

Temporal Trend of Occupational Injuries; First Versus Second Half of a Working Shift

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Objectives. To assess occupational injuries in the 1st versus 2nd half of a working shift in terms of (a) the likelihood of hospital referral following an injury event; (b) the external causes of injuries. **Methods.** Logistic regression analyses of data from a 16-year (1991–2007) experience of ongoing surveillance of occupational injuries in a synthetic fiber factory in Iran. **Results.** The likelihood of a hospital referral following an injury in the 1st half of a shift was higher than in the 2nd half (adjusted odds ratio [OR] 1.50, 95% confidence interval [CI] 1.10–2.00). Comparing the 2 halves of the shift, an injury occurring in the 2nd half was more likely to be due to exposure to smoke, fire and flames (OR 2.34, 95% CI 1.06–5.19) or transport accidents (OR 1.84, 95% CI 1.06–3.21). **Conclusions.** Time-specific safety interventions could be used in the risk management of occupational injuries. Further studies to investigate the effect of time-dependent interventions are recommended.

occupational injury temporal trend hospital referral shift work external causes of injury
synthetic fibre factory Iran

1. INTRODUCTION

Existing evidence suggests that the risk of injury events in the workplace varies with both the stage

of the work shift and the time of day [1, 2, 3, 5, 6, 7, 8]. For example, occupational injuries have been reported to occur at a higher frequency during day shifts [2, 3, 4].

The authors would like to express their deepest appreciation to the staff of the Occupational Health Department at Polyacryl Iran Corporation.

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The temporal trend of injuries through work shift phases has been carefully investigated; it has been frequently reported to peak in the first half of the workday [2, 3, 4, 5]. However, to the best of our knowledge, the likelihood of hospital referral as well as external causes of injuries through work shift phases has not yet been investigated. The current study aims to address this shortcoming by assessing occupational injuries in the first versus second half of a working shift in terms of (a) the likelihood of hospital referral following an injury event; (b) the external causes of injuries.

2. METHODS

This retrospective cohort study was conducted in a large factory manufacturing synthetic fibres in Iran. The study period was from March 21, 1991, to March 21, 2007.

The manufacturing plant featured a well-managed system for reporting injuries which was overseen by the Occupational Health Department (OHD). When an injury event was reported, the OHD followed the procedures for responding to an injury. This included the provision of first aid on site and/or hospital referral for treatment when first aid was not sufficient. This was followed by dispatching a safety inspector to the area in which the accident had occurred to begin an investigation. The injury and the circumstances surrounding the event were documented by safety inspectors who had received training in reporting and documenting injury events. The comprehensive reporting and record-keeping system provided a detailed account of workplace injuries in this factory. The opportunity to analyse these well-prepared reports made the development of the current study possible.

Data extracted from injury reports between March 21, 1991, and March 21, 2007, were entered into an injury surveillance software package. In this study, injury-related variables included time of injury and whether or not hospital referral was required. The external cause of injury was also included on the basis of ICD-10 codes [9].

The factory's work schedule was used to investigate occupational injuries by working

shifts. Operations at the factory were divided into three shifts. The day shift ran from 7:30 to 15:30; the evening shift from 15:30 to 23:30; and the night shift from 23:30 to 7:30.

Injuries sustained during the study period were reported as the number of injury events rather than the number of injured persons. Descriptive statistics were used to show the external cause of injuries in the first and second half of the shift (Table 1). A logistic regression model was used to compare the likelihood of hospital referral in the first versus second half of the shift. The odds ratio (OR) was adjusted for different shifts (i.e., day, evening, and night). This statistical approach was also employed to indicate the effect of external cause of injury in the first versus second half of the shift (Table 1). All analyses were performed using SPSS version 15.0.

The study was approved by the Ethics Committee of Isfahan University of Medical Sciences, Iran, and it was performed according to the Declaration of Helsinki.

3. RESULTS

There were 836 injury events during the study period. Of these, 828 (99%) had documented time of injury event.

Figure 1 shows an upward trend in injury frequency from midnight to 10:00, and then a downward trend towards midnight. Many injuries occurred during the day shift ($n = 553$, 66% of all injuries sustained). Also evident in Figure 1 is a sharp rise in the number of injuries during the first 3 h of that shift; so that 9% of the injury events occurred in the first hour ($n = 48$), 16.5% in the second hour ($n = 91$), and 23% in the third hour ($n = 129$). In total, almost half of the injury events in this 8-h shift occurred within 3 h of starting the shift ($n = 268$, 48.5% of injuries sustained in the day shift).

With regards to differences between the shifts, about two thirds of all injuries ($n = 553$, 66%) occurred during the day shift, 20% ($n = 169$) in the evening shift, and 13% ($n = 106$) in the night shift. Figure 2 shows that, of the 553 injury events that occurred in the day shift, 128 led to a hospital referral (23%). Of the 169 injury events

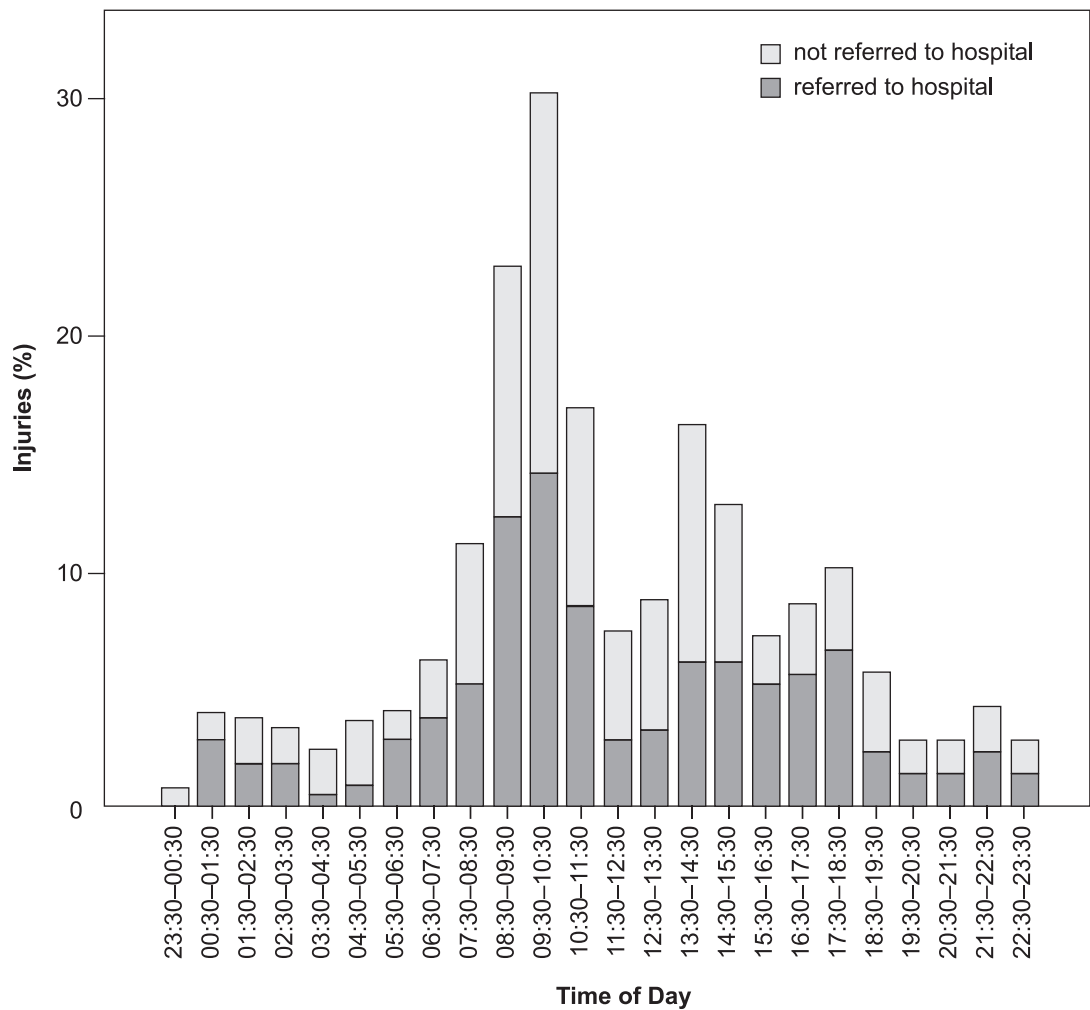


Figure 1. Time of day and percentage of injuries (total number of sustained injuries = 836).

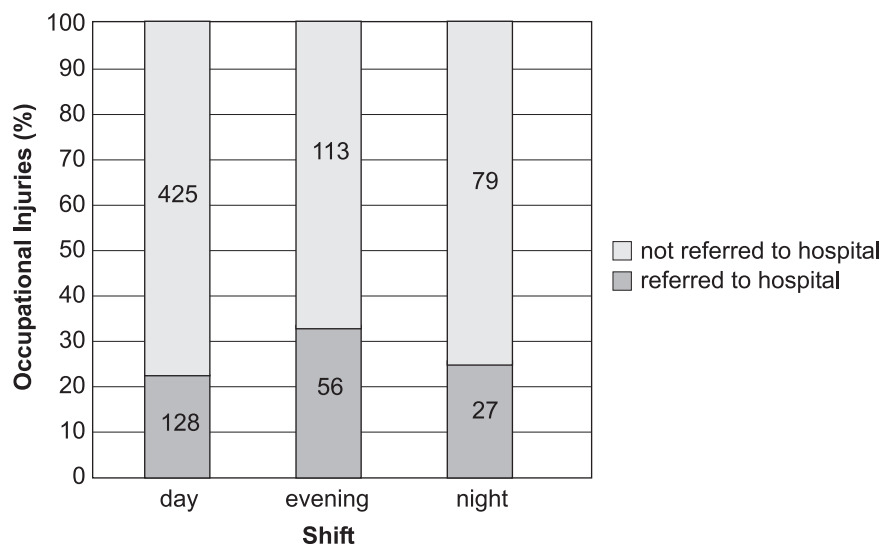


Figure 2. Occupational injuries in day, evening, and night shifts.

TABLE 1. External Cause of Injury in the 1st and 2nd Halves of a Shift

External Cause of Injury ([9])	1st Half (%)	2nd Half (%)	Crude OR† (95% CI)	Adjusted OR for Shift Type (95% CI)
Accidental exposure to other and unspecified factors (X58–X59)	62 (12.4)	31 (9.5)	1.00	1.00
Transport accidents (V01–V99)	67 (13.4)	64 (19.6)	1.91 (1.10–3.31)*	1.84 (1.06–3.21)*
Falls (W00–W19)	64 (12.8)	32 (9.8)	1.00 (0.54–1.83)	1.01 (0.55–1.85)
Exposure to inanimate mechanical forces (W20–W49)	155 (30.9)	96 (29.4)	1.23 (0.75–2.04)	1.24 (0.75–2.05)
Exposure to animate mechanical forces (W50–W64)	117 (23.4)	72 (22.0)	1.23 (0.73–2.07)	1.18 (0.70–1.99)
Exposure to smoke, fire and flames (X00–X09)	16 (3.2)	19 (5.8)	2.37 (1.07–5.24)*	2.34 (1.06–5.19)*
Contact with heat and hot substances (X10–X19)	20 (4.0)	13 (4.0)	1.30 (0.57–2.95)	1.30 (0.57–2.97)

Notes. * $P < .05$; OR—odds ratio, CI—confidence interval; †—reference category: accidental exposure to other and unspecified factors.

that took place in the evening shift, 56 led to a hospital referral (33%). Of the 106 injury events that occurred in the night shift, 27 led to a hospital referral (25%). The differences between shifts in terms of injuries leading to a hospital referral were statistically insignificant.

Approximately one quarter of all injury events (25%, $n = 211$) led to a hospital referral. The two halves of a shift had different injury frequencies; 60% ($n = 501$) of injury events occurred in the first half of the shift, 39% ($n = 327$) in the second half. For the first and second half, 28% ($n = 141$) and 21% ($n = 70$) of injury events led to a hospital referral respectively. A statistically significant crude increased risk of a hospital referral after an injury event was observed in the first half compared to the second half of the shift (OR 1.43, 95% CI 1.03–1.99). After adjusting for shift type (i.e., day, evening, and night), the OR increased slightly (OR 1.50, 95% CI 1.10–2.00). Table 1 provides the list of causes of injury events recorded in the first and second half of the shift during the study period. With an exception for injuries due to exposure to smoke, fire and flames, all other external causes of injuries were more common in the first half of the shift. Table 1 also shows that the likelihood of injury due to exposure to smoke, fire and flames (OR 2.34, 95% CI 1.06–5.19), and due to transport accidents (OR 1.84, 95% CI 1.06–3.21) was higher in the second half of the shift. The

likelihood of an injury event due to other causes was not significantly different between the first and second half of the shift.

4. DISCUSSION

In this retrospective 16-year cohort study of occupational injuries in a large factory with a well-managed system for reporting and recording injuries, it was found that the likelihood of an injury event which required hospital referral was higher in the first half of the shift comparing to the second half (OR 1.50, 95% CI 1.10–2.00). This could warrant efforts to increase safety during this time. The results also showed that, when comparing the two halves of the shift, an injury occurring in the second half was more likely to be due to exposure to smoke, fire and flames (OR 2.34, 95% CI 1.06–5.19) or transport accidents (OR 1.84, 95% CI 1.06–3.21).

Exposure to smoke, fire and flames was the only external cause of injury in which the frequency of injury events was greater in the second versus first half of the shift (Table 1). This finding can be used in injury prevention efforts. The finding regarding transport accidents can be due to increased tiredness in the later hours of the shift. Robb, Sultana, Ameratunga, et al. concluded in their systematic review that fatigue and sleepiness were consistently associated with

an increased risk of work-related traffic injuries [10].

In this study, the first 3 h of each of the three 8-h work shifts saw a significant rise in the frequency of injury events; a trend possibly linked to the onset of workers' main tasks in a shift. This was in line with the findings of a study based on young workers in West Virginia, USA, in which most injuries occurred within the first 3 h of a shift [11]. Horwitz and McCall observed in their investigation that the greatest accident risk occurred during the third hour of work [12]. The upward trend seen in the number of injuries during the first 3 h of each shift requires attention in developing prevention strategies. Short rest breaks during this period [13] or reassignment of risky tasks to other times may increase safety.

The production line in the case study factory operated round the clock. However, most higher risk tasks, such as repairs to machinery, were carried out during the day shift. Moreover, a significantly greater number of workers were on duty during the day as compared to the evening and night shifts. It is not surprising, therefore, that most injuries are associated with the day shift. Previous studies reported a higher frequency of injuries during earlier rather than later shifts (morning versus afternoon or evening) which is consistent with our finding [2, 3, 4]. A comparison of the evening and night shifts shows fewer injuries occur at night which again may be related to the proportion of time given to the more risky tasks and fewer workers on the night shift.

In this study, a second peak of injury events was observed near the end of the shift (Figure 1); this finding, which is consistent with previous observations [3, 6], may reflect the importance of short breaks or other possible countermeasures near the end of the working shift.

This study was based on a review of 16-year data, which is a sizeable period. There might have been minor changes in what constituted a hospital referral over the study period. This, however, was unlikely to have affected our result, as the change would have applied to both halves of the shifts.

The findings of this study provide evidence that the external causes of injuries and the subsequent

likelihood of hospital referral can be related to time elapsed from the start of the working shift. These findings support previous research into the brain area which links occupational injury and time [1, 3, 4, 5, 6, 7, 8, 11, 12]. Therefore, time-specific safety interventions may be an effective way to augment preventive measures.

The authors suggest that the impact of both elapsed time and the time of day should be recognised when establishing prevention plans. The time when occupational injuries took place could be included in surveys designed for developing preventive measures. On the basis of the survey results, appropriate counter-measures could be taken in the prevention plans. Enhanced vigilance and supervision during high risk hours as well as careful work planning over these times may increase safety. The factory at the centre of the present study could be used as an example. Here it was found that the likelihood of a hospital referral was significantly higher following an injury in the first half of a shift compared to the second half. This supports efforts to increase safety during the earlier parts of the shift. The suggested counter-measures to increase safety over these times could be reassignment of the risky tasks to other times as well as providing more rest breaks during this period.

The findings of this study, which provides further evidence of a relationship between occupational injury and the stage of the work shift, should be of interest to employers and other stakeholders in determining more effective injury preventative strategies. Further studies to investigate the efficacy of time-dependent interventions are recommended.

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