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Factors of Occupational Injury: A Survey in a Chemical Company

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Abstract: Chemical industries being the seat of dangerous occurrences frequently resulting in injuries, an occupational injury surveillance study was initiated involving 307 permanent and 419 temporary workers in a chemical company to understand the contribution of different possible factors on injury causation. Risk calculation was undertaken in relation to every individual factor using univariate and multivariate analysis techniques. Workers of lower age were found to be more susceptible to accidents (as evidenced by negative correlation coefficient), though non-significantly. Lower job duration (experience) had a significant impact on injury causation (correlation coefficient –0.5115, $p<0.05$). Alcohol habit could not show any significant impact but smoking/chewing habit showed significant effect (OR, 7.29: 95% CI, 3.88–9.33) on accident occurrence. Nature of job had no significant impact but nature of employment was found to have considerable effect on the causation of injuries. Temporary nature of employment was at greater risk (OR, 2.51: 95% CI, 1.42–3.77) in comparison to permanent workers.

Key words: Chemical company, Occupational injury, Job experience, Nature of employment

Background

The growing importance of safety regulations governing the production, use and sale of chemical products is a topic of interest not only for the chemical industry, but also for governments, nongovernmental organizations, consumers, and interested communities. The results of such regulation on behalf of the environment, health and safety of individuals, as well as its economic effects on industrial activity, are well understood in the United States and recently in the European Union. In less developed countries, however, the general level of public understanding of these issues is still minimal. It is common knowledge that the so-called "regulatory asymmetry" between countries at different levels of development contributes to the establishment of technical barriers to trade. Such asymmetries, however, also have other impacts: the displacement of polluting industrial sectors to countries which have less demanding regulations, the concentration of unsafe and harmful environmental conditions in certain parts of the globe, and the competitive disadvantage for industries located in countries where control is more rigid[1, 2].

So far as chemical industries of India are concerned, in spite of provision of moderately stringent regulations, such industries have been the point of concern for their significant contribution to environmental pollution and industrial accidents causing damage to environment, property and human health. This is probably because of the fact that implementation of different relevant regulations are far from the level of satisfaction in our country. Chemical industries rank in the first strata of industries so far as occupational hazards are concerned. In addition to the occurrence of major accidents[3] during the production process accidents do take place during storage also[4].

In order to ascertain the cause of the occupational injuries, a number of studies have been undertaken. Work conditions[5], age[6], educational status and safety training[7], experience[8], smoking[9], alcohol[10], psychosocial factors[11], shift of work[12], speed of work[13] have all been

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designated as responsible factors. Some epidemiological investigations[14, 15] have highlighted the role of job security in injury causation. These studies have shown that the temporary workers are more vulnerable to occupational injuries than permanent workers. Such studies being only a few, some workers have already mentioned the need of more research in relation to occupational injuries in temporary workers[15]. With this background this study was initiated in a chemical company to explore the possible responsible factors of injury causation.

Methods

An occupational injury surveillance study (record study of 5 yr duration) involving the workers of a chemical factory in eastern India was conducted. At the same time, to collect the personal details of the workers, an interview was also conducted with the workers who have worked in the factory in the study period of five years. Thus, data in relation to age, sex, job, level of education, experience, habits of smoking and alcohol etc. were collected with a pre-designed Performa. A total of 307 permanent and 419 temporary workers were interviewed. There were 9 permanent and 29 temporary workers, who worked during the study period, but could not be interviewed due to non-availability. So, data in relation to personal characteristics could not be obtained from them. But, accident related data was collected in relation to all 316 permanent time rated and 448 temporary piece rated workers. Accident registers and pay rolls were examined for the study period of 5 yr to collect data in relation to number of workers involved in activity, nature of employment, nature of activity and number of accidents committed. Data in relation to no time loss injury (where the affected person resumes work within 24 h of injury and no leave is taken) as well as time loss injury (where the affected person does not resume work within 24 h of injury and leave is taken until the person becomes fit to resume duty) was taken into consideration for analysis of occupational injury data. To understand the role of different personal and occupational factors on injury occurrence, univariate and multivariate analysis was carried out.

In this company rock phosphate and sulphuric acid is used as raw materials and super phosphate fertilizer is produced through a reaction of these two raw materials. Though it is a semi mechanized and closed system of production, a large work force is employed under sections; production, maintenance and packing. The industry is run in three shifts; morning, evening and night (each of 8 h duration). In this factory, whenever an occupational injury take place, the victim is given preliminary treatment in the occupational health centre of the company and the details of injury is reported to the concerned factory inspectorate and social security system. Thereafter all the relevant records are maintained in the occupational health center.

Statistical analysis

In order to estimate the contribution of different possible factors on accident causation, risk calculation was undertaken in relation to every individual factor. Initially univariate analysis with the help of Ep Info 5 software was done and odds ratios and corresponding 95% confidence intervals were calculated. Afterwards, multivariate analysis was also undertaken with the help of SPSS version 6.1.4 software to derive the effect of individual factors irrespective of the role of the others. In multivariate analysis, logistic regression technique was applied and coefficient values, significance levels, odds ratios, 95% confidence intervals were obtained. In logistic regression model variables like age and experience were fed as continuous variables, whereas variables like smoking habit, alcohol habit, chewing habit, department, temporary nature of employment were applied as categorical covariates. All the variables were applied simultaneously in the logistic regression model (Backward LR) in order to derive the effect of every individual variable on accident causation irrespective of the effect of other variables.

Results

Mean age of the workers was 35.1(± 11.6) yr. Around 65% of workers were in 25–55 yr age range. Among the workers 69.1%, 35.4% and 59.4% were smokers, alcoholic and chewers (tobacco and/or areca nut) respectively. Around eighteen percent of workers were illiterate while 8.9% were higher secondary or above level educated. Around twenty percent of workers had experience of less than 5 yr in the same factory. 27.3% workers had experience of 5–10 yr and 52.6% had experience of 10 yr or more. Majority of workers (40.5%) were involved in production division whereas 28.6% and 30.8% employees were involved in the job of maintenance and packing-loading-unloading respectively (Table 1).

Table 2 shows year wise distribution of occupational injuries and number of employed workers. A decreasing trend in the number of occupational injuries is observed in case of time loss accidents but in case of no time loss accidents no such trend is visible.

Table 3 shows the risk of accident occurrence in relation to different possible factors of accident causation (univariate analysis). Factors like smoking/chewing habit and alcohol habit had odds ratios of 5.37 and 1.04 respectively (though alcohol habit was not statistically signifi-

Table 1. Distribution of Characteristics of Workers

Personal Characteristics	Category	Number of Workers (%) (n=726)
Age (yr)	<25	197 (27.1)
	25–34	194 (26.7)
	35–44	137 (18.8)
	45–54	145 (19.9)
	≥55	53 (7.3)
Educational Status	Illiterate	133 (18.3)
	Primary (Class I-IV)	208 (28.6)
	Secondary (Class V-X)	320 (44.1)
	Higher Secondary (Class XI-XII)	55 (7.5)
	College	10 (1.4)
Smoking	Smokers	502 (69.1)
Alcohol	Alcoholic	257 (35.4)
Tobacco-areca nut chewing	Chewers	431 (59.4)
Experience (yr)	<5	146 (20.1)
	5–9	198 (27.3)
	≥10	382 (52.6)
Nature of work	Production	294 (40.5)
	Maintenance	208 (28.6)
	Packing, loading, unloading	224 (30.8)

Table 2. Year wise distribution of accidents

Year	Average no. of workers employed	No. of time loss accidents	No. of no time loss accidents
1996	563	260	788
1997	592	129	659
1998	597	177	585
1999	614	146	733
2000	664	194	777

cant). Smoking/chewing of tobacco was found to have significant risk with odds ratio of 5.37 (95% CI, 3.82–7.57). Production and maintenance job was having increased risk (OR, 1.29 and 1.17 respectively), though non-significant in comparison to the job of packing. Temporary nature of employment was found to have significantly higher risk of injury causation (OR, 2.04: 95% CI, 1.50–2.77) in comparison to the permanent nature of employment.

To eliminate the confounding effect of a variable on the other, multivariate analysis was undertaken (Table 4). Workers of lower age were found to be more susceptible to accidents (as evidenced by negative correlation coefficient), though non-significantly. But, lower job duration (experience) had a significant impact on injury causation (correlation coefficient –0.5115, $p<0.05$). Alcohol habit

Table 3. Effect of worker characteristics on injury occurrence (univariate analysis)

Variables	Injury (%)	χ^2	*p* value	OR	95% CI
Alcohol					
Yes	126 (49.0)	0.07	0.786	1.04	0.76–1.43
No	225 (47.9)				
Smoking/Chewing					
Yes	277 (64.3)	107.68	<0.00001	5.37	3.82–7.57
No	74 (25.1)				
Nature of Job					
Production	151 (51.4)	2.00	0.157	1.29	0.89–1.85
Maintenance	99 (49.0)	0.66	0.418	1.17	0.79–1.75
Packing	101 (45.1)	–	–	1	–
Nature of Employment					
Temporary	238 (53.1)	22.5	<0.00001	2.04	1.50–2.77
Permanent	113 (35.8)				

Table 4. Effect of worker characteristics on injury occurrence (multivariate analysis)

Variable	B value (Co-efficient)	Significance	Odds ratio*	95% CI	
				Lower Limit	Upper Limit
Age	–0.1710	0.091	–	–	–
Experience	–0.5115	0.02	–	–	–
Smoking/Chewing habit	1.9877	0.002	7.29	3.88	9.33
Alcohol habit	0.0089	0.332	1.01	0.81	1.34
Temporary nature of job	0.9221	0.007	2.51	1.42	3.77

*Adjusted for each other.

could not show any significant impact but smoking/chewing habit showed significant effect (OR, 7.29: 95% CI, 3.88–9.33) on accident occurrence. Nature of job had no significant impact but nature of employment was found to have considerable effect on the causation of injuries. Temporary nature of employment was at greater risk (OR, 2.51: 95% CI, 1.42–3.77) in comparison to permanent workers.

Discussion

Chemical industries have been the seat of dangerous occurrences frequently resulting in injuries[16, 17] not only because of the inherent hazardous nature of the materials handled but also due to the requirement of various physical and chemical treatment of these materials. Many times these dangerous occurrences do affect not only the workers involved in the process but also the surrounding environment[18] and the community including women and children[19]. Need of prioritizing hazards of such industries and rationalizing safety efforts to overcome such hazards have frequently been talked about[20, 21].

This study observed that accidents have taken place in the concerned chemical company in quite high numbers. Though some fall in incidence is observed over a period of 5 yr, much effort is needed to bring down the incidence rate of accidents.

In this study, workers of lower age were found to be more susceptible to accidents, though non-significantly. Lower job duration had a significant impact on injury causation. Smoking/chewing of tobacco and areca nut showed significant effect (OR, 7.29: 95% CI, 3.88–9.33). Though nature of job had no significant impact, nature of employment was found to have considerable effect on the causation of injuries. Temporary nature of employment was at greater risk (OR, 2.51: 95% CI, 1.42–3.77) in comparison to permanent workers. In a Canadian population-based study, age-related differences in work injuries were examined and on multivariate analysis they observed significant contribution of workers' age on their accidents adjusting for the effect of other contributing variables[22]. A case-control study also observed that young age (<30 yr) was a significant contributing factor[23]. The findings of our present study also is very much similar to that of the above studies. So far as the role of job duration is concerned a case-control study conducted on 1,305 male French railway workers and equal number of controls found that 5 yr or less in present job (1.43, 1.15–1.78) was a significant contributing factor[23]. Another study of risk factors of injuries of veterinarians also observed decreased rates for higher experience (RR = 0.6, 95% CI = 0.4–0.9)[24]. Different habits like smoking, alcohol habit etc. have already been found to have significant contribution to accident causation at workplaces as reported in literature.

Habits like smoking/chewing of tobacco and areca nut might have played their role in distracting the worker from his job (some jobs of subtle nature needs constant attention of worker) and thereby causing injury. So far as experience in job is concerned, longer job duration might have imparted greater on job attainment of knowledge regarding safety matters and thus played a role in averting occupational injuries.

Comparison between the permanent and temporary workers has shown that the temporary workers have been more responsible for high incidence of accidents in the company. This may have happened either due to type of job of the temporary workers (may be they are employed in more dangerous operations) or due to lack of sufficient proper training in relation to safety matters.

The factory had no established safety training system. Only way for gaining knowledge of safety was on the job experience. In this respect, the permanent workers may have been in a better position than the temporary workers although they have the same experience pattern of working in the same factory. This is because of the fact that the temporary workers do not get chance to work always in the year like the permanent workers. Accordingly, effective experience may be less in the temporary workers. This finding of higher accident risk of the temporary workers is similar to the experience of some already published reports[14, 15], which have dealt

with accidents of temporary workers. The cause of this increased risk can be attributed to some factors. This may be attributed to the temporary status of the working group also. Lack of job security might have played an important role in such workers. Effective experience and thereby safety knowledge may be relatively less in the temporary piece rated workers. Though very few studies are carried out till date to make a comprehensive comparative analysis of temporary and permanent workers, there are studies that have reported about the significant contribution of different factors (usually associated with non-permanent workers) in the causation of occupational injuries. Lack of job training[25], job characteristics like job dissatisfaction[26], work environmental condition[27] (in many occasions temporary workers have to face relatively more adverse environmental conditions) and sleep deprivation[28] (many times non-permanent workers are engaged in other part time activities) are such factors, which have been found to be responsible for occupational injuries in these studies.

So far as observations from sectors other than chemical industry is concerned, role of age of employee was found to have significant effect on occupational injury occurrence in a cross sectional study conducted in Japan involving nursing personnel[29]. Similar finding was also observed in a study conducted in India involving metal smelting workers[30]. Contribution of lesser job experience in injury causation has been confirmed by a study of occupational hand injuries from various industries[31]. Similar findings were also observed in the case of Seafarers' accidents[32]. A case control study of construction workers, where different personal characteristics were analyzed for their role in occupational injury causation, observed significant contribution of smoking status[33]. Significant role of alcohol was also observed in transit industry workers[34] and drivers[35]. Hazardous nature of job (e.g. machine related jobs)[36] and temporary work[37] has shown their potential role in occupational injury occurrence. A study involving textile production and metal manufacturing workers explored role of different factors on occupational injury and observed significant contribution of safety training status and age of employees[38] on such injuries.

This study however had also some limitations. This study was based on work injury records maintained in the company. Unfortunately, no record on 'grade of injury' being available, analysis in relation to different grades of injury could not be undertaken. This present study has only dealt with injury records of a single chemical company. Inclusion of similar data from more chemical companies could have made the findings of this study more generalisable.

This study observed that accidents have taken place in the chemical company under study in quite high numbers, experience and smoking/chewing (tobacco and areca nut) habit had a significant impact on injury causation and temporary workers were at a greater risk of coming across occupational injuries in comparison to permanent workers.

Conclusion

This study concludes that job duration (experience), smoking/chewing habit and nature of employment are significant contributors of occupational injuries and less experienced workers, smokers/chewers as well as temporary employees are at a greater risk.

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