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Full Length Research Paper

Loglinear model for assessment of risk factors of occupational injuries in underground coal mines

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In this study a loglinear model has been investigated to evaluate the role of various factors in coal mine injuries. Data on the varieties namely age, safety performance, working condition, safety environment, management and supervision, emotional stability, job involvement, job satisfaction, and job stress have been collected through questionnaire survey. The associations of the risk factors with occupational injuries are assessed through adjusted odds ratios (OR). The case study results reveal that significant contributing factors responsible for injuries are emotional stability (OR 2.36, 95% confidence interval (CI) 1.51-3.67), working condition (OR 2.14, 95% CI 1.37-3.35), safety performance (OR 2.04, 95% CI 1.30-3.17), safety environment (OR 1.96, 95% CI 1.25-3.06), and age with two ORs of 1.84 (95% CI 1.04 to 3.28), and 2.38 (95% CI 1.27 to 4.45). Identification of these risk factors of injuries will provide valuable information in injury preventive programs.

Key words: Occupational injury, human behavioural factors, loglinear model, odds ratio, association.

INTRODUCTION

Ever increasing demand for minerals has thrown greater emphasis on mechanisation, introduction of new mining techniques and tools which in turn will result in increased hazard potential. According to Galvin (1998), a new technology produces more output with lesser people, but introduces different types of occupational injuries. Engineering solutions to injuries are by themselves insufficient in the prevention of injuries in the wake of increased mechanisation and automation in the mining industry. Several studies revealed the role of human behaviour in mine injuries. For example, human error has been identified as the major causative factor in mine injuries in a study conducted by the former United States Bureau of Mines (Shaw et al., 1989). They concluded that while a few injuries are caused by a single factor, human error was the most significant contributing factor and accountted for 93% of the total injuries. Studies by other researchers also indicated the role of human behaviour in mine injuries (Ghosh and Bhattacherjee, 2007; Ghosh et al., 2004; Ghosh and Bhattacherjee, 2003). Peake and Ritchie (1994) suggested in their study that while mechanical and environmental failures are major contributors to many injuries, human behaviour plays a significant causative role and consequently must be addressed if any meaningful and long term reduction in mine injuries is to be achieved.

Companies have invested money and resources in redesigning their systems to engineer out safety hazards and risk wherever possible and in developing job safety procedures (Margolis, 1973). Yet despite the investment of money and resources, the incidence of fatalities remains relatively unchanged. Governments, companies and employees all agree that it continues to be unacceptably high. Hopkins (1995) reported that both

Government safety organizations and unions are quite optimistic on safety. They focus on equipment and not on the act of people. However, certain individual factors which concern many employed people such as age, safety performance, working condition, safety environment, management and supervision, emotional stability, job

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Abbreviations: W_CONDN, working condition; **SFTY_ENV,** safety environment; **MGT_SUP,** management and supervision; **EM_STABI,** emotional stability; **JB_INVLV,** job involvement; **JB_SATIS,** job satisfaction; **JB_STRSS**, job stress; **SFTY_PER,** safety performance; **AGE,** age**; ACCIDEN,** injury.

involvement, job satisfaction, and job stress have been identified as risk factors for occupational injuries (Ghosh and Bhattacherjee, 2007; Ghosh et al., 2004).

It was not certain whether these factors play a role in underground coal mine injuries. Such knowledge is important because it shows that the preventive measures concerning these factors can be carried out in mines. Regarding statistical methods, some authors suggested loglinear models for analysing cross-tabulated data due to the multifactorial nature of the causes of occupational injuries (Bhattacherjee et al., 2004; Maiti et al., 2001). This method has found a limited use though it gives valuable results and provides information on multiple interacttions between various factors which are useful for understanding the overall problem.

Therefore, the present study is aimed at assessing the relationships of age, safety performance, working condition, safety environment, management and supervision, emotional stability, job involvement, job satisfaction, and job stress with the incidence of occupational injuries in the underground coal mine workers from the three collieries of Eastern India by using a loglinear model for a cross-sectional study to compute the odds ratios and the contributions of various factors, and to assess the multiple interactions between these variables.

METHODOLOGY

Sample selection

The data reported in this study were collected as a part of an extensive questionnaire survey on the personality traits and injury occurrence among coal mine workers in Eastern India. As the coal mine workers were mostly illiterate and were not fluent in reading and writing, the questionnaires were filled up by interviewing them individually in an isolated area to reduce biasing effects of the observed variables. Interview for each person required a time span of 45 min. Only those workers who were voluntarily agreed to participate were included in the study. Thereby interviews were taken from 404 workers. Equal number of subjects was taken from injury group and non injury group of workers controlling their occupation. Participants were chosen in a ratio close to the occupation wise distribution of injuries in accident record book kept in the mine.

Data were collected from three underground coal mines during the period 1999-2001. The case study mines are located in the eastern part of India. The mining methods practiced in these three mines are mainly bored and pillar working. The mines operate six days a week and three shifts per day for coal production. The average annual productions from the mines were 0.10, 0.10, and 0.24 million tons, and average underground employments (per day) in these mines were 860, 722, and 1,323 miners, respectively. In the last five years, the three mines encountered 780 reportable injuries with the average annual injury rate of 54 per 1,000 workers. The numbers of subjects selected from the three mines were 130, 130, and 144, respectively. A database of 404 workers was developed for the analyses.

Statistical method

The loglinear model consists of a multidimensional contingency table. The analysis of the table was primarily aimed at investigating the statistical associations of the variables of interest. In addition, the strength of association between two or more variables can also be measured. While explaining a contingency table the variations in the observed cell counts can be attributed to main and interaction effects of the different variables. In this study, the log-linear model is investigated as a statistical representation of the contingency table to quantify the relative importance of various factors and to detect occasions where the effects of these factors can be presumed real or they are merely random variations (Upton, 1977). The loglinear model for the contingency table is expressed as follows:

Log (expected cell frequency) = Grand mean + Main effects parameters + Second and higher order interactions.

As the number of dimensions of a contingency table increases the number of possible models also increases. Hence, some procedures are clearly needed to indicate which model may prove reasonable for the data set and which are likely to be inadequate. One such procedure is to examine the likelihood-ratio chi-square values of all effects in the saturated loglinear model. The other approach is to examine the standardised parameter values in the saturated loglinear model. These values may indicate which parameters may be excluded and consequently which unsaturated models may be worth considering. The odds ratios of different factors were computed based on the second order interaction parameters of the significant factors (Upton, 1977). All the analyses were performed with the SPSS program (SPSS, 1999).

Study design

A retrospective study was designed. Two groups of individuals were initially identified: (i) a group that faced injury at least once (the cases) during the last five years and (ii) a group that did not face any injury (the controls) in their career. An attempt was then made to relate the risk factors to the injury status (injury or no injury). This type of study design is called in epidemiology a case-control study. This design is often the fastest and least expensive.

Instruments

The Worker's Response Device (WRD) and Supervisor's Response Device (SRD) were used in the present investigation (Ghosh and Bhattacherjee, 2007; Ghosh et al., 2004). The WRD is a questionnaire based on 7 factors: working condition, safety environment, management and supervision, emotional stability, job involvement, job satisfaction, and job stress. The SRD includes safety performance of workers. Questionnaires were developed in ordinal scale. There are questions in each questionnaire to judge how a respondent feels and acts. Every question in the developed questionnaires has three possible answers; 'Yes', 'Cannot say', and 'No'. Score is assigned as 3= 'Yes', 2= 'Cannot say', or 3= 'No', based on the answer for a question. Since workers were not conversant with English, questionnaires were translated into their native languages Hindi and Bengali. yourself? you

Data presentation

First, Chronbach's alpha coefficients were computed to measure the intercorrelation of the various items (Li et al., 2001) for all factors studied. Internal consistency of the items are classified as Poor (≤70), Acceptable (>70 - 80), Satisfactory (>80 - 90), and excellent (>90-100). The scores were computed by summing the score of individual items. The methods of quantification of the variables are described in details in the following subsections.

Working condition

The respondents were asked to rate to which extent they agreed or disagreed with statements intended to measure different aspects of the working condition. The perception of the workers on working condition was tapped by fifteen items (e.g. "Is there a feeling of heat below ground?"; "Do you face difficulty due to the bad quality of cap lamp?'; "Is drinking water available in underground?"; "Is the condition of the roof and sides good enough?" etc.). All items were scored on a three-point scale; "Yes", "Cannot say", and "No". Reliability of the variable was measured by Cronbach's alpha (0.83) based on average inter-item correlation. Reliability analysis revealed a satisfactory internal consistency of the items.

Safety environment

The respondents were asked to indicate whether they agreed or disagreed on different aspects of safety environment. The perception of safety environment was measured using thirteen-item scale, which includes items such as "Do supervisors actively discourage risk taking behaviour?"; "Are hazards eliminated promptly from your workplace?"; "Are the safety regulations followed properly?" etc. Scores for individual items were summed to produce a single *safety environment* score for each respondent. The items had satisfactory internal consistency (Cronbach's alpha = 0.83).

Management and supervision

To measure ratings of the respondents on management and supervision, twelve-item scale was used with statements such as, "Are you happy with the skills and competency of your supervisor?"; "Do the officers try to understand the problems of workers?"; "Is good performance of the workers appreciated?" etc. Reliability analyses revealed satisfactory internal consistency (Cronbach's alpha = 0.86).

Emotional stability

To measure individual's mood and emotional reactivity, a twelve-item scale was used. The items were like this: "Do you sometimes feel happy, sometimes depressed without any apparent reason?"; "Are you quick and sure in your action?"; "Do you feel rather hurt easily?"; "Does your mind often wander while you are trying to concentrate on some work?" etc. Reliability coefficient of the scale based on internal consistency was satisfactory (Cronbach's alpha = 0.80).

Job involvement

Job involvement of workers was measured by a thirteen item scale. Some of the items included were "Does it so happen to you that how your time is spent through your work you cannot realize?"; "Do you get disheartened when you become unsuccessful in your work?"; "Do you consider any loss to the mine is the loss of; "Are concerned with the future of this mine?" etc. The scale had acceptable Cronbach's alpha coefficient (0.73).

Job satisfaction

Job satisfaction represents individuals' overall feelings toward their job. It was assessed with fifteen-item scale (e.g. "Do you think you have got right job for yourself?"; "Does your boss appreciate your competency and quality?"; "Do you think your work is difficult and arduous?"; "Do other people give respect to your work?"; "Are your co-workers helpful and co-ordeal to you?" etc.). Reliability analyses revealed satisfactory consistency coefficient (Cronbach's alpha = 0.86) of the scale.

Job stress

A fourteen item scale was used to measure the amount of work that individual needs to accomplish and how hard and fast one needs to work. Some of the statements were like this: "Do you have to work hard in mining job?"; "Is the mining job boring and monotonous?"; "Is your work full of danger?"; "Do the other members of your family solely dependent on you?"; "Do you feel you have to work in hurry as you are assigned excess amount of job?" etc. Acceptable Chonbach's α value (0.78) was observed in this scale.

Safety performance

Safety performance is administered by the supervisors to indicate worker's behaviour and performance as he is closely monitored by his supervisor. It was assessed with 17 items (e.g. "Does the worker wear safety items?"; "Is the worker taking risks, short-cuts practiced by the worker?"; "Does the worker venture under unsupported roof?"; "Does the worker remain alcoholic while working?" etc.). Internal consistency coefficient was satisfactory (Cronbach's alpha = 0.88)

Categorization of variables

In this study except age all other variables were dichotomized in two categories on the basis of median value of the scores (Table 1): safety performance (≤45 and >45), working condition (≤26 and >26), safety environment (≤30 and >30), management and supervision (≤29 and > 29), emotional stability (≤30 and >30), job involvement (≤33 and >33), job satisfaction (≤35 and >35), job stress (≤26 and >26), and occupational injury (injury and no injury). Age was categorized into three groups (<30, 30-45, and >45).

The occupational injury data were cross-classified by the variables of interest as shown in Table 2. To explore the univariate patterns of injuries, the crude risk ratios (RR) were computed with SPSS software application (SPSS, 1999). This type of analysis may lead to very misleading results and is not sufficient to draw any conclusion.

RESULTS

Table 3 reveals some interesting univariate patterns of injuries regarding the variables studied. All individual characteristics such as age, emotional stability, job involvement, job satisfaction, and job stress emerged as significant factors. The perceptions of workers regarding working condition, safety environment, management and supervision also have significant contribution on occurrence of injuries. The null hypothesis was rejected in each case, which means that the risk of one group is significantly higher than the other group. This result suggests that individual characteristics play a significant role in injury involvement. Safety performance of the workers administered by their respective supervisors revealed that it was a significant predictor of injury Involvement. The SPSS HILOGLINEAR (SPSS, 1999) routine is used for the loglinear model run. This study consists of 10 factors, as listed in Table 1. In Table 4 the column labelled

Table 1. Description of the variables on the basis of their categories.

Variables	No. of categories	Name
Age	3	Age 0 (<30), Age 1 (30-45), Age2 (>45)
Safety performance	2	Low_SP (≤45), High_SP (>45)
Working condition	2	Low_WC (≤26), High_WC (>26)
Safety environment	2	Low_SE (≤30), High_SE (>30)
Management and supervision	2	Low_MS (≤29), High_MS (>29)
Emotional stability	2	Low_ES (≤30), High_ES (>30)
Job involvement	2	Low_JI (≤33), High_JI (>33)
Job satisfaction	2	Low_JS (≤35), High_JS (>35)
Job stress	2	Low_JST (≤26), High_JST (>26)
Injury	2	Injury, no injury

Table 2. Cross classification table of the variables of interest.

Age	Safety performance	Working condition	Safety environment	Management supervision	Emotional stability	Job_involvement	Job satisfaction	Job stress	Injury yes	Injury no
Age 0	Low	Low	Low	Low	Low	Low	Low	Low	$m_{1111111111}$	$m_{1111111112}$
-	-	-	-	-	-	-	-	High	$m_{1111111121}$	$m_{1111111122}$
-	-	-	-	-	-	-	High	Low	$m_{1111111211}$	$m_{1111111212}$
-	-	-	-	-	-	-	-	High	$m_{1111111221}$	$m_{1111111222}$
Age1	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
Age2	-	-	-	-	-	-	-	-	-	-
-	High	-	-	-	-	-	-	-	-	-
-	-	High	-	-	-	-	-	-	-	-
-	-	-	High	-	-	-	-	-	-	-
-	-	-	-	High	-	-	-	-	-	-
-	-	-	-	-	High	-	-	-	-	-
-	-	-	-	-	-	High	-	-	-	-
-	-	-	-	-	-	-	High	-	-	-
-	-	-	-	-	-	-	High	Low	$m_{3322222211}$	$m_{3322222212}$
-	-	-	-	-	-	-	-	High	$m_{3322222221}$	$m_{3322222222}$

Table 3. Relative risk (RR) and 95% confidence intervals for various factors (variables) for occupational injuries (n=404).

Variable	Crude Risk Ratio	95% Confidence Interval	p - value
Age (years)			
30 – 45 vs. <30	1.32	0.97 – 1.79	NS
>45 vs. <30	1.46*	1.07 – 2.00	<0.05
Working Condition (score)			
≤26 vs. >26	1.78‡	1.44 – 2.22	<0.001
Safety Environment (score)			
≤30 vs. >30	1.68‡	1.37 – 2.06	<0.001
Management and Supervision (score)			
≤29 vs. >29	1.46‡	1.20 – 1.79	<0.001
Emotional Stability (score)			
≤30 vs. >30	1.82‡	1.45 – 2.28	<0.001
Job Involvement (score)			
≤33 vs. >33	1.34†	1.08 – 1.65	<0.01
Job Satisfaction (score)			
≤35 vs. >35	1.45‡	1.18 – 1.78	<0.001
Job Stress (score)			
>26 vs. ≤26	1.56‡	1.28 – 1.91	<0.001
Safety Performance (score)			
≤45 vs. >45	1.65‡	1.35 – 2.02	<0.001

*p<0.05, †p<0.01, ‡p<0.001.

Table 4. Statistical tests for K-way and higher order effects are zero.

K	DF	L.R. Chi^2	Prob	Pearson Chi^2	Prob
10	2	0.000	1.000	0.000	1.000
9	21	0.000	1.000	0.000	1.000
8	102	0.324	1.000	0.164	1.000
7	306	3.393	1.000	1.739	1.000
6	642	15.816	1.000	8.289	1.000
5	1020	270.453	1.000	264.443	1.000
4	1314	722.146	1.000	1359.070	0.189
3	1470	886.723	1.000	1454.864	0.606
2	1524	1511.661	0.584	3270.020	0.000
1	1535	1581.956	0.197	3618.495	0.000

'Prob' gives the observed significance levels for the tests that K-way and higher-order effects are zero. Small observed significance level indicates the hypothesis that terms of particular orders are zero should be rejected. It is clear in Table 4 that interaction terms up to second order are sufficient to explain the variations in observed cell frequencies. Thus, it appears that a model up to second order effects is adequate to explain the variations in observed cell frequencies of the classification table.

Table 5 presents the effects of the main terms and second-order interaction terms of the saturated loglinear model run and the partial association of each of the effect terms; the third order and higher order interaction terms being non-significant. Further, the model run showed that the second order interaction parameters injury*job involvement, injury*job satisfaction, injury*job stress and injury*management supervision were not significant. These variables were discarded in the next model run. Finally, the model retained was the unsaturated one including all the main effects of the six variables injury, age, emotional stability, safety environment, safety performance, working condition and all their two-way interaction terms (Table 6). The results revealed that the variables emotional stability, working condition, safety performance, safety environment and age are signifycantly related with injury. By excluding injury, it is observed that there were also associations among the five factors, particularly between emotional stability and safety performance (EM_STABI* SFTY_PER), emotional stability and working condition (EM_STABI* W_CONDN), safety environment and safety performance SFTY_ENV*SFTY_PER), safety environment and working condition (SFTY_ENV*W_CONDN). Hence it can be concluded that these four factors are not purely independent. Based on partial chi-square values priority has been given to various factors. Table 7 shows the contributing factors of occupational injury with their percentage contribution. The emotional stability appeared to be the major contributing factor towards occupational injuries (28.06%) followed by working condition (21.46%), safety performance (19.16%), safety environment (16.57%), and

Table 5. Saturated loglinear model run for various risk factors (n=404).

Interactions	Degree of freedom	Partial Chi^2	p value
Main effects			
AGE_	2	49.076	.0000
JB_INVLV	1	8.944	.0028
EM_STABI	1	5.716	.0168
SFTY_ENV	1	1.942	.1634
JB_STRSS	1	1.674	.1957
SFTY_PER	1	1.427	.2322
W_CONDN	1	.991	.3194
JB_SATIS	1	.485	.4860
MGT_SUP	1	.039	.8430
ACCIDEN	1	.000	1.0000
All 2-way			
MGT_SUP*SFTY_ENV	1	38.604	.0000
JB_SATIS*JB_STRSS	1	37.196	.0000
JB_SATIS*MGT_SUP	1	17.146	.0000
MGT_SUP*W_CONDN	1	15.300	.0001
AGE_*JB_SATIS	2	12.678	.0018
JB_INVLV*JB_SATIS	1	11.898	.0006
ACCIDEN*EM_STABI	1	11.870	.0006
ACCIDEN*W_CONDN	1	9.857	.0017
ACCIDEN*SFTY_PER	1	8.933	.0028
JB_SATIS*SFTY_ENV	1	8.890	.0029
JB_STRSS*MGT_SUP	1	8.564	.0034
ACCIDEN*AGE_	2	8.152	.0170
AGE_*JB_INVLV	2	6.903	.0317
ACCIDEN*SFTY_ENV	1	4.879	.0272
EM_STABI*SFTY_PER	1	4.752	.0293
SFTY_ENV*W_CONDN	1	3.909	.0480
EM_STABI*JB_STRSS	1	3.177	.0747
JB_STRSS*SFTY_PER	1	2.772	.0959
SFTY_PER*W_CONDN	1	2.715	.0994
EM_STABI*W_CONDN	1	2.347	.1256
SFTY_ENV*SFTY_PER	1	1.712	.1907
ACCIDEN*JB_INVLV	1	1.645	.1996
JB_STRSS*SFTY_ENV	1	1.499	.2208
JB_INVLV*JB_STRSS	1	1.392	.2381
JB_STRSS*W_CONDN	1	1.379	.2402
ACCIDEN*JB_STRSS	1	1.335	.2480
AGE_*SFTY_PER	2	1.276	.5284
JB_INVLV*SFTY_PER	1	1.105	.2932
AGE_*EM_STABI	2	.927	.6292
JB_SATIS*W_CONDN	1	.908	.3408
AGE_*SFTY_ENV	2	.893	.6398
EM_STABI*JB_INVLV	1	.789	.3744
AGE_*JB_STRSS	2	.714	.6998
EM_STABI*JB_SATIS	1	.696	.4040
JB_SATIS*SFTY_PER	1	.654	.4186
AGE_*MGT_SUP	2	.425	.8085
ACCIDEN*MGT_SUP	1	.306	.5801
ACCIDEN*JB_SATIS	1	.277	.5986
JB_INVLV*W_CONDN	1	.199	.6556

Table 5 Cond.

EM_STABI*MGT_SUP	1	.177	.6743
AGE_*W_CONDN	2	.152	.9270
EM_STABI*SFTY_ENV	1	.029	.8637
JB_INVLV*MGT_SUP	1	.022	.8832
JB_INVLV*SFTY_ENV	1	.012	.9146
MGT_SUP*SFTY_PER	1	.008	.9298

Table 6. Final unsaturated loglinear model with six retained variables (n=404).

Interactions	Degree of freedom	Partial Chi^2	p-value
Main effects			
AGE	2	49.07	< 0.0001
EM_STABI	1	5.72	< 0.05
SFTY_ENV	1	1.94	NS
SFTY_PER	1	1.43	NS
W_CONDN	1	0.99	NS
ACCIDEN	1	0.00	NS
Interactions			
SFTY_ENV*W_CONDN	1	19.59	<0.0001
ACCIDEN*EM_STABI	1	14.53	< 0.0001
ACCIDEN*W_CONDN	1	11.11	< 0.001
ACCIDEN*SFTY_PER	1	9.92	< 0.01
ACCIDEN*SFTY_ENV	1	8.58	< 0.01
ACCIDEN*AGE	2	7.64	< 0.05
EM_STABI*SFTY_PER	1	6.16	< 0.05
SFTY_ENV*SFTY_PER	1	4.71	< 0.05
EM_STABI*W_CONDN	1	3.94	<0.05
SFTY_PER*W_CONDN	1	3.53	NS
AGE_*SFTY_PER	2	2.35	NS
EM_STABI*SFTY_ENV	1	1.88	NS
AGE_*EM_STABI	2	0.78	NS
AGE_*SFTY_ENV	2	0.29	NS
AGE_*W_CONDN	2	0.19	NS

Table 7. Contribution of various risk factors towards occupational injuries (n=404).

Factors	Contribution %
Emotional stability	28.06
Working condition	21.46
Safety performance	19.16
Safety environment	16.57
Age	14.75

age (14.75%). Table 8 presents the estimated parameter values of the final model as well as the adjusted odds ratios (OR) for the various risk factors. From the multi-variate loglinear model run, odds ratios (risk indices) for the various categories of variables were computed by taking the antilogarithm of their estimated parameters. It was observed that compared with the higher emotional stable workers, the lower emotional workers have an odds ratio (OR) of 2.36 (95% CI 1.51 to 3.67). The OR is 2.14 times higher (95% CI 1.37 to 3.35) for those workers who perceived working condition as poor compared to those who perceived it as good. Workers whose safety performance was poor are found to be more susceptible to injuries compared to the workers whose safety performance was good (OR 2.04, 95% CI 1.30 to 3.17). Those who perceived safety environment to be poor had OR 1.96 times higher (95% CI 1.25 – 3.06) compared to those who perceived it to be good. Compared to the age group of less than 30 years, the age groups of 30-45 years and more than 45 years had ORs of 1.84 (95% CI 1.04 to 3.28), and 2.38 (95% CI 1.27 to 4.45), respect tively.

Table 8. Estimated parameter values, adjusted odds ratios, and 95% confidence interval for various factors calculated with loglinear model (n=404).

Variables	Estimated parameters	Odds Ratio	95% Confidence Interval for Odds Ratio
Age (years)30 – 45 vs. <30 >45 vs. <30	0.611 0.865	1.84* 2.38†	1.04 – 3.28 ;1.27 – 4.45
Working Condition (score) ≤26 vs. >26	0.762	2.14‡	1.37 – 3.35
Safety Environment (score)≤30 vs. >30	0.671	1.96†	1.25 – 3.06
Emotional Stability (score)≤30 vs. >30	0.857	2.36‡	1.51 – 3.67
Safety Performance (score)≤45 vs. >45	0.711	2.04‡	1.30 – 3.17

* $p<0.05$; † $p<0.01$; ‡ $p<0.001$.

DISCUSSION

The present study shows that emotional stability is the most significant predictor of injury. Emotionally stable persons were found to be less involved with injury. It is a fact that some of the mining job can be very stressful at least to the workers who are emotionally unstable. This stress creates frustrations at times. When frustrations increase, adjustive response becomes inadequate and reactions are disorganized and exaggerated. Under such situations the individual becomes prone to be inflexible and unwilling to change his responses. Such an individual runs a higher risk of meeting with an injury.

This study shows that perception regarding working condition and safety environment had significant influence on injury occurrence. The result suggests that control group workers are highly satisfied with the existing working condition of mines in comparison to case group workers. Discussions with the workers revealed that non-injury group of workers have positive thinking about the physical environment and always take necessary precautions for safety. It was observed that the case group workers blame the physical environment for their mistakes and are also careless about safety instruct-tions those are necessary from actual working point of view. This was also observed by other researchers. For example, Sherry (1991) proposed that workplace injuries are caused by poor person-environment fit, which leads to an increased job stress and thus to an increased injury risk. According to Melamed et al. (1989), those individuals who are more sensitive to work environment are more likely to have been involved in an injury.

A higher risk of injuries amongst older workers was observed in this study. This has also been reported in other studies. Bennett and Passmore (1986) showed that older miners are more likely to receive fatality than younger. Hansen (1989) showed that older employees, rather than younger employees are more likely to be injured. Zwerling et al. (1996), however, indicated a bimodal distribution between injuries and age. They interpreted these results to indicate that younger workers have a higher injury rate because of less job experience; whereas, the older workers have high injuries due to age factor. Aging would result in a decrease in physical and mental abilities which may in turn result in poor quality of work and increased work environmental risks, particularly when the demanding level of the tasks is high.

A significant odds ratio was found for safety performance of workers. The study revealed that the control group of workers evinced better safety performance in comparison to the case group of workers due to their positive psychological traits and characteristics such as high emotional stability, better satisfaction, high involvement, less job stress, and better perception of physical environment. Dhar (1990) found a similar result when the performance of the workers was rated by their respective supervisors.

Conclusion

The findings of the loglinear model analysis indicate that both the personal and impersonal factors affect the occurrence of an injury. In this study, it is noticed that the factors emotional stability, working condition, safety environment, safety performance, and age of workers are significantly associated with injuries. Identification of these risk factors of injuries will provide valuable information in injury preventive programmes. Specifically, the management should pay due attention towards the problems of working environment and safety of the workers. Moreover, workers should be trained to develop the positive psychological traits to maintain the balance between rigidity and flexibility which is helpful in injury prevention. Factors which affect the psychological traits negatively should be eliminated. Workers with negative traits like emotionally instable and older workers should be employed in less hazardous job.

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