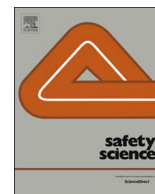




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## Characteristics and determinants of recurrent occupational accidents

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### A B S T R A C T

Recurrent occupational accidents provide valuable information for prevention purposes. Characteristics of recurrent occupational accidents were studied using a dataset of a Finnish insurance company including 21,580 subjects having at least two compensated workplace accidents with the same working process. For more than two thirds (70%) of the subjects, the circumstances and causes of the first accident did not reoccur in the second accident but their recurrence was substantial, typically around 30%. Working process and characteristics of the first accident affected the reoccurrence. In services, the violence-related accidents reoccurred for every second subject but losing control of machine only for every eighth subject. Moreover, the latter accidents were more severe than the former accidents. On average, two times more days were lost in the second than in the first accident.

The determinants of recurrent occupational accidents were examined for a small subset of 41 victims who had answered to a health-related questionnaire. Compared to age-matched controls with only one occupational accident, the subjects with at least two accidents were 3.2 times more likely to exercise less frequently, 3.2 times more likely to have relatives with diabetes and 2.6 times more likely to have symptoms of health problems.

The substantial reoccurrence of occupational accidents emphasizes the importance of assessing the prevention policies after each accident. Occupational accidents are related to work conditions and organizational practices but analysis of more in-depth data e.g. questionnaires may promote the means to improve the prevention policies of occupational accidents (e.g. violence-related) currently being difficult to prevent.

### 1. Introduction

The number of compensated accidents at work in Finland was about 124,000 in 2014 (Official Statistics of Finland (OSF)). The majority (106,000, 85%) of these accidents occurred at workplaces. Yearly costs of occupational accidents and injuries are estimated to be about 2–2.5 billion Euros in Finland (Rissanen and Kaseva, 2014). In addition, human suffering for the injured person and their families and co-workers provides indirect costs that are difficult to estimate (Manuele, 2011).

Occupational safety literature provides different theories about the recurrence of occupational accidents. Some of the previous studies on explaining occupational accidents show that there are more individuals with repetitive injuries than would be expected by chance alone (Visser et al., 2007; Kirschenbaum et al., 2000; Blascoa et al., 2003). A study by Day et al. (2012) shows that individuals who are stressed are more likely to have an accident in the workplace because of a propensity for cognitive failures. Wallace and Chen (2005) have found that stress

coupled with cognitive dysfunction is the major cause of accidents rather than the accident proneness of the employee.

In the latter part of the twentieth century, researchers have been focused more on the design of the work environment and the safety systems at workplaces than the idea that some people have a tendency to have more accidents than others (Burnham, 2009; Dekker, 2006). Furthermore, strong relationships between occupational hygiene conditions and occupational accidents have been identified (García-Herrero et al., 2012). Nowadays, it is generally accepted that the elements contributing to occupational accidents are related to work conditions and organizational practices (García-Herrero et al., 2012).

Accident statistics analyses can be used for defining characteristics of occupational accidents (Ciarapica and Giacchetta, 2009; Hovden et al., 2010; Papazoglou et al., 2015). In our study, we try to find out whether large-scale occupational accident categorization would provide good enough understanding for occupational accident prevention purposes. In detailed, this study aims at studying the recurrence of occupational accidents and further the characteristics of circumstances,

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<https://doi.org/10.1016/j.ssci.2017.12.020>

Received 4 April 2017; Received in revised form 7 November 2017; Accepted 14 December 2017  
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causes and consequences in recurring occupational accidents. In addition, an experiment for assessing determinants for recurrent occupational accidents with a small subset of victims is presented.

## 2. Materials and methods

### 2.1. Materials

This study employed a database of a Finnish insurance company, LocalTapiola, providing statutory occupational accident insurances for companies. The database included all compensated occupational accidents between January 2005 and February 2015. In total, there were 284,946 compensated occupational accidents from 199,047 workers (117,589 men and 81,458 women). Between January 2005 and December 2014, the total number of compensated workplace accidents in Finland was 1,081,816 (Finnish Workers' Compensation Center, 2017). As this study employed a database of only one insurance company, an employee may have also other occupational accidents compensated by other insurance companies before, after or in between the occupational accidents in the available database. However, the number of these cases cannot be estimated based on the data available.

The workplace accidents were described following the European Safety at Work (ESAW) – methodology (EC, 2001). The ESAW methodology variables describe the main type of work being performed by the victim at the time of the accident (“The Working Process”), the activity being performed by the victim just before the accident (“The Specific Physical Activity”), the last event deviating from normality which lead to the accident (“The Deviation”), the way how the victim was hurt in the accident (“The Contact – Mode of Injury”), the tool, object, or instrument with which the victim came into contact and injured (“The Material Agent of the Contact – Mode of Injury”), the accident’s physical consequences for the victim (“Type of Injury”), the part of body injured (“Part of Body Injured”), and the number of calendar days during which the victim was unfit for work due to the accident (“Days Lost”). In addition, information about the date of the occupational accident, the victim’s gender, date of birth and occupation was available. The victim’s occupation was reported following the categorization of the Finnish Workers’ Compensation Center (Federation of Accident Insurance Institutions, 2009) which is based on United Nations classification codes (2008). No information about the subject’s workplace or employee was available in the data.

Fig. 1 depicts the data selection process for studying the recurrent occupational accidents. Only workplace accidents were accepted for the analysis. If there were multiple compensated occupational accidents for a subject with the same date, only the accident that had resulted in the highest number of days lost was considered. In addition, only subjects whose all occupational accidents matched in terms of the ESAW variable “The Working Process” at the level of the first digit were included.

To study the characteristics of recurrent occupational accidents in different types of work, the occupational accidents were categorized by their working process. The categorization of the working processes and the number of subjects according to their number of occupational accidents are presented in Table 1.

In addition to the database of occupational accidents, this study employed a database of employees’ answers to health-related questionnaire issued by a company, Aino Health Management, which provides corporate health management via questionnaires and interventions. The database originally included a questionnaire results from over 7000 employees from years 2009–2011. The questionnaire comprised over 40 questions related to overall health status and habits, perceived stress, recovery, work ability and workplace circumstances. The employees were voluntarily participating answering the questionnaire or taking an intervention.

The questionnaire results together with the occupational accident dataset were used for studying the health- and work-related risk factors for recurrent occupational accidents. In total, there were 41 subjects

who had answered the questionnaire and who had at least two compensated occupational accidents by the insurance company’s in the following five years after fulfilling the questionnaire. Both workplace and work traffic accidents were accepted. However, there was no information available if the subjects had an occupational accident compensated by another insurance company.

### 2.2. Statistical analysis

For the recurrent occupational accident analyses, the first and second occupational accidents were defined for subjects who had at least two workplace accidents in the dataset available. The order numbers first and second are used here to denote the first and the second (following the first) occupational accident compensated by the insurance company after January 2005. Because the workplace or employer were not available in the database, the occupational accidents may have occurred in the same or different workplace and under the same or different employer. The single occupational accidents denote the occupational accidents of the subjects who had only one compensated workplace accident, and the recurrent occupational accidents denote the occupational accidents of the subjects who had at least two compensated workplace accident in the insurance company’s occupational accident database.

The analyses studying the characteristics and determinants of recurrent occupational accidents were performed using R statistical software (version 3.2.4). The characteristics of recurrent occupational accidents were studied separately for the three working process –categories presented in Table 1. The questionnaire data available for a small subset of victims was employed to identify the health- and work-related determinants for recurrent occupational accidents. The following analysis were performed to study the characteristics (Analysis I, II and III) and determinants (Analysis IV) of recurrent occupational accidents:

**Analysis I.** The differences between the single and recurrent occupational accidents were studied by comparing the single occupational accidents with the first of the recurrence occupational accidents. The comparisons of the proportions of ESAW variable codes, male subjects and occupations were performed Pearson chi-squared test. The results were interpreted with a significance level of  $< 0.01$  due to multiple comparisons done.

**Analysis II.** The recurrence of the occupational accidents was studied based on the first and second occupational accidents. The difference in the proportions of ESAW variable codes and occupations between the first and second occupational accidents were studied with McNemar’s test. A significance level of  $< 0.01$  was used in interpretation of the results due to the multiple comparisons. To study the recurrence of the occupational accidents, the conditional probabilities and standard errors for the ESAW variable codes of the first occupational accident to occur in the second occupational accident were calculated. In a more detailed analysis (data shown in Supplementary Material), the conditional probabilities for the different transitions of the ESAW variable codes between the first and the second occupational accidents were calculated. The conditional probabilities of ESAW variable’s codes in the second workplace accident were calculated given the ESAW variable’s code in the first workplace accident

**Analysis III.** The severity of recurrent workplace accidents was studied using the information about the days lost due to workplace accidents (EC, 2012). The ratio of days lost between the latter and former occupational accident was calculated as the sum of age-compensated days lost in the latter workplace accident divided by the sum of days lost in the former workplace accident. The 95% confidence intervals for the ratios were calculated using bootstrapping. In the comparisons, only the subjects who had both latter and former workplace accidents were involved.

There are differences between countries on the practices related to

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