 10.9) |
| Tertiary education ≥ 3 years | 690 | 26.1 (21.9 to 30.3) | 2957 | 21.7 (19.8 to 23.6) | 7653 | 20.2 (19.1 to 21.3) |
| Family composition | | | | | | |
| Single | 2689 | 23.3 (21.6 to 25.0) | 7662 | 17.4 (16.5 to 18.3) | 17688 | 14.6 (14.0 to 15.2) |
| Single with children | 768 | 21.5 (18.1 to 25.0) | 2374 | 19.7 (18.0 to 21.5) | 5174 | 16.9 (15.7 to 18.0) |
| Couple with children | 2274 | 23.2 (21.3 to 25.1) | 9584 | 17.8 (17.0 to 18.7) | 22079 | 15.0 (14.5 to 15.5) |
| Couple with no children | 544 | 18.0 (14.3 to 21.6) | 3559 | 16.2 (14.8 to 17.6) | 8554 | 14.7 (13.9 to 15.5) |

Nordic countries: Denmark, Finland, Iceland, Norway, without Sweden.

Europe: European continent including member and non-members of the EU-28 countries (without Nordic countries)

Table 2 Capture–recapture estimates of under-reported non-fatal occupational injuries (n=82 949) by severity and employment relationship in 2013 in Sweden

| Injury severity | Total observed | Under-report % (95% CI) | Captured ISA % (95% CI) | Captured AFA % (95% CI) |
|------------------------------|----------------|-------------------------|-------------------------|-------------------------|
| Total | | | | |
| No healthcare | 67 739 | 18.1 (17.8 to 18.5) | 70.2 (69.7 to 70.6) | 39.2 (38.9 to 39.6) |
| Outpatient | 13 494 | 8.9 (8.5 to 9.4) | 71.5 (70.7 to 72.4) | 68.4 (67.6 to 69.3) |
| Hospitalised | 1716 | 3.4 (2.9 to 4.0) | 78.9 (77.0 to 80.9) | 83.6 (81.7 to 85.5) |
| Precarious | | | | |
| No healthcare | 5021 | 25.6 (24.1 to 27.0) | 61.9 (60.2 to 63.6) | 32.9 (31.7 to 34.1) |
| Outpatient | 1139 | 12.8 (11.0 to 14.5) | 66.7 (63.7 to 69.7) | 61.7 (58.7 to 64.6) |
| Hospitalised | 115 | 7.3 (3.6 to 11.0) | 67.7 (59.1 to 76.3) | 77.4 (69.1 to 85.7) |
| Borderline precarious | | | | |
| No healthcare | 18986 | 19.7 (19.0 to 20.3) | 68.4 (67.6 to 69.2) | 37.7 (37.0 to 38.3) |
| Outpatient | 3684 | 9.9 (9.0 to 10.7) | 69.8 (68.2 to 71.4) | 67.4 (65.8 to 69.1) |
| Hospitalised | 509 | 4.2 (3.0 to 5.4) | 78.0 (74.1 to 81.8) | 81.2 (77.4 to 84.9) |
| Non-precarious | | | | |
| No healthcare | 43732 | 16.8 (16.4 to 17.2) | 71.7 (71.2 to 72.3) | 40.6 (40.1 to 41.0) |
| Outpatient | 8671 | 8.2 (7.8 to 8.7) | 72.8 (71.8 to 73.9) | 69.7 (68.7 to 70.7) |
| Hospitalised | 1092 | 2.9 (2.2 to 3.5) | 80.5 (78.0 to 83.0) | 85.3 (83.0 to 87.6) |

AFA, AFA Insurance; ISA, Information System on Occupational Injuries.

severity increased and increased with increasing precariousness across all severity groups. As an example, injuries for which the workers did not seek healthcare, under-report estimates were higher among the precarious 25.6 (95% CI 24.1 to 27.0), followed by the borderline precarious 19.7 (95% CI 19.0 to 20.3) and non-precarious 16.8 (95% CI 16.4 to 17.2). While for OIs resulting in outpatient visits and hospitalisation the captured proportions were similar in both ISA and AFA across all employment relationship groups, the proportions of OIs for which workers that did not seek healthcare were notably higher in ISA (~60%–70%) than AFA (~32%–40%).

Table 3 presents the estimates of under-reporting for the 15 occupations with highest number of reported OIs in 2013, stratified by employment relationship. These occupations represent 91% of the total occupations with reported work injuries that year. While not all the findings were statistically significant

across the occupations, we observed higher under-reporting in the precarious and borderline precarious groups as compared with the non-precarious group. The numbers of reported OIs in the precarious group are small, as reflected in the width of the CIs. Nevertheless, in the case of the personal and protective services, extraction and building trades, sales and services elementary occupations, and models, salespersons and demonstrators, a higher under-reporting was found among the precarious compared with the other groups.

Finally, under-reporting was examined separately for each of the PE dimensions (employment insecurity and income inadequacy) that had been combined to create the PE score. No differences in the under-reporting of OIs were found according to contractual relation insecurity. Within the employment insecurity dimension, under-reporting was higher in workers holding an unstable position (20.0%, 95% CI 19.3% to 20.7%) as

Table 3 Under-reporting estimates of non-fatal occupational injuries (n=82 949) in 2013 in Sweden among occupations reporting highest no of injuries (91% of total no of injuries) and sorted by highest under-reporting in the very precarious group

| Occupations | Precarious | | Borderline precarious | | Non-precarious | |
|--|----------------|-------------------------|-----------------------|-------------------------|----------------|-------------------------|
| | Total observed | Under-report % (95% CI) | Total observed | Under-report % (95% CI) | Total observed | Under-report % (95% CI) |
| Teaching professionals | 131 | 33.2 (23.0 to 43.3) | 440 | 21.5 (16.9 to 26.0) | 1293 | 21.7 (19.2 to 24.3) |
| Physical and engineering science associate professionals | 67 | 28.0 (15.3 to 40.0) | 428 | 19.3 (15 to 23.5) | 1276 | 15.2 (13.3 to 17.2) |
| Models, salespersons and demonstrators | 383 | 26.9 (22.0 to 31.0) | 805 | 22.8 (19.7 to 25.8) | 961 | 19.0 (16.5 to 21.4) |
| Life science and health associate professionals | 176 | 26.7 (16.2 to 37.1) | 790 | 20.7 (16.8 to 24.7) | 2090 | 20.3 (17.7 to 22.8) |
| Sales and services elementary occupations | 556 | 26.1 (22.2 to 30.1) | 2180 | 17.5 (15.9 to 19.2) | 1753 | 15.4 (13.7 to 17.2) |
| Extraction and building trades workers | 405 | 23.3 (19.1 to 27.5) | 1888 | 14.9 (13.4 to 16.4) | 5103 | 14.8 (13.9 to 15.8) |
| Personal and protective services workers | 2025 | 21.6 (19.3 to 23.8) | 8052 | 16.6 (15.7 to 17.6) | 12491 | 16.8 (16.0 to 17.6) |
| Other associate professionals | 233 | 21.1 (15.1 to 27.1) | 786 | 14.3 (11.9 to 16.7) | 3646 | 5.9 (5.3 to 6.6) |
| Drivers and mobile-plant operators | 328 | 19.4 (14.9 to 23.8) | 1157 | 16.2 (14.0 to 18.4) | 2572 | 13.2 (11.9 to 14.5) |
| Other professionals | 75 | 19.0 (9.2 to 28.8) | 403 | 24.9 (19.9 to 29.9) | 1243 | 21.6 (18.8 to 24.4) |
| Metal, machinery and related trades workers | 215 | 18.6 (13.2 to 23.9) | 967 | 14.8 (12.6 to 17.0) | 3237 | 12.8 (11.6 to 14.0) |
| Office clerks | 338 | 18.6 (14.0 to 23.1) | 994 | 14.9 (12.6 to 17.2) | 2423 | 15.4 (13.8 to 16.9) |
| Teaching associate professionals | 109 | 16.3 (8.9 to 23.6) | 541 | 18.4 (15.0 to 21.8) | 1381 | 19.2 (17.1 to 21.3) |
| Machine operators and assemblers | 438 | 15.7 (12.0 to 19.5) | 1452 | 14.3 (12.5 to 16.2) | 5989 | 13.5 (12.5 to 14.4) |
| Stationary plant and related operators | 64 | 6.9 (1.5 to 10.2) | 433 | 6.8 (4.7 to 8.8) | 2764 | 6.9 (6.0 to 7.7) |

Table 4 Under-reporting estimates of non-fatal occupational injuries (n=82 949) by precarious employment dimensions in 2013 in Sweden

| | | Total observed | Under-reporting % (95% CI) | %Captured ISA (95% CI) | %Captured AFA (95% CI) |
|-----------------------------------|--|---------------------|----------------------------|------------------------|------------------------|
| Employment insecurity | Contractual relation insecurity | | | | |
| | Directly employed | 76 036 | 16.2 (16 to 16.5) | 70.8 (70.4 to 71.2) | 44.4 (44 to 44.7) |
| | Agency employed | 1054 | 16.8 (14.4 to 19.3) | 70.6 (67 to 74.2) | 42.7 (39.8 to 45.5) |
| | Directly employed and self-employed | 5859 | 15.8 (14.8 to 16.8) | 70.4 (68.9 to 71.8) | 46.8 (45.5 to 48.1) |
| | Contractual temporariness | | | | |
| | Stable | 67 872 | 15.4 (15.1 to 15.7) | 72.0 (71.6 to 72.4) | 44.9 (44.6 to 45.3) |
| | Unstable | 15 077 | 20.0 (19.3 to 20.7) | 65.2 (65.2 to 66.1) | 42.6 (41.8 to 43.3) |
| | Multiple jobs/sectors | | | | |
| | 1–2 employer in 1–2 sectors | 77 504 | 16.0 (15.7 to 16.3) | 71.0 (70.6 to 71.5) | 44.8 (44.4 to 45.1) |
| | 3 or more employers in 1–2 sectors | 3951 | 21.4 (20.0 to 22.8) | 64.8 (63.1 to 66.6) | 39.2 (37.7 to 40.7) |
| 3 or more employers in 3+ sectors | 1494 | 15.9 (13.9 to 17.8) | 70.7 (67.8 to 73.6) | 45.8 (43.4 to 48.1) | |
| Income inadequacy | Income level | | | | |
| | >200% of the median | 1101 | 21.9 (19.0 to 24.8) | 65.1 (61.5 to 68.8) | 37.3 (34.3 to 40.1) |
| | 120%–199% of the median | 18 208 | 14.2 (13.7 to 14.7) | 72.4 (71.6 to 73.2) | 48.6 (47.9 to 49.4) |
| | 80%–119% of the median | 49 704 | 16.1 (15.7 to 16.4) | 70.8 (70.3 to 71.3) | 45.0 (44.6 to 45.4) |
| | 60%–79% of the median | 10 330 | 18.7 (17.8 to 19.7) | 69.6 (68.4 to 70.9) | 38.3 (37.4 to 39.2) |
| <60% of the median | 3606 | 21.6 (20.2 to 23.1) | 65.8 (63.9 to 67.7) | 36.8 (35.4 to 38.3) | |

AFA, AFA Insurance; ISA, Information System on Occupational Injuries.

compared with those with a stable one (15.4%, 95% CI 15.1% to 15.7%). Similarly, those in multiple jobs (three or more employers) presented higher under-reporting of OIs (21.4%, 95% CI 20.0% to 22.8%) compared with workers holding one or two jobs (16.0%, 95% CI 15.7% to 16.3%) and compared with multiple job holders in multiple sectors (15.9%, 95% CI 13.9% to 17.8%). In the income dimension, higher estimates of under-reporting were found for workers earning >200% of the median and for those earning <60% of the median (table 4). Covariates adjusted models including sex, age and country of birth were also run and crude results were in close agreement with the adjusted results, thus, we present only crude results in the tables. We present the covariate-adjusted model for table 2 in the online supplemental materials as an example. A separate subanalysis was performed aiming at comparing the CBA cut-off of >90% coverage used in this manuscript and the company size cut-off of >50 employees used in a recent published manuscript of our research group, in order to validate results found in both manuscripts.⁵ Results found in this study were in close agreement with those using the company size cut-off, besides the fact that using the company size cut-off of >60 employees resulted in a smaller number of 71 921 injuries (online supplemental S4).

Discussion

Our results support the study hypothesis that under-reporting of OIs is higher among precariously employed workers compared to those in standard employment relationships. Across all sociodemographic characteristics, there is likely to be more under-reporting of OIs among precariously employed workers, also when taking injury severity and occupation into account. Additionally, individual dimensions of PE were associated with under-reporting. Specifically, income, workers with unstable employment and multiple job holders with more than three employers presented the highest under-reporting. Also, our findings stratified by employment conditions suggest that sociodemographic characteristics such as age, gender and immigration are not strongly associated with under-reporting as previously reported by others.^{17 19 30 31}

Only a few previous studies exist to which our results can be compared and discussed. Opposite to our results, a small Canadian study found that permanent workers and single job holders were less likely to submit a workers' compensation claim for OIs compared with temporary and multiple job holding workers.¹ Data from USA and Italy suggest that perceived job insecurity is associated to higher under-reporting.¹⁵

Previous studies have associated low injury severity with a higher under-reporting.¹³ We expand those findings by showing that under-reporting still is highest among the most precarious groups irrespectively of severity. An unexpected finding was that higher under-reporting was found among both workers earning the least and among those earning the most. This finding is likely interconnected with the increased under-reporting found among individuals with increased educational level. Under-reporting in these two contraposed employment categories may be driven by different reasons: while low educated workers with a low income may tend not to report an OI in order not to lose their job, a highly educated worker with a high income may work in an occupation in which the injury does not impact workability. In some white-collar workplaces the risk of injury might also be perceived (right or wrongly) as so low that the workplace and workers lack awareness and routines for reporting. Furthermore, higher-wage non-precarious workers may not lose earnings while they are off work, which can reduce the incentive to report an OI for workers' compensation.

It is well known that large, blue-collar, high-risk, male-dominated and highly unionised workplaces, such as the paper and pulp industry, the motor vehicle industry, the police force and firefighters have very strong reporting routines in place in Sweden.²⁷ We did not find gender differences although there was a tendency that women had higher under-reporting than men. It has been suggested that male workers have more control over their jobs and receive more safety training than female coworkers,³¹ which could offer some explanation for this finding.

As for gender, estimates of under-reporting were overlapping between age groups except when comparing the youngest to the

oldest. The higher under-reporting in the youngest age group may relate to their inexperience, lack of health and safety knowledge and, as for women, lack of proper training.¹⁹ Other factors potentially explaining a lower OI report among young workers include their willingness to please employers³² and the perceived low severity of the injury.^{19 33}

Except for the non-precarious strata, we did not find differential under-reporting among immigrants compared with native Swedes. Evidence suggests that regardless of legal status, migrant workers experience several forms of exploitation at work, are less likely to receive workplace health and safety training but more likely to be employed in hazardous work, work longer hours with fewer breaks.^{17 30 34}

No previous study has explored under-reporting and occupations in concurrence with worker's precarious level. Highest overall under-reporting levels were found in female-dominated white-collar professions such as teaching and healthcare, while blue-collar male-dominated occupations in machine and plant operators and assemblers as well as other associate professionals (which is dominated by police). However, there were other occupational groups where under-reporting in the precarious group was higher than in non-precarious group: models, salespersons and demonstrators; sales and services elementary occupations; extraction and building trades workers; personal and protective services workers; and also other associate professionals.

Strengths and limitations

Our study is strengthened by the use of register data with high coverage and completeness of the working population, allowing a thorough exploration of sociodemographic and occupational characteristics, linking all data sources through the unique personal identity number. Another strength is the possibility to operationalise PE as a multidimensional construct and consequently be able to stratify the working population according to a precarious score. Finally, finding the same definition for OIs in two independent record systems allowed us to employ the capture–recapture methodology to explore under-reporting. Some limitations, however, should be specified. Both self-employed and those not covered by collective bargaining agreements were excluded as they are too unlikely to be covered by AFA insurance to include in the analysis. This may have resulted in having excluded a potential precarious population from our analysis. We define OIs in ISA and AFA as being the same using an overlap of data sources with a ± 7 days' range, leaving the possibility of ISA reported injuries not being the same as injuries accepted for compensation. Also, we cannot differentiate in our results whether it is the employee failing to file the report of the OI to the employer or the employer who fails to report the injury to the register.²² Furthermore, when using capture–recapture methodology, methodological issues may arise from the lack of true independence between data sources.⁵ Lastly, the current data are limited by the cross-sectional nature of the research design. Future examination of longitudinal data could explore the importance of cyclical changes in both our exposure and outcome variable.

Generalisability of results

The present findings suggest that under-reporting of OIs is higher among precariously employed workers in Sweden. We believe that our findings are generalisable to other settings as they are in line with previous studies from other countries. Additionally, this study confirms the existence of under-reporting in specific sections of the workforce well known in the international

literature for their labour market vulnerability—young workers, women and migrant workers. Nevertheless, our results are not generalisable to self-employed workers as well as workers employed in small companies, which were excluded in this study and may present additional and unknown mechanisms on top of those identified here.

Implications

Even though the present findings have important implications for both employers and employees, any financial, health and social consequence or responsibility arising from the injury shifts from the employer to the employee for each workplace injury not reported. Such consequences may particularly burden precariously employed workers who may not access social benefits for which they qualify through their employment. In addition, OIs if not properly treated could worsen and cause even greater consequences in the long term, as well as contributing to presenteeism and productivity loss.^{35 36} On the other hand, employers may experience losses in wages and productivity, as well as damage to the organisations' reputation and capacity of recruitment and retention of workers.³⁷ By increasing the understanding between PE and under-reporting of OIs, organisations may learn better approaches to improve reporting, address root causes of workplace injuries, and design health and safety programmes aimed at tackling specific component of the workforce—for example, precariously employed workers. Therefore, a good reporting system in the workplace is needed to assure reliable data so that effective and targeted educational, regulatory and technological interventions can be implemented.

Conclusions

To the best of our knowledge, this is the first register-based study to empirically demonstrate that under-reporting of OIs is consistently higher among precariously employed workers in Sweden. Under-reporting of injuries poses a major problem when it comes to the surveillance of OIs and targeted preventive measures. This problem is compounded when occurring among workers that are most vulnerable in the labour market—precariously employed workers.

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Contributors BK was involved in conducting data analysis, interpreting results, writing the manuscript and addressing editorial changes. TB is the principal investigator of the project and was involved in all aspects, including the conception and design of the study. CO was involved in all aspects, particularly the statistical model to obtain under-reporting estimates. All authors were involved in planning the study, interpreting results and reviewing the manuscript. All authors gave final approval of the final version and agreed to be accountable for all aspects of published work.

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REFERENCES

- Shannon HS, Lowe GS. How many injured workers do not file claims for workers' compensation benefits? *Am J Ind Med* 2002;42:467–73.
- Fagan KM, Hodgson MJ. Under-recording of work-related injuries and illnesses: an OSHA priority. *J Safety Res* 2017;60:79–83.
- Moore JT, Cigularov KP, Sampson JM, et al. Construction workers' reasons for not reporting work-related injuries: an exploratory study. *Int J Occup Saf Ergon* 2013;19:97–105.
- EUROSTAT. *European statistics on accidents at work (ESAW) methodology*, 2001.
- Orellana C, Kreshpaj B, Burström B, et al. Organisational factors and under-reporting of occupational injuries in Sweden: a population-based study using capture-recapture methodology. *Occup Environ Med* 2021;78:745–52.
- Van Charante AW, Mulder PG. Reporting of industrial accidents in the Netherlands. *Am J Epidemiol* 1998;148:182–90.
- Wuellner SE, Adams DA, Bonauto DK. Unreported workers' compensation claims to the BLS survey of occupational injuries and illnesses: establishment factors. *Am J Ind Med* 2016;59:274–89.
- Kreshpaj B, Orellana C, Burström B, et al. What is precarious employment? A systematic review of definitions and operationalizations from quantitative and qualitative studies. *Scand J Work Environ Health* 2020;46:235–47.
- Benach J, Vives A, Amable M, et al. Precarious employment: understanding an emerging social determinant of health. *Annu Rev Public Health* 2014;35:229–53.
- Koranyi I, Jonsson J, Rönnblad T, et al. Precarious employment and occupational accidents and injuries - a systematic review. *Scand J Work Environ Health* 2018;44:341–50.
- Dong XS, Wang X, Largay JA. Occupational and non-occupational factors associated with work-related injuries among construction workers in the USA. *Int J Occup Environ Health* 2015;21:142–50.
- Alali H, Braeckman L, Van Hecke T, et al. Relationship between non-standard work arrangements and work-related accident absence in Belgium. *J Occup Health* 2017;59:177–86.
- Marucci-Wellman HR, Willetts JL, Lin T-C, et al. Work in multiple jobs and the risk of injury in the US working population. *Am J Public Health* 2014;104:134–42.
- Hintikka N. Accidents at work during temporary agency work in Finland – comparisons between certain major industries and other industries. *Saf Sci* 2011;49:473–83.
- Probst TM, Barbaranelli C, Petitta L. The relationship between job insecurity and accident under-reporting: a test in two countries. *Work Stress* 2013;27:383–402.
- Hall A. Trust, uncertainty and the reporting of workplaces hazards and injuries. *Health Risk Soc* 2016;18:427–48.
- Brown MSchulz AJ, Mulling L, eds. *Immigrant workers: do they fear workplace injuries more than they fear their employers? gender, race, class and health: intersectional approaches*. San Francisco, CA: Jossey Bass, 2006: 228–58.
- Kosny A, MacEachen E, Lifshen M, et al. Delicate dances: immigrant workers' experiences of injury reporting and claim filing. *Ethn Health* 2012;17:267–90.
- Tucker S, Diekrager D, Turner N, et al. Work-related injury underreporting among young workers: prevalence, gender differences, and explanations for underreporting. *J Safety Res* 2014;50:67–73.
- Morassaei S, Breslin FC, Shen M, et al. Examining job tenure and lost-time claim rates in Ontario, Canada, over a 10-year period, 1999–2008. *Occup Environ Med* 2013;70:171–8.
- Quinlan M, Mayhew C, Bohle P. The global expansion of precarious employment, work disorganization, and consequences for occupational health: a review of recent research. *Int J Health Serv* 2001;31:335–414.
- Azaroff LS, Levenstein C, Wegman DH. Occupational injury and illness surveillance: conceptual filters explain underreporting. *Am J Public Health* 2002;92:1421–9.
- Boden LI, Ozonoff A. Capture-recapture estimates of nonfatal workplace injuries and illnesses. *Ann Epidemiol* 2008;18:500–6.
- Rosenman KD, Kalush A, Reilly MJ, et al. How much work-related injury and illness is missed by the current national surveillance system? *J Occup Environ Med* 2006;48:357–65.
- Orellana C, Kreshpaj B, Johansson G, et al. Precarious employment, business performance and occupational injuries: a study protocol of a register-based Swedish project. *BMJ Open* 2019;9:e026091.
- Jonsson J, Matilla-Santander N, Kreshpaj B, et al. Exploring multidimensional operationalizations of precarious employment in Swedish register data - a typological approach and a summative score approach. *Scand J Work Environ Health* 2021;47:117–26.
- Arbetsmiljöverket, S.W.E.A. *Occupational accidents and work-related diseases. Arbetskadorna*. Stockholm: Arbetsmiljöverket, 2014.
- Hook EB, Regal RR. Capture-recapture methods in epidemiology: methods and limitations. *Epidemiol Rev* 1995;17:243–64.
- Tilling K, Sterne JA. Capture-recapture models including covariate effects. *Am J Epidemiol* 1999;149:392–400.
- McKay S CM, Chopra D. *Migrant workers in England and Wales: an assessment of migrant worker health and safety risks*. HSE Books, 2006.
- Turgoose C HL, Carter A, Stride C. *Encouraging an increase in the employment of women Returners in areas of skill shortage in traditionally male industries*. Sheffield, U.K: Institute of Work Psychology, University of Sheffield, 2006.
- Zierold KM. Youth doing dangerous tasks: supervision matters. *Am J Ind Med* 2017;60(): :789–97.
- Hall A, Gerard Z, Toldo J. Workplace injuries and ESA violations among youngworkers: a preliminary report University of Windsor; 2011.
- Premji S, Duguay P, Messing K, et al. Are immigrants, ethnic and linguistic minorities over-represented in jobs with a high level of compensated risk? results from a Montréal, Canada study using census and workers' compensation data. *Am J Ind Med* 2010;53:n/a–85.
- Gallagher RM. Referral delay in back pain patients on worker's compensation: costs and policy implications. *Psychosomatics* 1996;37:270–84.
- Claes R. Employee correlates of sickness presence: a study across four European countries. *Work Stress* 2011;25:224–42.
- Hofmann DA, Morgeson FP, Gerras SJ. Climate as a moderator of the relationship between leader-member exchange and content specific citizenship: safety climate as an exemplar. *J Appl Psychol* 2003;88:170–8.