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The Ergonomics Open Journal, 2016, *9*, 15-26

The Ergonomics Open Journal

Content list available at: www.benthamopen.com/TOERGJ/

DOI: 10.2174/1875934301609010015

REVIEW ARTICLE

Long Working Hours and Shift Work as Risk Factors for Occupational Injury

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Received: December 17, 2015 Revised: May 24, 2016 Accepted: May 30, 2016

Abstract: The aim of this review is to examine the effect of extended working hours and shift work on occupational injuries. A calculation based on five studies shows that the risk of occupational injury during afternoon shifts was 6% lower than that during morning shifts. The same kind of calculation showed that the risk of occupational injury during night shifts was 15% lower than during morning shifts. A review of twelve studies showed that the risk of occupational injury was 15% higher for 10-hour working days compared to 8-hour working days. On the other hand, working 12-hour days increased the risk of occupational injury by 38%. When working more than 12 hours per day, four studies showed a 147% increase in involvement in occupational injury. The results of this review showed that shift work considerably increased the risk of occupational injury in the USA, but not in India and Singapore. Extended working hours was related to elevated risk of occupational injury. Thus shift work and long work hours did not suit for all employees.

Keyword: Long working hours, Occupational accidents, Review, Shift work.

INTRODUCTION

Success in global markets requires companies to be flexible and ready to make rapid changes. For workers, this can mean an increasing amount of shift work or extended working days. The aim of this review is to examine whether these factors (long working hours, shift work, and breaks) are related to occupational injuries.

METHODS

For this literature review, the studies were collected on the following criteria:

1) Occupational injuries included in this review are only accident injuries and diseases are excluded.

2) The studies were published, most of them in peer-reviewed journals. All the studies reviewed were published in English.

3) The study included a comparison of injury rates of morning, afternoon and night shifts. Especially studies presented in the summary table fill the criteria.

4) In the part of extended working days all studies identified in the literature and related to occupational safety during extended working days were included in the text. However, only studies including exact injury rates of 8 working hours compared to 10 hours, 12 hours or longer working hours were presented at the Table **2**.

The search of literature was done by picking articles from those that I have read. For example, titles did not told that the articles concerning long working hours and occupational injury.

The term “risk” in this review is meaning the risk of occupational accident. In the most cases the risk is determined

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by the multiplication of the probability of accidents and consequences of accidents.

SHIFT WORK AS RISK FACTOR

According to the European Union Survey on Working Conditions in 2000, 18.8% of the workforce is engaged in shift work including night work. More men (24%) than women (12%) were involved in shift work. About 7% of shift workers worked permanently at night [1].

In a review of 19 studies done between 1910 and 1985 in England, USA, Germany, and Netherlands *etc*., eight showed a higher frequency of accidents during night shifts, one during day shifts, two during morning shifts and two during afternoon shifts. In six studies there were no statistical significant differences between shifts [2].

The recent review showed that compared to morning shifts, the risk of occupational injury during afternoon shifts increased by 18.3% and in night shifts by 30.4%. This review is based on five studies published between years of 1972 and 1995 [3, 4]. However, the authors [5 - 7] later added two studies made in 2000 and 2001 to their review, and concluded that the risk of occupational injury was 15% higher during afternoon shifts and 28% higher during night shifts compared to morning shifts, which were 3.3% and 2.4% lower than the previous reviews. When they examined successive night shifts, the risk of occupational injury was 6% higher on the second night, 17% higher on the third night, and 36% higher on the fourth night. Compared to day shifts, the risk of injury increased by 2% for the second morning, 7% for the third morning, and 17% for the fourth morning. It was concluded that older workers had a greater risk of occupational injury in the shiftwork both in the review [8] and empirically in New Zealand (n=2,685) [9], although this claim requires more research.

Working on the off-shore platforms are a special case for shift work, because employees stay 2-3 weeks at the platform without leaving. A review studies published between 1996 and 2011 of shift schedules on North Sea oil-gas installations found 31 studies. Based on them, it was concluded that the risk of serious injuries requiring medical treatment was 22-32% higher in night shifts than of day shift injuries [10]. However, there was no possibility of comparing the injury rates for fixed-shift and swing-shift rotation schedules. Another review based on the four studies published between 1990 and 2001 in the offshore petroleum industry concluded that results are inconsistent and insufficient as a base for drawing general conclusion [11]. In Norwegian drilling rigs, operators had more injuries during the day shift than during the night shift (number of injuries = 3229, 1980-1987) ($p<0.05$), due to higher activity level and more people working at day time. However, there was no difference between day and night shifts in the injury rate among drilling crews [12]. At Campos Basin offshore drilling units in Brazil (n=172) working at dark period increased the risk of occupational injury by 51% compared to light period [13]. In the North Sea oil and gas installations shift pattern was significantly associated with work-related injury ($p<0.05$). Construction workers had almost three times more injuries than the reference group (OR = 2.91, 95% CI 1.58-5.36, n=1,462 exposed workers) [14].

A study involving workers of a large English engineering company (n= 4,645) showed that during afternoon shifts the risk of occupational injury was 15% higher (RR= 1.15, 95% CI 1.07-1.23), and during night shifts 23% higher than during morning shifts (RR = 1.23, 95% CI 1.14-1.31, $p<0.001$). Moreover, injuries in the self-paced work were more serious on the night shift compared with the morning shift [15].

Driving home after a night shift increased the risk of fatigue-related traffic accidents both in the review [16] and among American medical students (n=3,429, OR = 2.3, 95% CI 1.6-3.3, $p<0.001$) [17]: a systematic review concluded that the risk of crashing doubles after extended shifts [18].

Employees of evening and night shifts had a respectively higher risk of occupational injury of 43% (HR = 1.43, 95% CI 1.26-1.62) and 30% (HR = 1.30, 95% CI 1.12-1.52) compared to conventional day shifts according to the National Longitudinal Survey of Youth in U.S. (n=12 686). In addition, rotating shift work increased injury risk by 36% (HR = 1.36, 95% CI 1.17-1.58) and irregular shift work by 15% (HR = 1.15, 95% CI 1.03-1.30) [19]. The greatest risk of occupational injury in evening shifts was found among construction workers (n = 264, HR = 2.86, 95% CI 1.38-5.98) [20].

In a metallurgic plant in the former German Democratic Republic, occupational injuries (n=688 in 1968-1969) reached a maximum during night shifts ($p<0.01$) [21]. In an American paint company, workers (n=1,691) had a 25% greater injury rate during night shifts than during morning shifts, and the injury risk was highest in the last three hours of the night shift ($p<0.05$) [22]. Occupational injuries occurred most often in the fourth working hour during the morning shifts and the fifth and sixth hour during night shift in Indian textile industries (n=3,470 fatal and non-fatal injuries) [23]. In an Iranian mining industry in 2006-2007, shift workers (n=137) injured more often than non-shift

workers (n=130, p = 0.03) and shift workers reported more often fatigue-related injuries (p<0.001) [24]. In a synthetic fiber factory in Iran the occupational injury rate (n=836 injury events) was one and half time higher (OR = 1.50, 95% CI 1.10-2.00) during the first half of the shift than during the second half [25].

Fire fighters (n=447) from a Northeastern state were injured more often during the night shifts (p>0.05) [26]. Police officers (n=419) from a mid-sized urban police department in the U.S. were injured on the midnight shift 72% more often than in the day shift (Incident Rate Ratio = 1.72, 95% CI 1.26-2.36, p = 0.0007). High activity level combined with midnight shift doubled the risk of occupational injury for police officers (IRR = 2.31, 95% CI 1.46-3.65, p = 0.0003) [27]. A long-term injury (>89 days) for the same police officers occurred three times more often during night *versus* day shift (IRR = 3.12, 95% CI 1.35-7.21, p = 0.01) and two times more often in night shift *versus* afternoon shifts (IRR = 2.21, 95% CI 1.06-4.68, p = 0.04) [28].

In a Canadian glass factory and steel plant, injuries (n=3 309) peaked at noon, just before lunch time and between 2 and 4 a.m. during the night shift [29]. During afternoon and night shifts, injuries were less severe than in the morning shift in six automotive plants in Ontario, Canada (n=over 8 000 workers) [30]. Based on two population-based data sources in Ontario over 5 years 2004-2008 (n=457 141 injuries), in evening and night schedules women had 12.5% and men 5.8% more injuries than in the morning shift [31]. On the other hand, based on the Survey of Labor and Income Dynamics 1996-2006 (n=approximately 30 000), shift work increased risk of occupational injury 14.4% for Canadian women and 8.2% for men. Night shift work doubled the injury risk among women (OR = 2.04, 95% CI 1.13-3.69) and almost doubled among men (OR = 1.91, 95% CI 1.21-3.03), while rotating shift work increased the injury risk for women over two times (OR = 2.29, 95% CI 1.37-3.82) [32]. However, injuries were more serious during night shifts, although the injury rate was lower during night shifts than during the morning and afternoon shifts (p<0.001) in an iron and steel plant in Singapore (n=664 production workers) [33].

Dutch bus drivers (n=1 564 man-years 1973-1980) suffered injury more often during the morning shift than the afternoon shift (p<0.001). Starting early particularly increased the risk (p<0.001), so that the peak was during the fourth hour of the shift [34]. In the Belgian metal factory (n=730 male shift-workers), the higher accident rate was found in the morning shift compared to the late shift or to the night shift (p<0.01) [35].

In Australia, the risk of fatal occupational injury (n=1020, from 1982 to 1984) was double during the night shift compared to other shifts [36]. Female adolescents working on night shift in Queensland, Australia, were involved in occupational injuries almost five times more often than their adult counterparts, whereas male adolescents injured three times more often than adult males (n=3201 injured adolescents) [37]. Based on Multipurpose Household Survey (n= 14,267 in 2009-2010), it was shown that the risk of work injury in shift work was higher for women than for men (OR = 2.43, 95% CI 1.95-3.03 *vs*. OR = 1.56, 95% CI 1.26-1.94, p = 0.005). Women working in shiftwork and having children had the highest risk of occupational injury (OR = 3.67, 95% CI 2.41-5.59, p = 0.02) [38]. Nurses in the Philippines (n=655) had an increased risk of occupational injury at non-day shift (OR = 1.54, 95% CI 1.07-2.24) and when working mandatory overtime (OR = 1.22, 95% CI 1.06-1.41) [39].The risk of occupational injury doubled among American nurses (n=502 injured workers) after three and more 12-hour night shifts (OR = 2.09, 95% CI 1.10-4.98) [40].

In a Korean steel company shift workers (n=8,311) were 30% more often involved in occupational accidents than day workers (n.s) [41]. In 26 Korean companies (n=4,127 workers), the accident rate in 2-shifting system was 1.7 times higher than 3-shifting system (p<0.01) and 4 times higher than non-shift system (p<0.01) [42]. Based on the Korean Working Condition Survey of 2006 (n=7,075), it was shown that shift workers had two times more often occupational injuries than non-shift workers (OR = 2.40) [43] or in the later analysis (OR = 1.89, p= 0.026) [44].

The effect of rotating shift work on occupational injuries was examined in three studies. Working in rotating shifts with nights also doubled the risk of occupational injury among New Zealand Blood Donors (n=15 687, RR = 1.9, 95% CI 1.5-2.4) [45] and Massachusetts nurses (n=635, OR = 1.97, 95% CI 1.07-3.63, p<0.05) [46]. In a large German electronic factory, employees in rotating shifts (n=14 128) had 34% more injuries than employees in day shifts (n=17 218, HR = 1.34, 95% CI 1.30-1.39, p<0.0001) [47]. However, a fixed-term shift system was superior in performance to the rotating shift system in a resistor manufacturing company in Taiwan (n=180, p<0.05) [48].

Extreme morning-types suffered more from shift work than their evening-type counterparts [49]. In the U.S.A. Lake Superior iron ore mining region, 65% of occupational injuries (n=465) occurred in Sunday night and Monday morning shift after the weekend break (p<0.01) [50]. Workers in the day-to-evening shift had an elevated risk of occupational injury based on the Taiwan Social Development Trend Survey in 2005 (n=18,794, OR = 1.14, 95% CI 1.01-1.29, p<0.05) [51]. In a Turkish margarine production factory (n=25), accidents declined after the change from two-day

rotation to weekly rotation [52]. Based on the review of five studies with 441 shift workers, it is concluded that night work should be reduced as much as possible, and perhaps replaced by quickly rotating shift systems [53].

The review of Folkard and Åkerstedt [4] is based on studies published from 1962 to 1995, and the oldest studies in the review did not report exact results. That is why I have carried out the same review on more recent studies.

Table **1** summarizes the main details of the studies relating to the trend across the three shifts. The risk of occupational injury during morning shifts was set at 1.0 and the relative risk during afternoon shifts was calculated by dividing the injury frequency of the afternoon shift by the frequency of the morning shift. The same calculation was also carried out for night shifts.

Table 1. Summary of studies reporting incident rates across three shifts.

Authors	Industry	Country	Morning	Afternoon	Night
Levin [22]	Paint manuf.	USA	1.00	1.16	1.27
Ong [33]	Iron & Steel	Singapore	1.00	0.53	0.41
Nag [23]	Textile	India	1.00	0.60	0.41
Dembe [19]	NLSY	USA	1.00	1.45	1.32
Violanti [27]	Police	USA	1.00	1.22	2.17
Average:	All five		1.00	0.94	0.85
USA	Average		1.00	1.31	1.30
Developing	countries	Average	1.00	0.57	0.41

The new review showed that the risk of occupational injury was 6% lower during afternoon shifts than morning shifts (Table **1**). However, it is important to note the difference between the USA and developing countries. In the USA, workers of afternoon shifts had a 31% higher risk of occupational injury, whereas in the developing countries the risk during afternoon shifts was almost half (57%) that of morning shifts.

The analysis showed that the risk of occupational injury during night shifts was 15% lower than during morning shifts (Table **1**). Once again, the risk was 30% higher during the night shifts in American companies, but in developing countries, the risk of occupational injury during night shifts was 60% lower than during morning shifts.

The results of the actual revision are in line with the review of Folkard and Åkerstedt [4], if we focus on results from the USA. For both the afternoon and night shifts I found a slightly higher risk of occupational injury than Folkard and Åkerstedt. However, the new results from developing countries changed the overall situation, when both afternoon and night shifts had a lower accident frequency than morning shifts. One reason for this could be that there are fewer supervisors during afternoon and nights shifts and accidents are not registered as often as during morning shifts.

One critical question regarding the effect of shift work on occupational injuries is whether the employees permanently worked evening or night shifts or worked by rotating shifts. In two studies [22, 33] they worked in rotating shifts, whereas in the other two studies [19, 23] employees worked only evening or night shifts. However, permanently working evening and night shifts or in rotating shifts did not seem to influence injury rates.

EXTENDED WORKING DAYS AND OCCUPATIONAL ACCIDENTS

Extended working days are generally referring to working more than 48 hours per week [54]. Per a study in Australia, the primary reasons for employers to introduce 12-hour shifts are financial and productivity considerations (54% of employers in Australian Workplace Industrial Relations Survey 1995, n = 37 200 workplaces) [55]. Based on the 2002 General Social Survey made in the U.S. (n=1,744), overtime workers were more likely male ($p<0.01$), white ($p<0.05$), and middle-aged ($p<0.01$) with higher level of education ($p<0.01$) and income ($p<0.01$) [56].

In their review from 1985 to 1992, Duchon and Smith [57] found that in six out of seven studies, long working hours increased the number of occupational accidents, while in one study accidents decreased after the change to 12-hour shifts. In the later review of 49 studies from 1969 to 2001, Bendak [58] concluded that most workers preferred 12-hour shifts than 8-hour shifts although most of the objective performance measures showed negative effects. The extra 4 hours increased fatigue, which may in turn lead to an increased accident risk. Folkard and Lombardi [6] concluded that, based on four studies, 10-hour shifts increased the injury risk by 13% and 12-hour shifts by 28% compared to the risks of an 8-hour working day. Knauth [59] showed in his review of 18 studies from 1970 to 2005 that half of them showed increased risk of occupational injury with long work hours, whereas 5 were not significant associations, and 4 reported that the long work hours were associated with fewer injuries. Both in review of three studies published in the 1990's

[60] and 14 studies (up to June 2008) [61] it was concluded that working in a 12-h shift double the risk of occupational accident compared to a 8-h shift. According to these reviews, extended working days increased the risk of occupational injury.

A change from a three 8-hour shift system to a two 12-hour shift system in a Canadian synthetic yarn manufacturing company (n=247) decreased the occupational injury rate ($p<0.05$), but did not influence off-the-job injuries [62]. The workers of a large American manufacturing site (n=350) preferred the change from 8-hour/7-day rotating shifts to 12-hour rotating shifts, because of subjective feelings regarding health and family life. However, the change had no effect on the occupational injury rate [63]. In an Australian coal mine, a change from an 8-hour/7-day roster to a 12-hour/7-day schedule decreased accident frequency in a coal preparation plant (n=40, $p<0.05$), but increased absenteeism in the maintenance department (n=65, $p<0.05$) [64]. When workers of an Australian power station (n=27, $p<0.02$) [65] and an American nuclear power station (n=104 stations, $p<0.05$) [66] moved from an 8-hour roster to a 12-hour roster, operator errors increased. In an American police station (n=74), on the other hand, the change from 8-hour shifts to 12-hour shifts improved organizational effectiveness ($p<0.01$) and decreased the stress and fatigue of police officers ($p<0.01$) [67]. To conclude, two studies showed that the change to longer working days decreased the occupational injury rate, one showed no changes, and operator errors increased in two studies.

In a Canadian underground metal mine, workers (n=165) changed from seven by two 8-hours schedule to a four by four 12-hour shift schedule. An overwhelming majority of workers supported the change, because it improved sleep quality ($p<0.001$). No changes were found in fatigue-sensitive behavioral and physiological performance measures [68], and older workers in the same mine (n=25) had no more difficulties with a 12-hour shift than with an 8-hour schedule [69]. This study, in line with other studies, supported the claim that the majority of workers prefer 12-hour shifts due to improved sleep and family life.

In South Korea, people working over 60 hours per week had almost four times (OR = 3.94, 95% CI 3.04-5.09) more often occupational injuries than those working under 46 hours per week (n=1,576 injured workers) [70]. Based on the Occupational Safety and Health Survey in 2004 (n=65,921), it was found that people working 44-54 hours per week were one and half times (OR = 1.6, 95% CI 1.5-1.8) more often involved in occupational injuries and those working more than 54 hours had three times (OR = 3.0, 95% CI 2.7-3.4) more injuries than those working less than 44 hours per week [71]. The Korean experience showed that long work days increased the risk of occupational injury many times.

Based on the National Longitudinal Survey of Youth (n=12,686), Dong [72] found that among construction workers, working over 50 hours per week increased the risk of occupational injury (OR = 1.18, 95% CI 1.17-1.19). The risk was double for those working over 60 hours compared to those working 40 hours (OR = 1.98, 95% CI 1.88-2.05). Based on the same data set, Dembe and his co-workers [73] showed that working at least 12 hours per day increased the risk of occupational injury by 37% (HR = 1.37, 95% CI 1.16-1.59). Working over 60 hours per week raised the injury risk by 23% (HR = 1.23, 95% CI 1.05-1.45), working in a job with overtime (for overtime pay) increased it by 61% (HR = 1.61, 95% CI 1.43-1.79). Working overtime increased the risk of occupational injury among professional, technical and managerial personnel in particular [74]. These results showed that working overtime, especially over 60 hours per week, dramatically increased the risk of occupational injury.

Based on the US National Health Interview Study in 2004-2008 (n=69,248), it was shown that the longer work hours, the higher injury frequency (77% higher for over 60 hours/week). This effect is related to decreased sleeping time, for example working over 60 hours/week and sleeping less than five hours per night increased the risk of occupational three times (OR = 3.12, 95% CI not presented) [75]. Later based on the same interview study in 2004-2010 (n=96,915), it was found that women working 41-50 hours per week had 51% (OR = 1.51, 95% CI 1.03-2.21) higher risk of suffering an occupational injury and those working over 50 hours had 69% (OR = 1.69, 95% CI 1.06-2.70) higher risk of injury compared to women working 31-40 hours per week. For men, there was no significant difference [76]. Based on the Canadian Community Health Survey in 2003 (n=75,184) men working over 80 hours per week had twice more injuries than those working less than 35 hours per week (OR = 2.1, 95% CI 1.5-3.1, $p<0.05$), whereas among women the difference was not significant [77]. A questionnaire study to American and Canadian companies (n=326) showed that accident frequency in the companies using 12-hour shift was 25% lower and accident severity rate 50% lower than in the companies with 8-hour shift [78].

The risk of occupational injury increased exponentially beyond the 9th work hour among German workers (n=more than 1.2 million accidents in 1994). After 12 hours the risk was double compared to the first eight working hours ($p<0.0001$) [79]. American metal workers (n=6,895) who worked over 64 hours per week had an 88% higher risk of

occupational injury than those working 40 hours per week (HR = 1.88, 95% CI 1.16-3.05, p<0.05) [80]. A survey of American workers in 2001 (n=2,746) showed that those working over 60 hours per week were more likely to report occupational injuries (p<0.01) [81]. Based on the National Health Interview Survey in 2004-2009 (n=89,366), 10-hour increase in weekly working hours increased the injury risk by 14% (OR = 1.14, 95% CI 1.06-1.22) and 1-hour decrease in sleep increased the injury risk by 10% (OR = 1.10, 95% CI 1.02-1.19, p<0.01). In addition, long working hours increased the risk of short sleep duration (p<0.05), which in turn increased occupational injury risk [82] In the Thai Cohort Study in 2009 (n=51,751), women working over 49 hours per week had 1.4 times (OR = 1.4, 95% CI 1.1-1.9) more occupational injuries and men working as much as women had 1.3 times (OR = 1.3, 95% CI 1.0-1.6) more injuries than those working 40 hours per week [83]. These studies show that the risk of occupational injury is almost double when working hours exceed 60 per week compared to 40 hours per week.

Table **2** shows the main details of the 12 studies relating to extended work days. The risk of occupational injury in an 8-hour working day was set at 1.0 and the relative risk of a 10-hour working day was calculated by dividing the injury frequency of the 10-hour working day by the frequency of the 8-hour working day. The same calculation was made for working days of 12 hours and over. Only studies with exact injury rates were included in the Table **2**.

Table 2. Summary of the studies across hours on duty (accident rate).

References	Industry type	Country	10h shift	12h shift	Over 12h
[62]	Textile	Canada	-	0.55	-
[79]	All industrie	Germany	1.69	1.92	2.23
[63]	Manufacturing	USA	-	1.01	-
[64]	Coal mine	Australia	-	0.34	-
[81]	Manufacturing	USA	1.58	0.73	-
[72]	Construction	USA	1.18	1.98	-
[73]	NLSY	USA	-	1.38	1.84
[80]	Metal	USA	1.19	1.21	1.88
[74]	NLSY	USA	-	2.02	-
[70]	All industries	Korea	0.95	1.21	3.94
[71]	All industries	Korea	1.60	3.00	-
[75]	NHIS	USA	1.08	1.26	-
Average			**1.15**	**1.38**	**2.47**

Based on seven studies, the review showed that the risk of occupational injury was 15% higher for 10-hour working days compared to 8-hour working days (Table **2**). Twelve comparisons were found between 8-hour and 12-hour working days, showing that working 12 hours increased the risk of occupational injury by 38%. Four studies showed a 147% increase in occupational injuries when working more than 12 hours per day.

Compared to the review of Folkard and Lombardi [6], this review showed a slightly lower increased risk of occupational injury during a 10-hour working day than during an 8-hour shift. The newest study [81] in particular showed a high increase in the risk of injury during 10-hour shifts. On the other hand, I found a slighter higher elevated risk of occupational injury during 12-hour shifts than Folkard and Lombardi [6]. I used 12 studies compared to the four studies in their review, three of which [62, 64, 81] showed a lower risk of injury during a 12-hour working day than during an 8-hour working day.

One critical point for occupational safety is to note that the risk of occupational injury is highest during the last working hour on an extended working day [6, 73, 74, 77]. As this is an exception to the hourly distribution of occupational injuries during the 8-hour work shift, it shows the hazardousness of extended working hours more clearly. It is recommended that employees work 8-hours per day for a longer period if necessary, rather than extended working days for a shorter time period.

THE EFFECT OF REST BREAKS

In his review, Tucker [84] concluded, based on six studies from 1977 to 2003, that rest breaks are an effective means of controlling the accumulation of accidents during industrial shift work. He considered that there is only limited direct epidemiological evidence on the effects of rest breaks on accident occurrence. The risk of occupational injury increased during the second and third half-hours after the break in a large engineering company in the US (n=4,250 shift

workers, $p<0.01$) and among patients of traumatic occupational hand injuries (n=1,179, $p<0.001$) [85]. On the other hand, at a car assembly plant in the United Kingdom (n=2,224), the accident risk rose significantly during the fourth half-hour after the break (RR = 2.08, 95% CI 1.73-2.43, $p<0.0001$), and fell immediately after the break [86]. Based on the work-related ladder-fall picked up from National Electronic Injury Surveillance System (NEISS, n=306) used in the United States, longer accumulated break time was associated with a longer time to injury. Workers without rest breaks worked a median 3.0 hours before the injury, workers with 1-15 minute break time worked 3.8 hours (HR = 0.60, 95% CI 0.44-0.83), with 16-30 minutes break they worked 6.0 hours (HR = 0.50, 95% CI 0.33-0.75) and over 30 minutes break moved the injury a median of 5.0 hours (HR = 0.34, 95% CI 0.23-0.51, $p<0.05$) [87]. The results of these studies supported the present system in which workers take a break after two hours of work.

DISCUSSION

Increasing flexibility in work life also means working longer hours in order to increase productivity [55, 58]. On the other hand, workers are no longer tied to their work all the time, or to one particular place. This flexibility also requires workers to maintain their work capacity and health by themselves, which MacEachen, Polzer and Clarke [88] called "strategies of resilience". It also supports workers with personal and home-related stress to sustain productivity levels. Especially women worked more often overtime without compensation than men in Finland as part of flexible work life [89].

In conclusion, this review showed that extended work hours increased the risk of occupational injury. Especially working over 12 hours per day doubled the risk of injury. Extended working days may be suitable, if the nature of the work and the workload allow it [53].

On the other hand, afternoon and night increased the risk of occupational injury compared to morning shift in industrialized countries. A new finding was that in the developing countries the situation is vice versa; the injury frequency was higher in morning shifts than in afternoon and night shifts. One possible explanation is the lack of supervisors during afternoon and nights shifts, and that is why more injuries were not reported during afternoon and night shifts. Both stimulus and transactional models of stress explained the link between shift work and health [90]. Napping before working a night shift is an effective countermeasure to fatigue with night shift among Italian police drivers ($p<0.05$) [91].

CONCLUSION

The aim of this review is to examine whether long working hours, shift work, and breaks are related to occupational injuries.

An exact analysis of five studies showed that employees had 6% lower risk of occupational injury during afternoon shift and 15% lower in night shift compared to morning shift. The new finding of this review was that there is a total difference between USA and developing countries. In the U.S. working in afternoon increased the risk of injury by 13% and in night shift by 30%, whereas in developing countries employees in afternoon shift had 43% lower and in night shift 60% lower risk of injury compared to morning shift.

A review of 12 studies showed that employees working over 12 hours per day had 38% higher risk of occupational injury than those working 8 hours. Working 10 hours per day increased the risk of injury by 15% compared to working 8 hours per day. It is recommended that employees work 8 hours per day in the long run because of increased injury risk.

Four studies showed that accidents increased linearly after the break, escpecially two hours after the break. The results supported the present system: employees have a break when they had worked two hours.

The results of this review supported the present system of 8 hours work day. Night work, long work hours and long work periods without breaks increased considerable the risk of occupational injury.

DISCLOSURE

This article is an updated version of the article published in "Shift Work and Extended Working Hours as Risk Factors for Occupational Injury". The Ergonomics Open Journal, 2010, 3, 14-18.

CONFLICT OF INTEREST

The author confirms that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

Declared none.

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