

## Study of Demographic Factors on Incidence of Accidents in Heavy Metal Industries between 2001 to 2010: A Study in a Shift Work Rotation System in Iran

Ghader Dargahi<sup>1</sup>, Abbas Karimi<sup>2</sup>, Gholamreza Moradi<sup>3\*</sup>, Mehdi VosoughiNiri<sup>4</sup>, Bahram Azarifard<sup>5</sup>

<sup>1</sup> MSc of Medical Epidemiology, faculty of health, Tehran University of Medical Sciences, Tehran, Iran.

<sup>2</sup> PhD student of Molecular Medicine, Cellular and Molecular Research Center, Tehran University of Medical Sciences, Tehran, Iran.

<sup>3</sup> MSc of Occupational Health Engineering, faculty of health, Tehran University of Medical Sciences, Tehran, Iran.

<sup>4</sup> MSc of environmental health Engineering, faculty of health, Tehran University of Medical Science, Tehran, Iran.

<sup>5</sup> MSc of Medical Epidemiology, faculty of health, Yazd University of Medical Sciences, Yazd, Iran.

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### ABSTRACT

To evaluate the impact of accidents on health and economy it is necessary to have enough information about the incidence of risks and severity of them. The aim of this study is to assess the potential risk and patterns of accidents among work shift in heavy industries. In this retrospective study, registered data of 9235 workers in heavy industry in 9 years (2001 to 2010) were analyzed. Data were collected in two sections of demographic characteristics and comprehensive accidents software. Average ages of victims were 38.5 years old. Each accident led to a reduction of 3.25% working days for an accident. 70.4% of occurring incidents were between 9 to 11 AM hours. Injuries to fingers were the highest of incidents among other events. Most of the incidents had been occurred in April and May, October and March had lower rat of accidents. Prevalence of accidents among hired workers with cycle certificate was high and low among scientific workers. Most common types of injuries were strike to hands. In occurring of accidents unsafe operations, unsafe condition and systemic reasons have been involved 64%, 23% and 13% respectively in accidents. According to these result to lessen the accidents technical accomplishments, foundation of organizational and decision-making committee on safety issues, establishment of OHSAS, preventive and educational programs offered. This study shows that analysis of incidents was not one-way and it must be analyzed systemically, if it be, the results of this study can be used in other industries.

**KEYWORD:** heavy metal industries, injury, shift work, Iran.

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### 1. INTRODUCTION

One of the industrialized outcomes is ever-increasing amount and variety of occupational accidents (1). In addition to economic costs, occupational accidents can also impose damages on human resources. Based on Social Security Organization of Iran statistics paid fees due to occupational accidents in 1997 compared to 1990 has been Eleven-fold. Work shift as a social phenomenon, originated from human history, also nowadays exist due to the economic and technological reasons. Work shift phenomena exist in many industries and factories such as oil industry, power plants, steel and iron industries and generally any industry having profoundly economical investment also in some service jobs include medicine, nursing, firefighters, security force, water services, electricity, telephone etc. (2, 3). Thus, people in this kind of occupations are at work day and night. Outcomes, industrial processes, economic crisis and demand of service sector have created work shift in human societies. Typically, daily work hours are from 6 am to 6 pm. Any kind of work to be done outside of these hours called work shift. Work shift is an unstandardized work (4).

Usually work shift problems can cause fatigue, health problems, impaired social life, reduced productivity and increasing of accidents (5). Any incidents that occur in occupational environments are defined occupational accident. The incidences of occupational accidents in various countries especially in industries are relatively high and are being increased with time. Wherein about 250 million occupational accidents leading to injury and 300 thousands occupational accidents occurred in the world (6) Incidence of occupational accidents causing deaths in developing countries is three to four times more than developed countries and these accidents occur mainly

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\*Correspondence author: Gholamreza Moradi, MSc of Occupational Health Engineering, faculty of health, Tehran University of Medical Sciences, Tehran, Iran. Enghelab square, PO Box: 6446-14155, Tehran, Iran. Email: gh.moradi84@gmail.com

unintentionally (7). In Iran about 14,000 incidents of occupational occur each year that is often pertaining to industry employees (8).

A number of industrial disasters in recent decades such as Three Mile Island, Chernobyl, Bhopal and Exxon Valdez have occurred close to morning. Studying of these results have shown that these occurred due to fatigue or human errors because one have to work in night shift (9). Main factors in the incidence of injuries out of accidents are personal circumstances, environment condition, social and political conditions (economic policy and employment) (10). A wide range of personal and occupational factors such as age, sex, education level, employment status etc has been proposed as factors associated with risk of accidents. Generally, little etiological studies have been done around these issues particularly studies on variables that have major a role in incidence of occupational injuries (11). Many investigations over impact of specific variables on causes and severity of accidents have been done. Salimian *et al* showed that young workers register higher incident rate and lower fetal accident rates (12). Effect of impairment and discomfort by a work shift based on physical and psychological conditions of work may be uncomfortable for older workers (13). Epidemiological studies are in priority concerning the causes of occupational injuries, because these studies can help improvement of awareness on risk factors and determination of effective risk factor in increasing accidents. Furthermore, effective preventive schedules and increasing of awareness from importance of the performer's policy must be considered. The aim of this study is to analyze several occupational factors in incidence of accidents in order to provide further evidence for designing and implementation of preventive actions in industries.

## 2. MATERIALS AND METHODS

In this retrospective study, registered data of 589 affected workers for 9 years (2001-2010) in heavy metal industries were analyzed. Information was collected in two sections demographic characteristics and comprehensive accidents software. Scheduling of work shift in these industries is 1) morning shift or first shift of 7 am to 4 PM 2) afternoon shift or second shift of 4 PM to 11 PM and 3) night shift or third shift of 11 PM to 6 AM o'clock. In each of these three shifts the average age of workers was different. Different approaches including statistical and epidemiological analysis, risk analysis and accident analysis used to collect data. In order to collect and determine association statics of comprehensive accidents software were used for some demographic characteristics of affected workers with prevalence of accidents such as age, education, occupation and work history, the amount of exempt from workdays due to injury. Analysis of data was done using SPSS software, in this way descriptive statistical tests, chi-square test used to evaluate significance of results between accidents and other variables.

## 3. RESULTS

This study details the pattern of occupation in heavy industries in which some human factors have had significant impact in occurrence of accidents. In this study, the age range of workers varied between 20 to 58 years old, wherein 22.1% of accidents were in 25 to 35 years age group versus 41.9% among people aged up to 45 years old. These results have been shown in Table 1. Descriptive data of types of injures according to age has been showed in table 2.

Table (1): distribution of accidents based on age.

| Age group      | Frequency | Percent | Valid Percent |
|----------------|-----------|---------|---------------|
| <b>Valid</b>   |           |         |               |
| <25            | 46        | 7.8     | 7.9           |
| 25-35          | 128       | 21.7    | 22.1          |
| 35-45          | 158       | 26.8    | 27.3          |
| > 45           | 247       | 41.9    | 42.7          |
| Total          | 579       | 98.1    | 100.0         |
| <b>Missing</b> | System    | 11      | 1.9           |
| <b>Total</b>   |           | 590     | 100.0         |

Table (2): descriptive data of types of injures

|              | Type of injury |         |     |        |            |         |                 |      |       | Sum |
|--------------|----------------|---------|-----|--------|------------|---------|-----------------|------|-------|-----|
|              | Fracture       | Crushed | Cut | strike | amputation | Burning | Impaired vision | Kink | Other |     |
| <25          | 4              | 1       | 10  | 17     | 1          | 4       | 2               | 0    | 3     | 42  |
| 25 to 34.9   | 20             | 11      | 41  | 21     | 3          | 7       | 4               | 8    | 8     | 123 |
| 35 to 44.9   | 19             | 16      | 38  | 31     | 1          | 18      | 5               | 11   | 13    | 152 |
| > 45         | 49             | 14      | 52  | 56     | 5          | 27      | 14              | 10   | 6     | 233 |
| <b>Total</b> | 92             | 42      | 141 | 125    | 10         | 56      | 25              | 29   | 30    | 550 |

There was a significant association between age and injury (P-value < 0.024). Similarly, the amount of injuries rise with increasing of age so linear by-linear association was observed between these two variables (P value < 0.039,  $\chi^2$  value: 0.731). This industry had mechanized mode and prevalence of accidents in this related industries depended on several factors including man, machine and environment. Most of the accidents occurred due to falling objects, a portion of body caught in a rotating machine, manual materials handling, environmental stress like noise and heat. Time variations as day and month of accidents have been shown in Fig 1. According to figure 1 prevalence of accidents in May and June and is 12.93%, 10.71% respectively, April had lowest, 3.74% accidents. Data on distribution of accidents date has been shown on figure 2 in which prevalence of accidents during the first 10 days of month in 9 years had the highest number of accidents. There are no obvious reasons for this event; carelessness to work may be the reasons them. This study has revealed that 31.7% of accidents had occurred between 8 -10 AM of morning shift, and 2.7% between 1 to 4 AM of night shift which was lowest prevalence of accidents (table 3). Figure 3 shows that 70.4% of accidents in morning shift, 23.9% in afternoon shift only 5.8% in night shift have occurred.

Table (3): occurred accidents at different times of day and night

|              | time   | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------|--------|-----------|---------|---------------|--------------------|
| Valid        | 0-4    | 16        | 2.7     | 2.7           | 2.7                |
|              | 4-7    | 19        | 3.2     | 3.3           | 6.0                |
|              | 7-10   | 187       | 31.7    | 32.1          | 38.1               |
|              | 10-13  | 125       | 21.2    | 21.5          | 59.6               |
|              | 13-16  | 129       | 21.9    | 22.2          | 81.8               |
|              | 16-19  | 69        | 11.7    | 11.9          | 93.6               |
|              | 19-24  | 37        | 6.3     | 6.4           | 100.0              |
|              | Total  | 582       | 98.6    | 100.0         |                    |
| Missing      | System | 8         | 1.4     |               |                    |
| <b>Total</b> |        | 590       | 100.0   |               |                    |

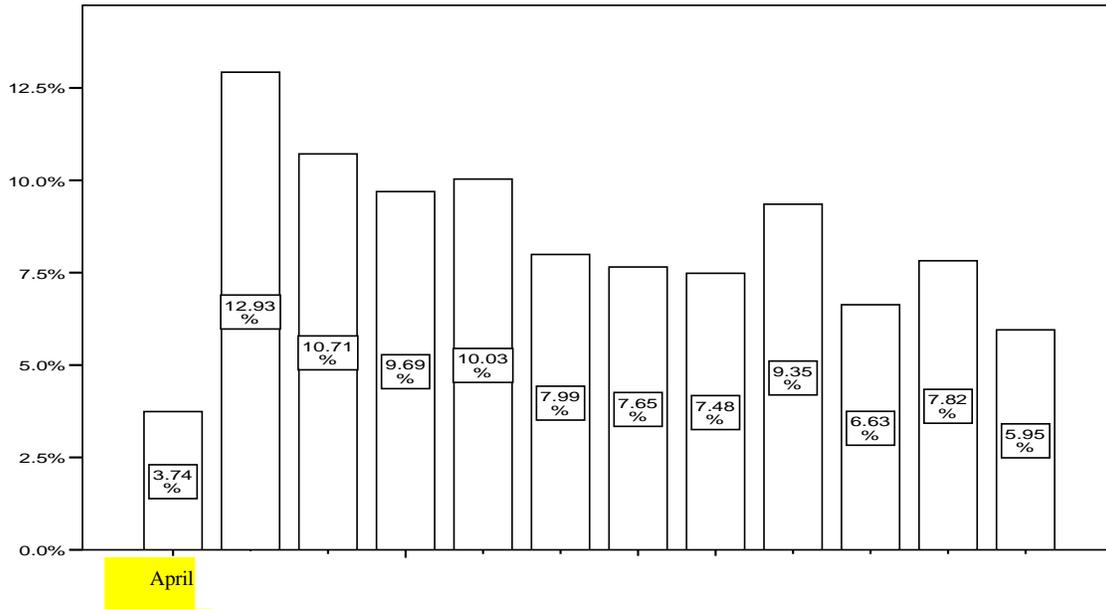


Figure (1): date distribution of accidents

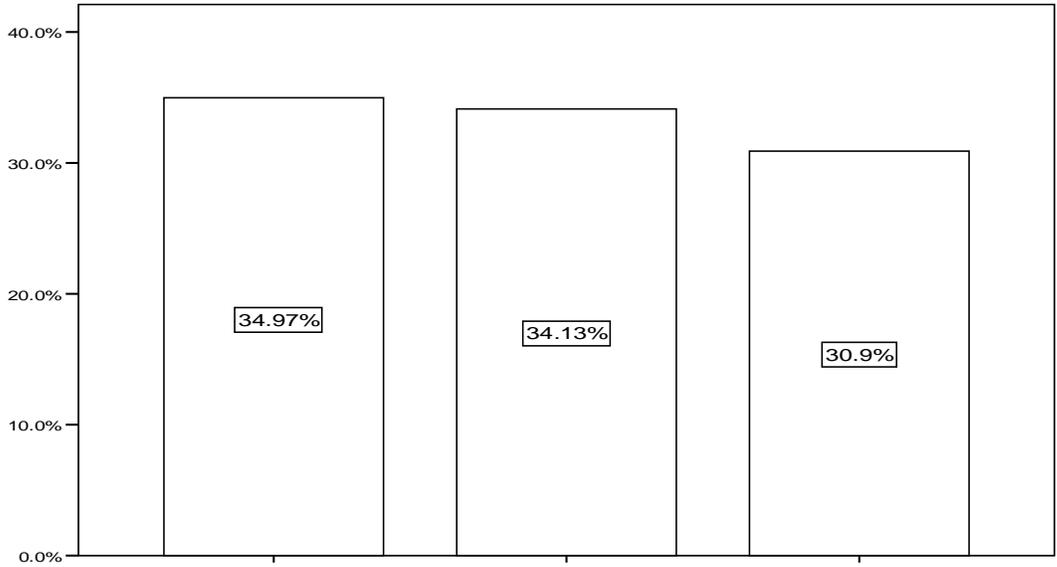


Figure (2): ratio of repetitive accidents at month days

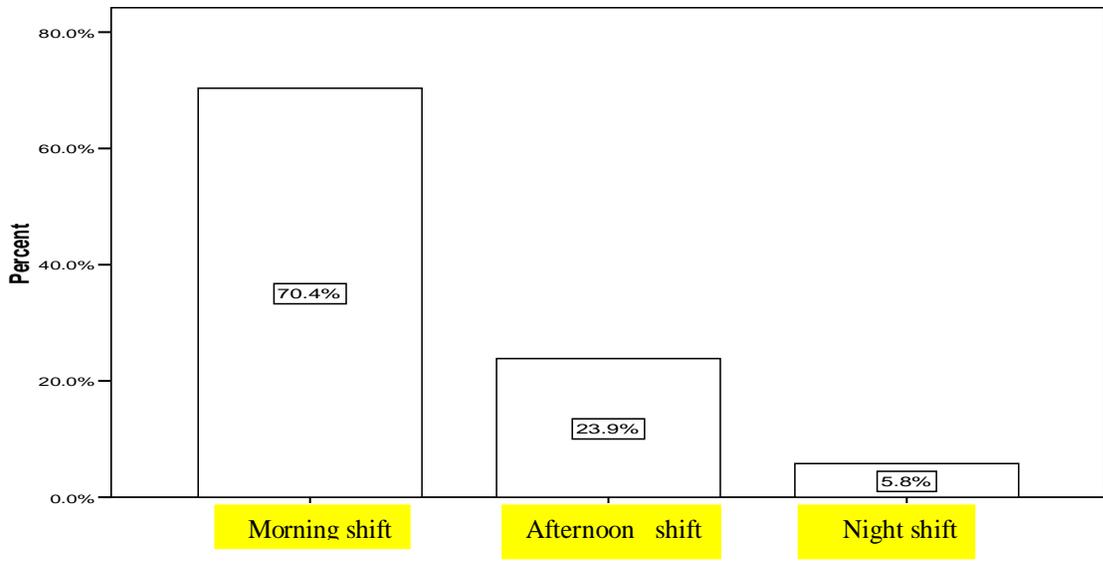


Figure (3): ratio of repetitive accidents according to work shift.

#### 4. DISCUSSION

Prevalence of accidents in heavy metal industries is depended on many factors such as human-machinery interaction, working methods, working conditions and environmental stress. Given to observations and conducted analysis on time factors such as month, day and work shift related variables significant association observed to prevalence of accidents. Personal factors associated with accidents are age, work experience, occupation, nature of accident, affected organ, types of accident, action taken at time of incident, type of work shift and time of accident (14).

We showed persons under 40 years old had high risk of injury than adults. Hallsten *et al* studied the point of time on 31,580 of work accidents occurring in four different industries during approximately two years. They observed that most industries and occupational groups have experienced the highest peak of accident in morning work shift. In the current study, the largest numbers of accidents have occurred in early hours of the morning work shift. This study revealed two important risk factor starting work time and accumulation of fatigue as causes of

occurrence of most accidents. Starting of work shift so as to peak time working in the production process may increase risk among workers of morning work shift.

Critical age for tolerance of work shift is between 40-50 year old among various operator, also in some studies it has been shown that the maximum performance is at age of 36 (15). Furthermore, results from sleep duration, sleep quality among work shift personnel is reduced with increasing of age especially over 45 years (16). Often potential business risks are not identified by workers even those who are more familiar with the work, so a portion of accidents and semi accident may lead to occupational injuries in workers. Thus, identifying and assessment of risk is required to industries, which could be able to educate and participate individuals in recognizing potentially dangerous situations, this may lead to preventing and avoiding of accidents (14).

Wholly, no clear organizational commitment toward comprehensive safety programs such as systematic study of accidents, safety analysis, safety regulations is one of the recurring causes of accidents in industry. Our study emphasize on having special program on humans, machines, techniques and other aspects of the organization to prevent further accidents in industry. To reduce the incidence of accidents technical actions, formation of organizational and decision-making committee on safety issues, establishment of OHSAS, conservation and education programs offered. Technical actions include redesigning of human, machine and working methods interaction. It is concluded that the change in management attitude towards safety principles is prior to production, therefore in any circumstances transferring of this attitude through regulation of safety and propagation of safety culture to personnel could be worthwhile. Moreover, creating motivation and improving working condition could have an effective role in increasing performance and reducing of accidents.

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