Occupational Injuries and Workplace Risks

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Research to Improve Safety

By

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PREFACE

Throughout my career of almost thirty years in research, I have explored occupational accidents and injuries, their characteristics and causes. My major motivation has always been that, in the end, this work is about preventing accidents from happening and preventing human suffering and loss of life. The value base of this target is generally accepted: Who would want accidents and injuries? Instead, there is often disagreement about exactly how safety should be improved in real workplaces.

Over the years, I have been engaged in various kinds of research work. At the very beginning, in 1988, I was recruited to a research group that investigated serious occupational injuries in southern Finland. Each investigation started with a visit to the site of the accident. My task was to interview the injury victims, their closest workmates and their boss. The other group members gathered information about the work task that had been going on at the time of the accident and any factors contributing to the injury.

Sometimes, I found the interviewing emotionally very hard. In one fatal accident, for instance, I learnt during the interview that the man whom I was talking to was not only the victim's foreman but also his father and the grandfather of his three-year-old son. All in all, this project allowed me to see the seamy side of working life from a close distance and realize that there are always real human beings behind injury statistics.

The traditional surveys and interview studies that I carried out later on were aimed at finding out the opinions and experiences of larger groups of people. For instance, young employees were asked how they saw the work safety knowledge they had acquired in vocational education match the real-life requirements in the workplace. In analysing occupational injury statistics, I found that fixed-term employment increases the risk of injury at work. The study with the longest time span was a ten-year project on hazards in work-related traffic. As a result of it, a special discussion method was introduced for improving traffic safety. During the most recent years, I have compiled several literature reviews, such as a review of seventy studies on occupational injuries among young people.

Constant changes in work methods and processes, and the advancement of technology create new work environments and new risks. There is always space for improvement in work safety. In this imperfect world, there is no such thing as perfect safety.

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INTRODUCTION

In the early 1990s, in Finland, a deaf man was run over by a forklift truck in a factory yard as he was unable to hear the forklift truck behind him and the driver failed to see him because of a high load (Salminen 1997). This incident was included in the figures of the International Labour Organization (ILO) when it reported the number of occupational injuries around the world in 1994. That year, there were about 335,000 fatal occupational injuries globally (Takala 1999).

In 1998, the estimated number of non-fatal injuries was 264 million and that of fatalities 350,000 (Hämäläinen, Takala and Saarela 2006). In 2003, there were almost 360,000 fatal occupational accidents. Every day, more than 960,000 workers were hurt because of accidents (Hämäläinen, Saarela and Takala 2009).

The ILO updates on these estimates indicate an increase in accidents, injuries, and ill health. Recently, it was estimated that there are around 340 million occupational accidents annually worldwide. Moreover, the underreporting of occupational accidents, injuries and fatalities is giving a false picture of the real scope of the problem.

According to the ILO data, the construction industry still has a disproportionately high rate of recorded accidents, including falls, falling objects, collapses, being struck by heavy equipment, and being crushed under, between or even inside heavy objects or machinery.

Younger, older and inexperienced employees are particularly vulnerable in the workplace. As the population is ageing in developed countries, an increasing number of older persons are working and need special attention at work. Besides, immigrant and migrant workers face poorer working conditions than the native populations of developed countries.

In addition to human suffering, occupational injuries are a serious public-health problem. They also cause considerable economic losses. As the probability of accidents at work increases with any increase in safety hazards, all efforts to identify and control or eliminate such hazards are worthwhile, if not lifesaving.

In my studies on occupational safety, I have applied the traditional research approach, including accident and injury reporting, and analyses of the causes and risk factors for injuries. This book describes how employees' individual properties, such as gender, age, and health status, affect their risk

of suffering occupational injuries. It also analyses the effects of different ways of organising work, such as precarious work and shift work, on risk rates. Further, it looks at the risk sources encountered by workers in a number of industrial environments, such as transportation, construction sites, manufacturing plants, and mines. Finally, it touches on more recent trends in this sector, i.e., migration and climate change.

PART I

EMPLOYEE-LEVEL RISK SOURCES

CHAPTER ONE

DOES GENDER MAKE A DIFFERENCE?

Gender can affect the occupational injury and safety risks in several ways. Differences in the participation of men and women in various occupations in the labour market can lead to differences in occupational exposures. Further, men and women working in the same occupations may not perform the same work tasks. Sociocultural factors and gendered expectations may also have their effect, as well as the biological and physical differences. Gender-differentiated data will be discussed throughout this publication. In this chapter, I will first discuss male risk-taking behaviour and then look at the gender differentiation of statistics in work-related injuries in the light of statistical data.

Risk-taking Behaviour among Men

The statistics of occupational injuries are dominated by men. In 2011, for example, it was found that men suffered 96 % of fatal and 76 % of non-fatal occupational injuries in workplaces across Europe, while they accounted for only 54 % of the labour force (Oortwijn *et al*. 2011). If we assume that men generally take more risks at work than women, risk-taking should be considered a special factor in male injuries. In the context of work environments, in particular, a major problem is that there are various ways to measure risk-taking.

For analysing risk-taking in occupational injuries in Finland, I developed a risk-point measure (Salminen 1997, 38) that was based on the definition of risk-taking as a voluntary and conscious exposure to danger. The measure was constructed as a Guttman scale in the following way:

0 = the victim failed to recognise the danger
1 = the victim recognised the danger but could not act otherwise
2 = the victim could have acted otherwise but acted in the normal way in the accident situation
3 = the victim worked in an irregular way

My analysis of ninety-nine serious occupational accidents in southern Finland showed that risk-taking played a role in 54 % of the accidents. The most important motives for taking risks were the saving of time and trouble, and the strain of timetables (Salminen 1994a). A questionnaire study we carried out among 228 Finnish forestry workers showed no significant relationships between risk-taking and accident frequency. The study also indicated that impulsiveness and neuroticism were related to risk-taking but not to accident frequency (Salminen, Klen and Ojanen 1999).

A comparison of Finnish forestry (n = 228) and construction workers (n = 45) showed that in both of these professional groups the workers with higher scores on external locus of control took more risks than workers with higher scores on internal locus of control. The forestry workers scored as having a more external locus than the construction workers (Salminen and Klen 1994).

Risk-taking has also been studied by Honkasalo (1991), who interviewed thirty-nine Finnish professional divers and found that they accepted risks as part of their work. For example, a certain length of time under water causes time pressure. Diving is primarily a male profession where craftmanship is valued.

Honkasalo (1990) also interviewed twenty-eight male welders at a Finnish machinery manufacturing plant. They connected risk-taking with being in a hurry imposed by piece payment. Besides, Honkasalo (1988) has claimed that risk-taking is more typical for men than for women. Risk-taking can also be seen as one way to resist the boss in a male culture.

Risk-taking is often related to young ages. Westaby and Lowe (2005) examined over 2,500 American youths and found that the risk-taking orientation was significantly related to work injury. Supervisory influence and co-worker risk-taking predicted the risk-taking behaviour of young workers.

Among 3,415 municipal employees in Birmingham, Alabama, risk-taking was associated with an increased risk of occupational injury. Risk-taking and injuries were related to the male sex (Forrester *et al*. 1996). Turner, McClure and Pirozzo (2004) published a systematic review of six case-control studies and one retrospective study, concluding that risk-taking was associated with an increased probability of sustaining an injury except in high-skilled sports. Among Australian drivers, a high level of risk acceptance was associated with an eight-fold increased risk of serious injury (Turner and McClure 2004)

A meta-analysis of 150 studies showed that males take more risks than females. The gender gap was larger in intellectual risk-taking and physical skills than in smoking. In the oldest age group, the difference between the

genders was significantly smaller than in the age group of high-school students (Byrnes, Miller and Schafer 1999).

Arch (1993) argued that when faced with risk-taking situations males were more likely to see the situation as a challenge that called for further participation, while females tended to respond to a threat in ways that encouraged avoidance of risk. Knowles *et al*. (1973) found, with fifty-six American student nurses, that risk-taking was a single motivational trait or a tendency to approach or avoid risk situations.

Among male Danish ambulance workers and slaughterhouse workers, those with a traditional masculinity orientation reported less safety oversights and made more safety violations (Nielsen *et al*. 2015). Based on an analysis of sky divers, Lyng (1990) defined edgework as an activity where the subject gets as close as possible to the edge without going over it. Such edge workers had a high regard for their own abilities to deal with danger.

The most effective means of preventing risk-taking leading to accidents are better planning and putting in place work arrangements that prevent hurry, and rectifying the underestimation of hazards by workers. In addition, the commitment of the top management of a company to safety enables the entire safety culture of the company to support the elimination of unnecessary risk-taking.

Gender-differentiated Injury Statistics

Women are a minority in the occupational injury statistics compiled in Finland. Their proportion of injuries was 34.8 % (Statistics Finland 2015), while their proportion of all employed was 48.3 % (Statistics Finland 2018). On account of the minority status of women in occupational injuries, the official statistics often conceal the specific characteristics of female injuries. Perez (2020, 129) considers this to be due to data bias, whereby any increase in serious injuries to women remains unnoticed.

Our study with 1,681 Finnish employees (Salminen *et al*. 2017) showed no statistically significant difference between the genders in the frequency of occupational injury, although men were more often involved in injuries than women. My analysis of ninety-nine serious occupational accidents showed that women were less often involved in injuries than men (Salminen 1994b). Besides, women working on production lines, usually on a single machine in serial production, were found to have the highest incidence of serious injury (Salminen *et al*. 1992a). In service work, two out of three injuries happened to women (Seppälä 1993).

A review of fifteen studies showed that men were injured at work on average three times more often than women (Messing *et al*. 1994). Another review of sixteen studies (Salminen *et al*. 1992a) showed that the median relative injury risk for men was 3.3, while their median fatal risk was 13. The two reviews unanimously indicated that men were injured at work three times more often than women. With regard to fatalities, the gender gap was even larger.

In Boston, US, a study among new postal employees showed that women had an increased risk of occupational injuries (Zwerling *et al*. 1993). Among 24,000 American aluminium manufacturing workers, the risk of injury was higher for women in four out of five injury outcomes between 2001 and 2010 (Tessier-Sherman *et al*. 2014). It was only in the risk of lost-time injury that no gender difference was found. Among blue-collar employees in Quebec, Canada, no significant difference was found between the genders (Messing *et al*. 1994).

As regards fatal accidents in Taiwan, male workers had a significantly higher physical injury claims prevalence than female workers (Lin, Chen and Luo 2008). The same results were obtained in Canada (Essien, Trask and Feng 2022). Lindqvist, Schelp and Timpka (1999), in turn, analysed 677 work-related injuries in Motala, Sweden. They found that males suffered almost four times more occupational injuries than females.

In a study of 11,054 Spanish employees, it was found that men were injured more often than women although women had bad working conditions more often than men (Campos-Serna *et al*. 2012). Gyekye and Salminen (2011) showed, with 320 Ghanaian employees, that gender was not related to accident frequency. Berecki-Gisolf *et al*. (2015) analysed 254,704 compensation claims made in Victoria, Australia. They found that men had a higher rate of physical injury claims than women. Furthermore, an analysis of 31,438 injuries among Californian electric utility workers indicated that males had substantially higher injury rates than females. After an adjustment for occupations, job experience and age, female workers, however, had a higher injury rate (Kelsh and Sahl 1996). On the other hand, gender differences in the occupational accident mortality decreased between 1955 and 1998 in the US and Italy (Waldron, McCloskey and Earle 2005).

One interesting finding is from Dalton (1960), who showed that, among female hospital employees, more than half of occupational accidents occurred during menstruation or in the four days preceding menstruation. However, this result has not been confirmed since. Another study (Dunning *et al*. 2003) found that one out of four pregnant women had had a fall and one fourth of these falls had occurred at work. Walking on slippery floors,

hurrying, and carrying an object or a child had contributed to two out of three falls.

In economic terms, injuries were more expensive to women than to men in the long term. Injured at work, women lost an average of 9.2 % of their earnings, while men lost only 6.5 % (Boden and Galizzi 2003).

The results of the above studies on injuries to women were contradictory. Some studies showed that men were injured more often than women while others indicated a higher frequency for women. However, it is hard to find jobs where men and women perform exactly the same work tasks, and some gender differences usually exist in all work tasks. Based on the Finnish Study on Working Conditions (1984) with 4,502 respondents, Kauppinen-Toropainen, Kandolin and Haavio-Mannila (1988) concluded that women often profit from performing the same sort of work as men, whereas men often profit from sex-segregated work.

Jensen *et al*. (2014) found that gender roles and expectations also impact occupational safety, and that gender is constantly produced and reproduced. For example, working-class men perform manual work, whereas women are employed in offices and shops. These stereotypes are also reflected in occupational safety, as men are expected to work in more hazardous environments. The analysis of Bauerle, McConagle and Magley (2016) showed that men had fatal injuries over 25 % more often than women, even when men and women were working in the same occupation.

CHAPTER TWO

YOUNG AND OLD AT HAZARD

The relationship between age and occupational injury has been studied intensively. The interest of researchers has focussed on young employees on the one hand and on older employees on the other. The reason is that middle-aged employees generally have the lowest accident frequency.

My extensive literature review of sixty-three studies on occupational injuries showed that young employees had a higher non-fatal injury rate than older employees. Moreover, of the forty-five review studies dealing with fatal occupational injuries, the majority indicated that older employees had a higher fatality rate than younger ones (Salminen 2004a). An earlier review of twenty-two studies had concluded that the injury frequency tended to decrease with age, whereas the age-related injury severity increased with age (Laflamme and Menckel 1995). Furthermore, Crawford *et al*. (2010) made a systematic review of 180 publications. They concluded that older employees had a reduced risk of injuries, while they had an elevated risk of fatal injuries. Later, Schwatka, Butler and Rosecrance (2012) reviewed twenty-two studies in the construction industry and found higher injury costs but lower injury frequency among older employees. These reviews unanimously showed that young employees had a higher injury frequency than older ones, whereas the injuries of older employees more often led to fatality.

Older employees are generally also more experienced workers. Previous experience protects from injuries in all age groups, which will be discussed in more detail later in this chapter.

Older Employees

Based on our study including ninety-nine serious occupational injuries in southern Finland, I found that the most typical accident risk of employees aged over 50 was getting run over by a moving vehicle (Salminen 1993). My later analysis of the same data set showed that the proportion of employees aged over 35 was higher in serious injuries than in all injuries (Salminen 1994b). According to the official Finnish occupational injury

statistics, the injury risk to female employees aged over sixty-three was almost three times higher (5/100) than that of females aged between twenty-five and forty-four (2/100). In the manufacturing industries, the injury risk among male employees aged over sixty was almost two times higher (12.7/100) than among young employees (7/100) (Pukkila 1995). Later, it was shown, using the same data set, that the injury frequency of employees aged over sixty-three was 36 % higher than that of middle-aged employees (Salminen, Heinonen and Sysi-Aho 2016).

Accordingly, my conclusion is that, in Finland, the oldest employees have an increased risk of injury. Therefore, raising the retirement age from sixty-three to sixty-eight years, for instance, would lead to a slightly greater number of injuries and fatalities.

Between 2000 and 2006, the injury mortality rate for people over sixty-four increased by 3 % in the US. A significant rise in death rates occurred in motorcycle crashes, machinery, poisoning and drowning (Hu and Baker 2010). In the US, the fatality rate of employees aged over sixty-four was three times higher than that of younger employees. The four leading causes of death among older employees were machines, motor vehicles, homicides, and falls (Kisner and Pratt 1999). In the crops production agriculture industry in the US, the fatality risk involving tractors was almost double for employees aged sixty-five or older compared with employees in the twenty-to-twenty-four-year age group. Tractor rollovers, falls from moving equipment, and falls and vehicle collisions were typical fatalities of older farmers (Janicak 2000). In highway transportation, the fatality rate among employees over fifty-four was three times higher than that of employees aged between eighteen and fifty-four (Pratt and Rodriguez-Acosta 2013). On the other hand, looking at non-fatal occupational injuries in the US, injury rates for falls on the same level, fractures or dislocations, and hip injuries were higher for older than for younger employees (Layne and Landen 1997; Wuellner *et al*. 2011). Furthermore, Baidwan *et al*. (2018) analysed the US Health and Retirement Study from 2004 and 2014 of 7,212 employees over fifty. They found that the risk of work-related injuries was more than two times greater among those whose job included physical effort, lifting heavy loads, and kneeling.

In British Columbia, Canada, workers' compensation claims from 1997 to 2006 were analysed. Older employees reported more traumatic bone, nerve and spinal cord injuries, whereas younger ones had more open-wound injuries (Smith *et al*. 2013). In a study of 320 industrial employees in Ghana, older employees over forty had experienced fewer injuries than their younger colleagues (Gyekye and Salminen 2009).

One reason for the higher fatality rate of older employees is that they are more fragile than younger employees. Based on the Volvo Car Crash Registry, Brorsson (1989) indicated that the risk of fracture was more than three times higher among drivers or front seat passengers aged sixty-five to seventy-four than among those aged from eighteen to twenty-four and that the risk of fracture in the rib cage was nearly eleven times higher in the older age group. Employees over fifty-four were hospitalised after a fall injury more often than younger ones, although there was no difference in the risk of fall injury between the age groups (Layne and Pollack 2004). Furthermore, in Australia, heavy physical demands at work increased the risk of work injury among employees over fifty-five more than among younger employees (Smith and Berecki-Gisolf 2014). Older employees in New Hampshire, US, received more severe injuries than younger ones, but they recovered better because of longer workplace attachment and the healthy worker effect (Pransky *et al*. 2005). The latest meta-analysis (Peng and Chan 2019) showed that the risk of fatalities among older employees was twice that of younger ones, whereas the incidence of non-fatal injury among older employees was 5.8 % lower than that of younger employees.

One way to prevent injuries among older employees is to allow them to move from physically demanding to lighter work tasks. Another important way of prevention is to ensure that older employees can avoid work tasks that require swift reactions. In addition, due to their long work experience, older employees could be utilised as mentors to their younger colleagues as well as in occupational safety training.

Younger Employees

My analysis of ninety-nine serious occupational injuries showed that young employees hurt themselves more often than older ones when feeding or cleaning machines. Incautiousness contributed more often to injuries of young employees than to injuries to older ones (Salminen 1996). In a questionnaire study of 1,681 Finnish employees, those under thirty-five were involved in occupational injuries significantly more often than middle-aged employees (Salminen *et al*. 2017). The highest injury risk was found among young machine repairers and construction metal workers (Sysi-Aho 2013).

American adolescents working in convenience stores and gas stations were at risk of shooting, whereas those working in gas stations and restaurants had an increased risk of burn injuries (Runyan and Gerken 1989). In North Carolina, seventy-one adolescents under twenty died at work between 1980 and 1989. Over half of the fatalities involved a motorised

vehicle, typically a tractor. For females, homicide was the leading cause of fatal occupational injury (Dunn and Runyan 1993). A total of 9,656 adolescents aged fourteen to seventeen were compensated for occupational injury in New York State from 1980 to 1987. The highest rates were seen in manufacturing and agriculture. The most dangerous occupation was unskilled labour (Belville *et al*. 1993). Based on a questionnaire study (n = 3,574) done in Wisconsin, Zierold and Anderson (2006) concluded that African American teens and Hispanic teens were seriously injured over two times more often than white teenagers. Although young employees had a higher injury frequency than middle-aged employees, their injuries were more often minor, and the costs of their injuries were lower (Miller and Waehrer 1998).

As part of the West Jutland Cohort study, 2,181 Danish adolescents born in 1989 were asked to report their work experiences. Approximately 5 % of working adolescents had been involved in an occupational injury. The risk of occupational injury was increased by heavy work, high psychological demands, and low social support (Rasmussen *et al*. 2011).

An analysis of 1,700 occupational injuries of British adolescents aged sixteen to eighteen showed that the most serious injuries occurred in situations that involved no normal work activity, e.g., during work breaks (Glendon and Hale 1986). The industries where Australian adolescents (fifteen to twenty-four years) were most often injured fatally were agriculture, forestry, and fishing, followed by the transport, postal and warehouse industries, and mining (Ehsani *et al*. 2013). An analysis of 317 work-related injuries of Italian youngsters revealed two groups of injuries: transportation injuries to lower extremities, and hand/wrist and head injuries (Aggazzotti *et al*. 2006).

At two hospitals in Aracaju, Brazil, 4 % of 917 patients aged five to seventeen had been injured at work. Transportation injuries and contact with tools and equipment were the main mechanisms of injuries (de Vasconcelos *et al*. 2010). In the Cusco Province, Peru, 97 % of 410 public night-school students had been injured at work during their lifetime. Higher income was associated with falls, and severe injuries with physical violence at work (Schlick *et al*. 2014).

Furthermore, an analysis of 19,547 Canadian adolescents showed that employees aged fifteen to eighteen reported more non-lost-worktime accidents, less safety voice, less safety compliance and more safety neglect than workers aged nineteen to twenty-two (Turner, Tucker and Kelloway 2015). One out of three Canadian adolescents reported that they worked at least part of the day without supervision. Young females worked more often without supervision or alone than young males (Lewko *et al*. 2010).

Young employees are not a homogenous group. Turner and his colleagues (2022) also criticise that studies include inconsistent definitions of young employees. In a Danish study of twenty-six young adults, the researchers (Nielsen *et al*. 2013) found five distinct groups: skilled workers, apprentices, sabbatical year workers, student workers, and school dropouts. They argued that exposure to an accident risk was not equally distributed among these groups. In my own review (Salminen 2004a), I found that young employees had a higher injury frequency than older ones and men were involved in injuries more often than women, which suggests that young men are a special risk group of occupational injuries. Based on their review, Richter and Jacobs (1991) recommended eliminating the worst working conditions and controlling hazards as the most important ways to decrease injuries among young employees.

As mentioned above, my studies in Finland have shown that working with machines is especially dangerous to young employees. Youngsters may not know how machines operate or they may underestimate the hazards caused by machines. One factor that clearly protects young employees is better guidance and control by older co-workers. Studies from Australia and Brazil indicate that young employees have many injuries in the transportation industry. This might be explained by the fact that young people often work in delivery tasks (e.g., delivering pizzas) and that they are also often prone to driving overspeed. Injuries in such transportation jobs are very difficult to prevent as the drivers are not under the immediate control of their employer.

Work Experience

Experience in the workplace is related to injury frequency. Young employees are often inexperienced, but not all inexperienced employees are young.

When examining ninety-nine serious occupational injuries in Finland, I found that the injury risk was highest for employees who had been working for their employer for less than one year. Their proportion of injury victims (31 %) was almost twice that of the entire working population (Salminen 1994b). Furthermore, the same data set indicated that new employees used hand tools for most of their working time or transported things from one place to another. Therefore, cuts caused by moving parts of machines and falls from a height were the most typical injuries for novice employees (Salminen *et al*. 1992b). In yet another study in Finland, we found the highest injury frequency among employees who had been working in the company for two to ten years (Salminen *et al*. 2017).

A study of 22,952 female employees in a French national railway company showed that female employees with shorter lengths of service had a higher risk of fall on the same level and fall to a lower level (Chau *et al*. 2014). Besides, Cellier, Eyrolle and Bertrand (1995) analysed the effects of age and tenure among French fruit and vegetable packing employees, who worked over nine million work hours. Novice employees had the highest injury and seriousness rates in all age groups.

In a study of 58,271 Italian employees, injury rates decreased with an increase in job tenure. Young employees had both the highest injury rate and the highest decrease with job tenure (Bena *et al*. 2013). In Mexico, there were 1,140 fatal occupational injuries in 2012. Employees who had worked on the same task for one to ten years had a 37 % higher risk of fatality than novice employees (Gonzalez-Delgado *et al*. 2015).

Kumar, Rathnakar and Kumar (2010) examined 416 employees of tile factories in Mangalore City, Karnataka, India. They found that employees who had worked in the company for less than five years were significantly more often involved in injuries (33 %) than employees with longer tenure (16 %). Among British bus drivers, experience was found to have the strongest effect on injuries in the first year of driving. Experience was more important than age in injury involvement (Dorn and af Wåhlberg 2008). An analysis of workers' compensation records and a labour force survey in Ontario, Canada, showed that lost-time injury rates were significantly higher for employees with shorter job tenure (Morassaei *et al*. 2013). Among Canadian adults, the work disability absence rate within the first two months on the job was over eight times higher than that of those who had spent more than twenty-five months on the job (Breslin *et al*. 2008). Burt (2015) concluded that new employees had an increased risk of injury during the first year of employment. He also gave several recommendations on how to improve their safety at work.

The first day in the workplace is the most critical for occupational safety. For example, the injury risk for a wood industry worker was over fifty times higher on their first day on the job (Larsson 1988a). An analysis of occupational injuries at small construction companies in Taiwan showed that 12 % of injuries occurred during the first day on the work site (Cheng *et al*. 2010). Accordingly, the employer or supervisor should focus more attention on the behaviour of new employees during their first day of work.

Age and tenure are, of course, interrelated. Novice employees are often young, but an older employee can also be a novice in a job. Blanch *et al*. (2009) studied 156 male employees of a plastic film factory in Barcelona. They found a significant association between age by tenure interaction and

occupational injuries. In many studies, it was impossible to distinguish the effects of age from those of tenure.

To a degree, it is an open question, on the basis of the above studies, whether experience reduces the frequency of injuries. Most studies show that injuries decrease with experience while some studies reveal no such effect (Salminen 1997).

CHAPTER THREE

HEALTH AS A RESOURCE

Health is recognised as more than the absence of disease. My approach is to see health as a resource to support the capacity to function in the workplace. In the world of work, healthy employees are needed, but there is, of course, also space for people with disabilities. Unfortunately, occupational injuries impair employees' work capacity and, vice versa, health problems and disabilities expose employees to injuries.

According to the US National Health Interview Survey 1997–2011, employees with disabilities were more often involved in overexertion and falls than those without disabilities (Shi *et al*. 2015). It was also shown on the basis of the same survey that employees with disability had an elevated risk (OR = 2.39) of occupational injury compared to employees without disability (Price *et al*. 2012). The Health and Retirement Survey (n = 5,600) indicated that poor sight, poor hearing and other disabilities increased the risk of occupational injury among American employees over fifty (Zwerling *et al*. 1998). The Health and Retirement Study also indicated that both impaired hearing and impaired vision were associated with an increased risk of occupational injury among older American employees (Zwerling *et al*. 1996a).

Effects of Noise and Hearing Impairments

An early review based on five studies suggested that high noise levels may be associated with higher injury rates (Wilkins and Acton 1982). When Dias, Cordeiro and Goncalves (2006) compared 600 Brazilian employees involved in occupational injuries to a control group of 822 employees in the same age group (aged fifteen to sixty) but not involved in injuries, they found that employees exposed to noise at work had been injured two times as often as the control group.

Among 5,876 sawmill employees from British Columbia, Canada, an inverse-U-shaped trend was observed between noise exposure and occupational injuries. Cumulative noise over a very short period of time decreased the risk of injury, whereas noise exposure over a longer period

(over ninety-one days) increased the risk of injury (Kling *et al*. 2012). Among 52,982 male employees in Quebec, a hearing loss of 20 dB significantly increased the risk of occupational injury. Noise exposure in the workplace was associated with 12 % of injuries (Picard *et al*. 2008). In their study, Moll van Charante, Snijders and Mulder (1991) compared injured Dutch shipyard employees with injury-free employees. They found no significant difference in posture control either in silence or during exposure to heavy noise.

Based on a review of fifteen studies, Palmer *et al*. (2008) found that hearing problems moderately increased the risk of injury. A computer-aided telephone interview with 150 farmers from Iowa showed that hearing loss in the better ear, hearing asymmetry, and poor self-reported hearing were among the risk factors for agricultural injuries (Choi *et al*. 2006).

Toppila, Pyykkö and Pääkkönen (2009) reported that impaired hearing may increase the risk of occupational injury because of reduced speech intelligibility and reduced capability to perceive the direction of incoming sound. In both Finland and the United Kingdom, poor hearing has been a contributory factor in fatalities. My study of ninety-nine serious occupational injuries included a fatality as a result of an accident where a deaf man was run over by a forklift truck in the yard of a factory as he was unable to hear the forklift truck behind him and the driver failed to see him because of a high load (Salminen 1997).

The conclusion to be drawn from these studies is that exposure to noise and hearing impairments consistently increase the risk of occupational injury. However, it is difficult to say what the thresholds are for hearing loss to affect occupational safety.

Vision Impairments and Eye Injuries

A review of ten studies showed little evidence of impairment of vision increasing the risk of occupational injury (Palmer, Harris and Coggon 2008). An earlier review of thirty-one studies revealed a positive association between falling and visual impairment in people over seventy-five and an association between visual acuity and hip fracture. In 2000, no studies showed a connection between visual impairment and occupational injury (Legood, Scuffham and Cryer 2002). In Quebec, however, Laberge-Nadeau *et al*. (1996) found that crashes of truck drivers were related to problems with binocular vision, whereas collisions of bus drivers were associated with hypertension. Later, they (Maag *et al*. 1997) showed that taxi drivers with binocular vision problems had more crashes than other drivers.

Based on the National Health Study carried out in Australia, 2004–2005, Lam (2008) concluded that the risk of occupational injury increased by 60 % among those who had any uncorrected or untreated vision problems and that the risk was 3.5 times higher for those with untreated macular degeneration compared with the healthy population. Davies *et al*. (2001) analysed 1,326 injuries and 1,504 employees, based on the Merseyside Accident Information Model, from Liverpool, United Kingdom. They found that wearing bifocal/varifocal spectacles increased the risk of missed step and, especially, problems with manual handling of loads at workplaces.

Lombardi and his co-workers (2005) compared 1,353 welders to 822 non-welders, based on data from a US workers' insurance compensation provider. One out of four injuries to welders were eye injuries. Almost all victims were male and 70 % of them worked in manufacturing. McCall, Horwitz and Taylor (2009) analysed workers' compensation data from Kentucky from 1994 to 2003 and found 10,545 claims of ocular injury. Men were injured three times more often than women and helpers and construction workers had a higher frequency of eye injury. Based on the 2002 National Health Interview Study (n = 28,913), the overall lifetime prevalence rate of work-related eye injuries was calculated to be 4.4 %. Men had eye injuries four times more often than women (Forrest and Call 2009). Bauza *et al*. (2013) identified 183 work-related open-globe injuries from the University Hospital in Newark, New Jersey. Males accounted for 97 % of the cases, their average age being thirty-five years.

An analysis of 420 patients at the Eye Clinic of Dicle University Hospital in Turkey showed that 13.1 % of eye injuries were due to occupational injury (Cakmak *et al*. 2004). An examination of 182 patients in the First Eye Hospital, Lublin, Poland, showed that 16 % of penetrating eye injuries were work-related agricultural injuries. Most injuries were due to repair and maintenance work (Mackiewicz *et al*. 2005).

Shaikh and Shaikh (2005) interviewed 208 welders in Islamabad and Rawalbindi, Pakistan. The most common injury was a foreign body in the eye. Woo and Sundar (2006) examined 133 patients with eye injuries who had sought medical treatment at the National University Hospital in Singapore. A typical victim of eye injury was a young, non-Singaporean male working with power tools in the construction industry. Furthermore, industrial eye-related injuries were studied in a retrospective analysis of 300 occupational injury victims with ocular trauma seen by Tan Tock Seng Hospital in Singapore (Ngo and Leo 2008). The patients were mainly young, non-resident men.

Ho and co-workers (2007) analysed 486 eye injuries in an academic medical centre in the city of Kaohsiung, Taiwan. Almost 40 % of these

injuries were work-related, and men were injured four times more often than women. Later, they (Ho *et al*. 2008) found that occupational eye injuries were predicted by temporary employment and fewer than ten years of education. The highest frequency was shown for foreign body injuries.

Zghal-Mokni and his co-worker (2007) examined seventy-eight patients at an eye clinic in Tunis in 2000. About 9 % of these cases were due to occupational injury. The most common lesion was corneal superficial foreign body. Lamellar injuries (foreign bodies, chemicals) accounted for 92 % of the 105 eye injuries at an accident and emergency department in Scotland analysed by Thompson and Mollan (2009). About 31 % of these injuries were occupational eye injuries and those injured were male in 91 % of these cases. An analysis of 768 eye injuries at the Farabi Eye Hospital in Tehran, Iran, showed that 74 % of injuries were work-related. Most of the patients with work-related eye injuries were young men (Mansouri *et al*. 2010). Cai and Zhang (2015) examined 1,197 eye injuries at the Ninth People's Hospital of Chongqing, China, of which 43 % were work-related injuries. The most common diagnosis was foreign body on external eye.

To sum up, the effect of vision impairment on occupational injury was not consistently confirmed in the reviews dealt with above. Several studies based on data from eye hospitals in different countries showed that 9 % to 74 % of eye injuries (average 31 %) were work-related. Men injured their eyes many times more often than women, which is due to their differential work tasks—in the construction industry, for instance. Penetrating eye injuries can lead to the loss of sight, especially in developing countries. A foreign body in the eye was the most common diagnosis in work-related eye injuries. Victims of eye injuries wore safety glasses significantly less often than their colleagues without injuries (Okoye and Umeh 2002; Yu, Liu and Hui 2004; Blackburn *et al*. 2012).

Mental Health Problems

A review (Palmer, Harris and Coggan 2008) based on eleven studies showed mixed results on the relationship between mental health and occupational injury. However, the researchers concluded that employees with emotional problems might have a higher risk of injury at work. Cherry, Burstyn and Beach (2012) analysed 389,903 compensation claims from Alberta, Canada, over the 1995–2004 period. They found that employees with a recent history of mental health illness at the time of their first occupational injury were at a greater risk of a second injury. Furthermore, a questionnaire study of 7,979 adults from Cardiff and Merthyr Tydfil showed that psychotropic medication increased the risk of injury, especially among

those with continuing mental health problems (Wadsworth *et al*. 2005). Among 120 patients with hand injuries in Taiwan, self-perceived mental health helped to decrease the number of days off work, whereas self-perceived physical functioning was negatively correlated to days off (Chen *et al*. 2012). Among 67,182 male Korean employees and 12,146 female Korean employees, neuropsychiatric impairment made returning to work and receiving a new job more difficult (Rhie, Jeong and Won 2013).

A questionnaire study among 2,882 French employees indicated that depressive symptoms were related to occupational injury (Chau *et al*. 2011). A secondary analysis of workers' compensation claims in British Columbia—102,997 men and 53,882 women—showed that depression was higher among women than men and peaked in the middle age groups (Smith *et al*. 2014).

In a Canadian social enterprise, Lysaght *et al*. (2011) compared 255 employees with intellectual disability to 320 employees without such disability. Employees with intellectual disability had almost three times less occupational injuries than the comparison group. When a health risk appraisal survey of 8,563 employees in a large American manufacturing company was carried out, attention deficit hyperactivity disorder (ADHD) was diagnosed in 1.9 % of the employees. ADHD was associated with a 4 % to 5 % reduction in work performance and with double the risk of occupational injury (Kessler *et al*. 2009).

My conclusion is that there seems to be weak confirmation of the relationship between mental illness and occupational injury. One study confirms the association between depression and occupational injury. Further studies are needed on all these issues.

Musculoskeletal Symptoms

Palmer, Harris and Coggon (2008) reviewed six studies on musculoskeletal problems related to occupational injury. Most of these studies showed that self-reported arthritis increased the risk of occupational injury. Based on the National Health Interview Survey, from 1985 to 1994, Zwerling *et al*. (1997) found a 34 % higher risk of occupational injury among employees with arthritis compared to healthy employees. The Lorhandicap Group examined 2,888 employees in the Lorraine area in northeastern France. Musculoskeletal disorders almost doubled the risk of occupational injury (Chau *et al*. 2008). Bunn and his co-workers (2006) made a staged communication and educational intervention to prevent musculoskeletal injuries at the International Truck and Engine Corporation factory in Springfield, Ohio (n = 3,417). This intervention reduced work-related