Medycyna Pracy 2016;67(6):729–742
http://medpr.imp.lodz.pl/en
http://dx.doi.org/10.13075/mp.5893.00429
ORIGINAL PAPER

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MINERS' RETURN TO WORK FOLLOWING INJURIES IN COAL MINES

POWRÓT DO PRACY GÓRNIKÓW POSZKODOWANYCH W WYPADKACH W KOPALNI WĘGLA

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ABSTRACT

Background: The occupational injuries in mines are common and result in severe socio-economical consequences. Earlier studies have revealed the role of multiple factors such as demographic factors, behavioral factors, health-related factors, working environment, and working conditions for mine injuries. However, there is a dearth of information about the role of some of these factors in delayed return to work (RTW) following a miner's injury. These factors may likely include personal characteristics of injured persons and his or her family, the injured person's social and economic status, and job characteristics. This study was conducted to assess the role of some of these factors for the return to work following coal miners' injuries. **Material and Methods:** A study was conducted for 109 injured workers from an underground coal mine in the years 2000–2009. A questionnaire, which was completed by the personnel interviews, included among others age, height, weight, seniority, alcohol consumption, sleeping duration, presence of diseases, job stress, job satisfaction, and injury type. The data was analyzed using the Kaplan-Meier estimates and the Cox proportional hazard model. **Results:** According to Kaplan-Meier estimate it was revealed that a lower number of dependents, longer sleep duration, no job stress, no disease, no alcohol addiction, and higher monthly income have a great impact on early return to work after injury. The Cox regression analysis revealed that the significant risk factors which influenced miners' return to work included presence of disease, job satisfaction and injury type. **Conclusions:** The mine management should pay attention to significant risk factors for injuries in order to develop effective preventive measures. Med Pr 2016;67(6):729–742

Key words: risk factors, occupational injuries, return to work, Cox proportional hazards models, Kaplan-Meier estimate, coal mining

Streszczenie

Wstęp: Podczas pracy w kopalni często dochodzi do urazów, które powodują poważne konsekwencje społeczno-ekonomiczne. Wcześniej przeprowadzone badania wykazały, że powstanie urazów u górników wynika z wielu czynników – demograficznych i behawioralnych, a także związanych ze zdrowiem zatrudnionych oraz środowiskiem pracy i jej warunkami. Brakuje jednak informacji na temat wpływu niektórych z tych czynników na opóźniony czas powrotu do pracy poszkodowanego w wypadku. Mogą się do tego przyczyniać cechy osobowe pracownika i jego rodziny, jego status społeczny i ekonomiczny, a także warunki pracy. Celem badania była ocena wpływu niektórych z ww. czynników na powrót do pracy poszkodowanego w wypadku w kopalni. **Materiał i metody:** Grupę badaną stanowiło 109 pracowników podziemnej kopalni węgla, którzy ulegli wypadkowi w latach 2000–2009. W wyniku przeprowadzonego badania kwestionariuszowego uzyskano m.in. następujące dane: datę urodzenia, wzrost i masę ciała, staż w zawodzie, spożycie alkoholu, czas trwania snu, choroby, stres w pracy, satysfakcję z pracy i typ urazu. Do analizy wyników użyto estymatorów Kaplana-Meiera i modelu proporcjonalnego hazardu Coxa. **Wyniki:** Obliczenia wykonane z wykorzystaniem metody Kaplana-Meiera wykazały, że duży wpływ na szybki powrót do pracy po urazie ma mniejsza liczba członków rodziny, dłuższy czas snu, brak stresu w pracy, niewystępowanie chorób, brak uzależnienia od alkoholu i wyższy dochód miesięczny. Natomiast analiza regresji Coxa wykazała, że istotnymi czynnikami ryzyka, które wpływają na czas powrotu górników do pracy, były występowanie choroby, satysfakcja z pracy i typ urazu. **Wnioski:** Kierownictwo kopalni powinno zwracać uwagę na istotne czynniki ryzyka urazów w celu opracowania efektywnych środków prewencyjnych. Med. Pr. 2016;67(6):729–742

Słowa kluczowe: czynniki ryzyka, urazy związane z pracą, powrót do pracy, modele proporcjonalnego hazardu Coxa, estymator Kaplana-Meiera, górnictwo węgla

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Received: December 24, 2015, accepted: July 5, 2016

INTRODUCTION

Mining is known to be an inherently hazardous occupation in the world. The underground mine workers are exposed to several job related hazards such as narrow openings, heat and humidity, improper ventilation, noise and vibration, poor illumination, airborne dust, noxious gases, and slippery floor, which certainly impose additional stress upon the workers. These physical hazards pose a serious problem in managing the safety

and health risk of mine workers. As a result, accidents/injuries are prevalent in underground mining. For example, the industries in the United States of America (USA) with the highest death rates per 100 000 workers were mining (30.3), agriculture/forestry/fishing (20.1), and construction (15.2) based on the fatality information during the 16-year period (1980–1995) [1]. In India, the hazardous nature of coal mine operations may easily be depicted from the national statistics of mine accidents and injuries. For example, in Indian coal mines the number of fatalities and serious injuries in 2012 were 99 and 495, respectively. Similarly, the fatal and serious injury rates per 1000 persons employed for the year 2012 were 0.27 and 1.34, respectively [2].

Consequences of injuries include increased absenteeism, use of medical care services, reduced productivity, loss of working time and disabilities. Injury is well recognized as a main cause of workers' disability. Estimates of the economical costs associated with lost work days following injuries occurring in a single year in the USA exceed 95 billion dollars [3]. Despite these high costs, a few attempts have been made to delineate the factors associated with delayed return to work (RTW) after injury. The return to work of an injured worker is influenced by a range of factors: some of them are related to the worker, some factors are related to the environment outside of the workplace, and some factors are related to the workplace itself.

A multiple of factors influence workers' return to work: age, education, gender, injury severity, psychosocial and socio-economical factors. Several studies reveal that younger employees have a higher incidence of return to work than their older counterparts [3–5]. These results could be explained by the findings that when younger workers are injured, they do not sustain as severe injuries as older workers. This hypothesis was supported by Dasinger et al. (2000) [6]. They indicated that younger age is a predictor of reduced disability. In addition to age, education level may also be a predictor of return to work since educated workers tend to return to work more quickly than less educated ones [5,7].

The relationship between education and return to work is likely due to the fact that education level often dictates whether one is employed in a white-collar or blue-collar job. Kearney's (1997) return to work survey demonstrated that blue-collar workers such as factory workers, trade workers, and truck drivers were among the claimants who were most likely to have not returned to work when surveyed at 1 and 2 years intervals after work stoppage [7]. Mackenzie et al. (1998), in their study of factors influencing return to work following lower extremity fractures, found that those who were employed in white-collar jobs had a higher incidence of return to work [3]. While it is possible that there is something inherently different between white-collar and blue-collar workers with regard to return to work attitudes/patterns, it is more likely that less physically demanding jobs (typically white-collar jobs) have lesser impact on the body, and, therefore, may better accommodate people who are recovering from injuries.

This study was conducted to assess the role of some of these factors in return to work following coal miners' injuries. Injury severity plays an important role for workers' return to work. Most of the time it was observed that the workers with least severe injuries were more likely to be accommodated by their employers and therefore they return to work more quickly than others [8].

Psychological effect has a significant role for the return to work. Krause et al. (1998), in their study, have found that job satisfaction has a significant impact on how capable workers feel about returning to work, which may, in turn, increase the return to work rates [9]. Recent studies have suggested an important role of psychological work environment for the RTW with particular emphasis on work stress and job satisfaction [10,11]. Leontaridi and Ward (2002) investigated work related stress among a group of 15 Organisation for Economic Co-operation and Development (OECD) countries using the data from the International Social Surveys Program (ISSP) [12]. It examined the determinants of work related stress and explored the importance of work related stress as a predictor of individuals' quitting behavior and the rate of absenteeism. They find that those individuals reporting to experience at least some stress in their current position are 10–14% more likely to hold intentions to quit or be absent from work than those without any job stress, with the probability of intending to quit or being absent increasing with successively higher work related stress levels.

Manning and Osland (1989) explored the relationship between stress and absenteeism with a non-managerial white collar sample (N = 147) [13]. Absenteeism was considered in terms of frequency, hours, and length of absence (1 day, 2 days, > 2 days). Stress was considered from both work and non-work domains. Results found small but consistent relationships between absence (1 day, > 2 days, and total absence) and many of the stress measures (work events, work conditions, life events, life conditions, job satisfaction, strain and negative affect).

Glynn (2013) found the relationship between perceived stress, job satisfaction and absences. The method used was a cross-sectional correlational design [14]. Job Satisfaction Scale and Perceived Stress Scale were used for measuring the variables. Participants were all part-time students from the Dublin Business School College and they were in employment. The students were asked to fill in the questionnaires and to disclose how many times they were absent from work in the past 12 months. The analyses showed that there was a significant inverse relationship between job satisfaction and absenteeism. However, the study found that there is no significant relationship between perceived stress and absenteeism.

An injured worker's level of motivation to return to work is influenced by workplace variables such as the presence (or not) of supportive co-workers as well as the severity of the injury and the quality of the treatment received [15,16]. Supervisors and managers may play an important role for the RTW process. Therefore, their education about work disability management is crucial in enabling them to manage the RTW work environment, and providing a link between the injured workers and senior managers.

Education of supervisors and managers, particularly about ergonomic requirements and safety issues play an important role for workers' RTW. Economic conditions of workers influenced the workers' return to work. Better economic conditions of workers has a higher incidence of the return to work than worse economic conditions of workers [5,6]. Mackenzie et al. (1998) in their research study found that persons employed in physical demanding jobs, where significant hazards play an important role, are also at a higher risk of not returning to work [3].

Some studies revealed that the correlation between physical impairment and the rate of the return to work is weak, suggesting that the other factors played a significant role in the delayed return to work. These factors may likely include personal characteristics of the injured person and his or her family, the health status of the injured worker, the income of the injured person, job characteristics, and the extent to which disability compensation is received. The relative importance of these factors in explaining the RTW, however, has not been well characterized as most of the studies focused on only one factor at a time and a failure to incorporate objective measures of impairment in the analysis.

This study was designed to address these limitations while examining factors influencing the RTW for determining any relation with the social, economic, personal and hazardous jobs. In this study we collect some information regarding workers' personal matters as well as injury related activities and days lost due to injury. The underlying hypothesis of the study is that while a strong correlation may exist between severity of the injury and the rate of the RTW, other factors related to the injured person and his environment are equally important in explaining variations of the RTW.

MATERIAL AND METHODS

The study mainly focused on the role of risk factors for the return to work after injury in underground coal mines. In this study, the following individual factors were considered:

- demographic factors, namely age and experience,
- socio-economic factors, namely family size, monthly income, and educational level,
- life style related factors, namely tobacco smoking and regular alcohol consumption,
- health related factors, namely body mass index and presence of various diseases,
- behavioral factors.

The response devices were used for the measurement of the risk factors through interviewed questionnaires. The interviewed questionnaires were based on factors, namely demographic factors, socio-economic factors, behavioral factors, and health related factors. In this study an injury was considered on the basis of the classification system of the Directorate General of Mines Safety (DGMS) which is the Indian Government Regulatory agency for safety in mines.

The DGMS classified the severity of an injury in terms of fatal, serious, reportable and minor injuries [17]. Specifically, a fatal injury results in death of one or more persons. A serious injury, also known as a serious bodily injury, is defined as an injury which involves the permanent loss of any part of the body or permanent loss of or injury to the sight or hearing or any permanent incapacity or fractures of any bone or joints. A reportable injury is any injury other than a serious bodily injury which involves the enforced absence of the injured person from work for a period of 72 h or more. A minor injury is defined as any injury other than a serious bodily injury which involves the enforced absence of the injured person from work for a period exceeding 24 h but shorter than 72 h.

A case study was conducted for injured workers from an underground coal mine which is located in the eastern part of India. The selection of the mine was

recommended by the mining company as the mine was experiencing several serious bodily injuries per year based on the DGMS classification system. A total number of 136 injured cases (serious and reportable injuries) was recorded during the 10-year period (2000–2009) by the mine authority. The injured workers' data was collected from the accident registry of the mine. Serious injuries accounted for 24% of the total number of injuries which was a matter of concern to the mine authorities. Minor injuries were not recorded by the mine authorities. As a result, workers who suffered minor injuries could not be considered in this study.

The mine operates 6 days a week, 3 shifts per day for coal production. The mining methods practised in this mine are longwall and shortwall mining. A total number of 1046 workers were employed during the study period. The working duration of a worker is 8 h/day and 6 days/week. The average coal production in the mine was 2700 t/day. All the injured workers who were available at the mine during the study period were interviewed. As a result, a total number of 109 workers out of 136 injured persons were interviewed as the rest of the miners left the mine premises or died or retired at the time of interview. A standardized questionnaire was completed by the trained personnel through face-to-face interviews during the 6-month study period in 2010.

The questionnaire consists of both qualitative and quantitative type variables. It included birth-date, height, weight, experience (years with the job), educational level (no-formal/formal education), regular consumption of

Table 1. Categories of variables used in the study of miners from the underground coal mine in India, 2010
Tabela 1. Kategorie zmiennych zastosowane w badaniu górników z podziemnej kopalni węgla w Indiach w 2010 r.

Variable Zmienna	Coding scheme in statistical model Schemat kodowania w modelu statystycznym
Education / Wykształcenie	education_cat (0) = formal / formalne[a] education_cat (1) = no-formal / nieformalne[b]
Age / Wiek	age_cat (0) ≤ 45 years old / lat age_cat (1) > 45 years old / lat
Body mass index (BMI) / Wskaźnik masy ciała	bmi_cat (0) ≤ 23 kg/m^2 (normal weight / masa ciała w normie) bmi_cat (1) > 23 kg/m^2 (over weight / nadwaga)
Family size / Liczebność rodziny	dpndnt_cat (0) ≤ 5 dependents / osób dpndnt_cat (1) > 5 dependents / osób
Sleeping duration / Czas snu	slp_hbt (0) > 6 h / godz. slp_hbt (1) ≤ 6 h / godz.
Job satisfaction / Satysfakcja z pracy	job_sat (0) = yes / tak job_sat (1) = no / nie
Job stress / Stres w pracy	job_stress (0) = yes / tak job_stress (1) = no / nie
Presence of disease / Występowanie choroby	disease (0) = no / nie disease (1) = yes / tak
Regular alcohol consumption / Regularne spożywanie alkoholu	alcohol (0) = no / nie alcohol (1) = yes / tak
Tobacco smoking / Palenie tytoniu	smoking_cat (0) = no / nie smoking_cat (1) = yes / tak
Monthly income / Dochód miesięczny	income_cat (0) > 10 000 rupees / rupii income_cat (1) ≤ 10 000 rupees / rupii
Injury type / Typ urazu	inj_type (0) = reportable / umiarkowany[1] inj_type (1) = serious / poważny
Seniority / Staż pracy	exprn_cat (0) > 15 years / lat exprn_cat (1) ≤ 15 years / lat

[a] Primary/secondary/beyond secondary education / Wykształcenie podstawowe/średnie/wyższe.
[b] Category includes those subjects who were not able to read and write / Kategoria obejmuje tych badanych, którzy nie potrafili czytać ani pisać.
[1] Any injury other than a serious bodily injury which involves the enforced absence of the injured person from work for a period of 72 h or more (according to Directorate General of Mines Safety [17]) / Każdy uraz inny niż poważny, który powoduje absencję w pracy trwającą 72 godz. lub dłużej (wg Generalnej Dyrekcji Bezpieczeństwa Kopalń [17]).

alcohol (yes/no), tobacco smoking (non smoker/current smoker/ex-smoker), diseases, total number of dependents, and occupational injuries during the 10-year period (2000–2009). The birth dates, experience, monthly income and information on occupational injury of the workers were taken from the mine records available in the mine. Regarding diseases, the subjects were asked the question: "Has your physician told you that you have 1 or several of the following diseases: no diseases, diabetic, asthma, other respiratory diseases, hypertension, musculoskeletal disorders, vision disorders, cancers, mental disorders?" (response: yes/no). For educational level purposes, this study focused on no-formal education (that is, those subjects who were not able to read and write) and formal education (primary/secondary/beyond secondary education).

To know the relationship between the risk factors and the days of the return to work after injury/days lost, the Kaplan-Meier analysis and Chi^2 test were performed. Cox proportional hazard analysis is a useful tool to identify the hypothesized risk factor for the return to work. The relative odds ratios (OR) were calculated using the Cox proportional hazard model. The explanatory variables in the models were the following: education level, age, body mass index, family size, sleeping habit, job satisfaction, job stress, presence of disease, regular alcohol consumption, tobacco smoking, monthly income, injury type and present experience. The response variable considered in the model was the days lost. All the variables were divided in 2 categories according to their descriptions (Table 1). Overweight and normal weight were defined as body mass index (weight/height^2) > 23 kg/m^2 and ≤ 23 kg/m^2 according to recommendations of the World Health Organization (WHO) for Asian population [18]. Data was analyzed using the Statistical Package for the Social Sciences (SPSS v. 20.0, IBM, USA).

RESULTS

Injury statistics are given according to the classification system of the DGMS. Injury statistics for the mine for the 10-year period are shown in the Table 2 which reveals that there are 136 injuries during the 10-year period and the serious injuries account for 24% of the total number of injuries. The mean time for the return to work (MTRW) after injury has been calculated for all the factors (Table 3).

The Table 3 reveals that the MTRW values are higher for the persons suffering from some type of prior disease (such as high blood pressure, diabetes, and musculoskeletal disorder), experiencing serious injury and

Table 2. Injuries of miners due to accidents in the underground coal mine in India, 2000–2009
Tabela 2. Urazy u górników w wyniku wypadków w podziemnej kopalni węgla w Indiach w latach 2000–2009

Year Rok	Injuries of miners Urazy u górników [n]		
	serious poważne	reportable[1] umiarkowane[1]	total ogółem
2000	5	14	19
2001	2	10	12
2002	3	9	12
2003	5	12	17
2004	3	6	9
2005	2	13	15
2006	1	9	10
2007	4	5	9
2008	4	14	18
2009	4	11	15
Total / Ogółem	33	103	136

[1] As in Table 1 / Jak w tabeli 1.

Table 3. Mean time of return to work of miners (N = 109) after injury due to accidents in the underground coal mine in India, 2000–2009
Tabela 3. Średni czas powrotu do pracy górników (N = 109) po urazie w wyniku wypadków w podziemnej kopalni węgla w Indiach w latach 2000–2009

Respondents' characteristics Charakterystyka respondentów	Return to work [days] Powrót do pracy [dni] (M)
Education / Wykształcenie	
formal / formalne[a]	50
no-formal / nieformalne[b]	43
Age / Wiek	
≤ 45 years old / lat	49
> 45 years old / lat	42
Body mass index (BMI) / Wskaźnik masy ciała	
≤ 23 kg/m^2	46
> 23 kg/m^2	45
Family size / Liczebność rodziny	
≤ 5 dependents / osób	42
> 5 dependents / osób	47
Sleeping duration / Czas snu	
> 6 h	43
≤ 6 h	53
Job satisfaction / Satysfakcja z pracy	
yes / tak	43
no / nie	52
Job stress / Stres w pracy	
yes / tak	59
no / nie	39
Presence of disease / Występowanie choroby	
no / nie	35
yes / tak	74
Regular alcohol consumption / Regularne spożywanie alkoholu	
no / nie	39
yes / tak	58
Tobacco smoking / Palenie tytoniu	
no / nie	53
yes / tak	38
Monthly income / Dochód miesięczny	
> 10 000 rupees / rupii	37
≤ 10 000 rupees / rupii	48
Injury type / Typ urazu	
reportable / umiarkowany[1]	38
serious / poważny	72
Seniority / Staż pracy	
> 15 years / lat	46
≤ 15 years / lat	45

[a, b, 1] As in Table 1 / Jak w tabeli 1.
M – mean / średnia.

having job stress, and these values are 74 days, 72 days, and 59 days, respectively. The cumulative proportion of miners returning to work by characteristics of the miners and pre-injury job is presented in the Table 4.

Cumulative proportions of the RTW of the injured miners were carried out for 30 days, 60 days, 90 days and 120 days, respectively. The cumulative proportion of miners who had returned to work 30 days, 60 days, 90 days and 120 days after injury were 0.46, 0.72, 0.91 and 0.96, respectively. The Kaplan-Meier results give survival curves of the event to occur, that is the return to work after injury. The survival curves give the instantaneous potential per unit of time for the return to work after injury. According to Kaplan-Meier estimate (Table 4) it is revealed that family size, sleeping habit, job stress, disease, monthly income, injury type, and present experience have some effect on the RTW.

The Figures 1–6 are revealed how the RTW is related with job stress, injury type, disease, sleeping habit, alcohol consumption, and monthly income, respectively. The Figure 1 summarizes that the injured workers having low job stress are more likely to return to work after injury. Accordingly, the Figure 2 summarizes that the probability of employees' return to work after a reportable injury is more than a serious injury. Workers' individual characteristics are significantly associated with higher rates of return to work. It is also found that probability of the return to work is higher in the case of workers having no disease, regular sleeping habit (> 6 h), no alcohol consumption, and monthly income > 10 000 rupees (Figures 4–6).

The Chi^2 test was performed to know the relationship between different factors and the RTW within 60 days. Percentages of workers' RTW (within 60 days) after injury for each factor were calculated (Table 5) as it was expected by the mine management that the workers should have returned to work within 2 months (60 days). The Chi^2 test reveals that the predicted value of the RTW is significant for disease (Chi^2 = 26.689, $p < 0.005$), alcohol (Chi^2 = 8.434, $p < 0.005$), job stress (Chi^2 = 5.967, $p < 0.05$), and injury type (Chi^2 = 17.543, $p < 0.005$). The predicted value of the RTW is not significant for the rest of the factors which are presented in the Table 5 as $p > 0.05$.

Before conducting the multivariate analysis, Spearman's rank correlation coefficient had been computed among all the risk factors to deal with potential confounders. The results revealed that the potential confounding variables were age, education level, body mass index, job stress, and monthly income. As there

Table 4. Kaplan-Meier estimates of the cumulative proportion of miners returning to work after injury due to accidents in the underground coal mine in India, 2000–2009
Tabela 4. Estymatory Kaplana-Meiera dla skumulowanego odsetka górników wracających do pracy po urazie w wyniku wypadków w podziemnej kopalni węgla w Indiach w latach 2000–2009

Respondents' characteristics Charakterystyka respondentów	Miners Górnicy (N = 109) [n]	Kaplan-Meier estimates Estymatory Kaplana-Meiera			
		return to work in 30 days powrót do pracy w ciągu 30 dni	return to work in 60 days powrót do pracy w ciągu 60 dni	return to work in 90 days powrót do pracy w ciągu 90 dni	return to work in 120 days powrót do pracy w ciągu 120 dni
Education / Wykształcenie					
formal / formalne[a]	58	0.368	0.638	0.862	0.948
no-formal / nieformalne[b]	51	0.448	0.824	0.961	0.980
Age / Wiek					
≤ 45 years old / lat	57	0.428	0.684	0.895	0.947
> 45 years old / lat	52	0.401	0.769	0.923	0.981
Body mass index (BMI) / Wskaźnik masy ciała					
≤ 23 kg/m^2	24	0.386	0.700	0.900	0.950
> 23 kg/m^2	69	0.412	0.739	0.913	0.971
Family size / Liczebność rodziny					
≤ 5 dependents / osób	39	0.462	0.718	0.923	0.974
> 5 dependents / osób	70	0.369	0.729	0.900	0.943
Sleeping duration / Czas snu					
> 6 h	81	0.434	0.765	0.938	0.975
≤ 6 h	28	0.308	0.607	0.821	0.929
Job satisfaction / Satysfakcja z pracy					
yes / tak	86	0.333	0.744	0.895	0.953
no / nie	23	0.217	0.652	0.957	0.957
Job stress / Stres w pracy					
yes / tak	34	0.248	0.559	0.880	0.941
no / nie	75	0.475	0.800	0.920	0.973
Presence of disease / Występowanie choroby					
no / nie	80	0.487	0.863	0.975	0.987
yes / tak	29	0.172	0.345	0.724	0.862
Regular alcohol consumption / Regularne spożywanie alkoholu					
no / nie	72	0.438	0.819	0.972	0.986
yes / tak	37	0.332	0.541	0.784	0.892
Tobacco smoking / Palenie tytoniu					
no / nie	54	0.335	0.667	0.833	0.926
yes / tak	55	0.471	0.782	0.982	0.982
Monthly income / Dochód miesięczny					
> 10 000 rupees / rupii	29	0.416	0.828	0.966	0.966
≤ 10 000 rupees / rupii	80	0.397	0.687	0.888	0.950
Injury type / Typ urazu					
reportable / umiarkowany[1]	85	0.471	0.824	0.941	0.976
serious / poważny	24	0.167	0.375	0.792	0.917
Seniority / Staż pracy					
> 15 years / lat	76	0.405	0.737	0.921	0.961
≤ 15 years / lat	33	0.397	0.697	0.878	0.970

[a, b, 1] As in Table 1 / Jak w tabeli 1.

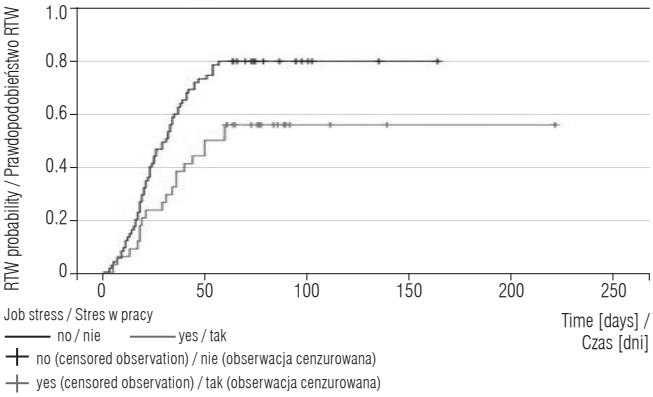
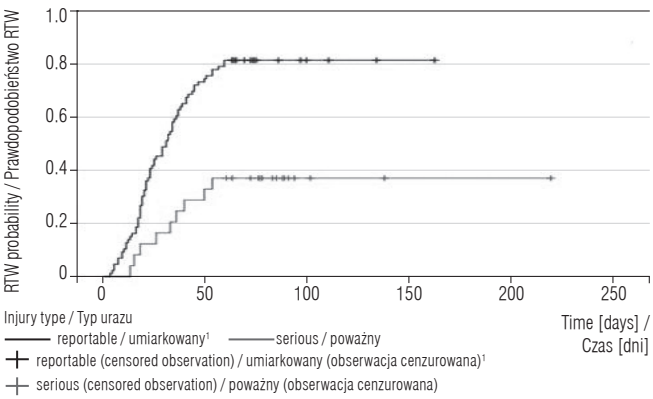


Fig. 1. Time of return to work (RTW) for miners after injury due to accidents in the underground coal mine in India, 2000–2009, depending on the job stress
Ryc. 1. Czas powrotu do pracy (RTW) górników po urazie w wyniku wypadków w podziemnej kopalni węgla w Indiach w latach 2000–2009 w zależności od stresu w pracy



[1] As in Table 1 / Jak w tabeli 1.

Fig. 2. Time of return to work (RTW) for miners after injury due to accidents in the underground coal mine in India, 2000–2009, depending on the injury type
Ryc. 2. Czas powrotu do pracy (RTW) górników po urazie w wyniku wypadków w podziemnej kopalni węgla w Indiach w latach 2000–2009 w zależności od typu urazu

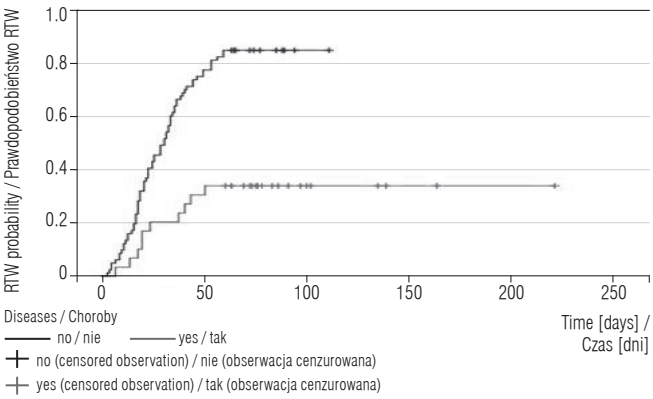


Fig. 3. Time of return to work (RTW) for miners after injury due to accidents in the underground coal mine in India, 2000–2009, depending on the presence of disease
Ryc. 3. Czas powrotu do pracy (RTW) górników po urazie w wyniku wypadków w podziemnej kopalni węgla w Indiach w latach 2000–2009 w zależności od występowania choroby

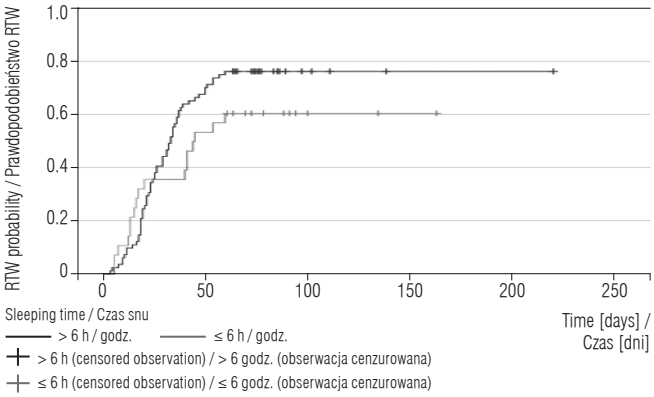


Fig. 4. Time of return to work (RTW) for miners after injury due to accidents in the underground coal mine in India, 2000–2009, depending on the sleeping duration
Ryc. 4. Czas powrotu do pracy (RTW) górników po urazie w wyniku wypadków w podziemnej kopalni węgla w Indiach w latach 2000–2009 w zależności od czasu trwania snu

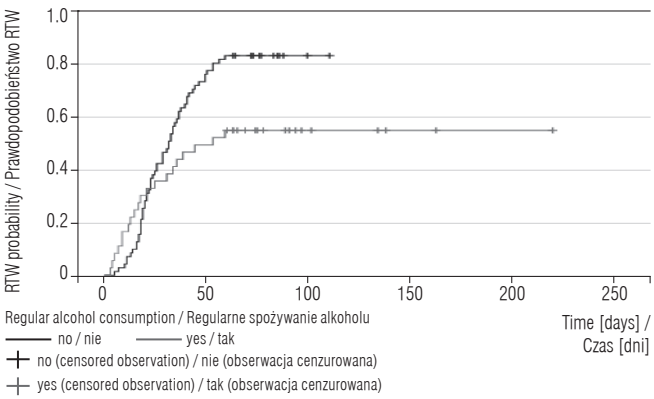


Fig. 5. Time of return to work (RTW) for miners after injury due to accidents in the underground coal mine in India, 2000–2009, depending on the regular alcohol consumption
Ryc. 5. Czas powrotu do pracy (RTW) górników po urazie w wyniku wypadków w podziemnej kopalni węgla w Indiach w latach 2000–2009 w zależności od regularnego spożywania alkoholu

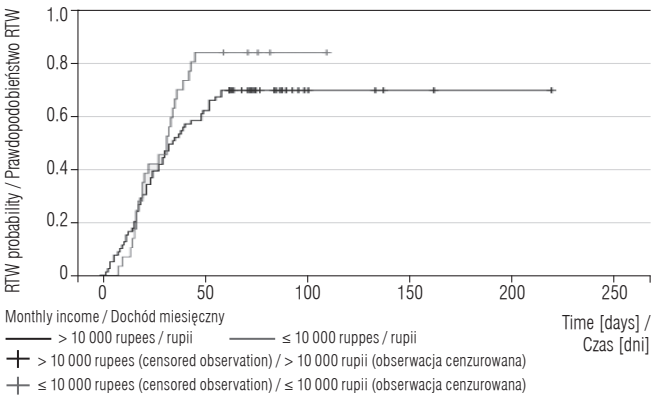


Fig. 6. Time of return to work (RTW) for miners after injury due to accidents in the underground coal mine in India, 2000–2009, depending on the monthly income
Ryc. 6. Czas powrotu do pracy (RTW) górników po urazie w wyniku wypadków w podziemnej kopalni węgla w Indiach w latach 2000–2009 w zależności od dochodu miesięcznego

Table 5. Miners (N = 109) returning to work in 60 days after injury due to accidents in the underground coal mine in India, 2000–2009
Tabela 5. Górnicy (N = 109) wracający do pracy w ciągu 60 dni od urazu w wyniku wypadków w podziemnej kopalni węgla w Indiach w latach 2000–2009

Respondents' characteristics Charakterystyka respondentów	Return to work Powrót do pracy [n (%)]	Chi^2	p
Education / Wykształcenie		1.554	n.s.
formal / formalne (N = 58)[a]	36 (62.0)		
no-formal / nieformalne (N = 51)[b]	42 (82.3)		
Age / Wiek		0.578	n.s.
≤ 45 years old / lat (N = 57)	39 (68.4)		
> 45 years old / lat (N = 52)	39 (75.0)		
Body mass index (BMI) / Wskaźnik masy ciała		0.076	n.s.
≤ 23 kg/m^2 (N = 40)	28 (70.0)		
> 23 kg/m^2 (N = 69)	59 (85.5)		
Family size / Liczebność rodziny		0.002	n.s.
≤ 5 dependents / osób (N = 39)	28 (71.8)		
> 5 dependents / osób (N = 70)	50 (71.4)		
Sleeping duration / Czas snu		2.178	n.s.
> 6 h (N = 81)	61 (75.3)		
≤ 6 h (N = 28)	17 (60.7)		
Job satisfaction / Satysfakcja z pracy*		0.576	< 0.05
yes / tak (N = 86)	63 (73.2)		
no / nie (N = 23)	15 (65.2)		
Job stress / Stres w pracy*		5.967	< 0.05
yes / tak (N = 34)	19 (55.9)		
no / nie (N = 75)	59 (78.7)		
Presence of disease / Występowanie choroby**		26.689	< 0.005
no / nie (N = 80)	68 (85.0)		
yes / tak (N = 29)	10 (34.5)		
Regular alcohol consumption / Regularne spożywanie alkoholu**		8.434	< 0.005
no / nie (N = 72)	58 (80.6)		
yes / tak (N = 37)	20 (54.0)		
Tobacco smoking / Palenie tytoniu		1.259	n.s.
no / nie (N = 54)	36 (66.7)		
yes / tak (N = 55)	42 (76.4)		
Monthly income / Dochód miesięczny		2.435	n.s.
> 10 000 rupees / rupii (N = 29)	24 (82.8)		
≤ 10 000 rupees / rupii (N = 80)	54 (67.5)		
Injury type / Typ urazu**		17.543	< 0.005
reportable / umiarkowany (N = 85)[1]	69 (81.2)		
serious / poważny (N = 24)	9 (37.5)		
Seniority / Staż pracy		0.081	n.s.
> 15 years / lat (N = 76)	23 (69.7)		
≤ 15 years / lat (N = 33)	55 (72.4)		

[a, b, 1] As in Table 1 / Jak w tabeli 1.
* $p < 0.05$, ** $p < 0.005$.
n.s. – not statictically significant / nieistotne statystycznie.

Table 6. Cox regression analysis of return to work for miners (N = 109) after injury due to accidents in the underground coal mine in India, 2000–2009
Tabela 6. Analiza regresji Coxa dotycząca powrotu do pracy górników (N = 109) po urazie w wyniku wypadków w podziemnej kopalni węgla w Indiach w latach 2000–2009

Respondents' characteristics Charakterystyka respondentów	OR	95% CI
Education / Wykształcenie		
formal / formalne[a]	1.13	0.64–1.99
no-formal / nieformalne[b]	1.00	ref.
Age / Wiek		
≤ 45 years old / lat	1.20	0.71–2.03
> 45 years old / lat	1.00	ref.
Body mass index (BMI) / Wskaźnik masy ciała		
≤ 23 kg/m^2	1.20	0.71–2.02
> 23 kg/m^2	1.00	ref.
Family size / Liczebność rodziny		
≤ 5 dependents / osób	0.91	0.55–1.50
> 5 dependents / osób	1.00	ref.
Sleeping duration / Czas snu		
> 6 h	0.92	0.50–1.70
≤ 6 h	1.00	ref.
Job satisfaction / Satysfakcja z pracy*		
yes / tak	2.06	1.11–3.83
no / nie	1.00	ref.
Job stress / Stres w pracy		
yes / tak	1.00	ref.
no / nie	1.33	0.73–2.43
Presence of disease / Występowanie choroby**		
no / nie	4.91	2.36–10.22
yes / tak	1.00	ref.
Regular alcohol consumption / Regularne spożywanie alkoholu		
no / nie	1.15	0.64–2.09
yes / tak	1.00	ref.
Tobacco smoking / Palenie tytoniu		
no / nie	0.90	0.54–1.70
yes / tak	1.00	ref.
Monthly income / Dochód miesięczny		
> 10 000 rupees / rupii	1.36	0.79–2.38
≤ 10 000 rupees / rupii	1.00	ref.
Injury type / Typ urazu**		
reportable / umiarkowany[1]	3.38	1.54–7.40
serious / poważny	1.00	ref.
Seniority / Staż pracy		
> 15 years / lat	1.20	0.67–2.16
≤ 15 years / lat	1.00	ref.

[a, b, 1] As in Table 1 / Jak w tabeli 1.
* $p < 0.05$, ** $p < 0.005$.
OR – odds ratio / iloraz szans, CI – confidence interval / przedział ufności, ref. – reference group / grupa referencyjna.

are more than one potential confounder, it has not been possible to control the effect of all the potential confounders through the process of stratification using the SPSS package. Moreover, the stratified analysis works best if only 1 or 2 confounders have to be controlled [19].

The Cox regression model was then used for estimating the relative odds ratios considering all the factors including the potential confounders while accounting for the effect of the return to work within 2 months (60 days) (SPSS multivariable linear models and logistic regression, test No. 1–5). As the injuries were investigated retrospectively, the time spent by the event was considered in the Cox regression model as Time variable while running the model using the SPSS package. Results of the Cox regression analysis are summarized in the Table 6. Injury type, disease and job satisfaction were significant predictors of the return to work. Significant relative odds ratios were found for injury type (OR = 3.44, 95% confidence interval (CI): 1.57–7.50), disease (OR = 4.96, 95% CI: 2.38–10.32) and job satisfaction (OR = 2.11, 95% CI: 1.15–3.88). The other factors are not statistically significant.

To consider whether there is any significant effect of the potential confounders in the model results presented in the Table 6, the Cox regression model was given another run after removing the potential confounders from the model [20]. The results have revealed that there are negligible changes in the relative odds ratios of the factors considered in the model run and the relative odds ratios are very close to the model results presented in the Table 6. The Cox regression model was also given a run using the backward stepwise regression procedure ($p > 0.05$ for exclusion of variables). The final model retained only the 3 significant factors namely injury type, disease and job satisfaction. The relative odds ratio values of the 3 significant factors were also very close to the model results presented in the Table 6.

DISCUSSION

In this study, an attempt has been made to identify the various causal factors in returning to work after injury in mine and to estimate the risk of different factors in returning to work. The status of Indian mining industries was reviewed and it was found that for the last 25 years there has been no apparent improvement in coal mine safety as far as fatality and fatality rates are concerned. Mining industry is the worst sufferer as it experiences several injuries due to the presence of various hazards at work places. So, the return to work is of prime concern rather than amount of money utilized for treatment because the amount of capital losses due to not returning to work after injury is far more than the treatment cost of the injured workers. In the Indian mining scenario, most of the studies were conducted to analyze fatal accidents and injury data by the classification-based approach but did not study on return to work after injury.

This study was based on the collection and analysis of the following safety related information:

- injury data analysis based on mine-specific records,
- workplace-based observations and discussions with the mine officials,
- questionnaire data analysis.

The data collected from the questionnaire survey was analyzed through univariate and multivariate statistical methods. The univariate analyses included the Kaplan-Meier test. The multivariate analysis includes Cox-proportional hazard model. A successful return to work function is influenced by many factors. These include worker's age, occupation, and severity of injury. Clinical care, income support and access to a variety of services are also important determinants.

In this study the MTRW values were higher for the persons suffering from some type of prior disease, experiencing serious injury and having job stress, and these values are 74 days, 72 days, and 59 days, respectively. According to Kaplan-Meier analysis it is found that a smaller family size, more hours of sleeping habit, less job stress, no disease, no alcohol addiction, and high monthly income have an impact on the early return to work after injury. This study has found that low job stress group has better survival prognosis than high job stress group (Figure 1). Moreover, as the number of days increases, the 2 curves (little job stress, big job stress) appear to get further apart suggesting the beneficial effect of a little job stress injured worker over a big job stress injured worker in return to work after injury. These results are encouraging given the complex nature of injuries. A similar type of results on job strain was reported by Fukuoka et al. (2009) [16] in their study on returning-to-work after acute coronary syndrome.

Disease is found to be a statistically significant factor in return to work after injury. Eighty-five percent out of the total number of injured persons, who had had no diseases, returned to work within 60 days whereas only 34.5% of the total number of injured persons, who had been suffering from some disease, returned to work after injury, which meant that the diseased persons had

fewer chances for the early return to work. This finding generally supports the other studies that have concluded that diseased workers take a longer time to return to their pre-injury level activity [3].

Cox proportional hazard analysis has revealed that the chance for the return for the non-diseased workers is 5 times higher than in the case of diseased workers. Interventions involving occupational physicians, safety officers, and mine managers to reduce work related diseases and to improve health status are necessary as measures of preventive policies at workplaces aiming at reducing occupational injuries. Alcohol consumption has been found to be a statistically significant risk factor for the return to work after injury. Alcohol consumption is significantly and negatively correlated with the RTW. Its role for returning people to work after an injury should not be underestimated especially for mining workers. This factor is found to be a significant risk factor for accepted rate of alcohol abuse on US adults [3].

Lower income is associated with inadequate health insurance coverage, inferior social life, which often is limited to appropriate use of rehabilitation. In this study high monthly income has a significant impact on early return to work. Education may reflect an individual's level of understanding about the consequences of the injury, expectation for recovery or ability to adopt changing circumstances. In particular, people who are highly educated may have more job mobility to fit in physically demanding job after the return to work after injury. Though monthly income, present experience, family size, alcohol, job stress factors are not statistically significant; however, Kaplan-Meier analysis has revealed that they have some effect on the return to work.

The Cox regression model has revealed that job satisfaction is associated with the return to work with a relative OR = 2.11 (95% CI: 1.15–3.88). According to a study by Luthans (1995), it is revealed that a consistent inverse relationship between job satisfaction and absenteeism, that is when satisfaction is high, absenteeism tends to be low and when satisfaction is low, absenteeism tends to be high [21]. In some other studies it is revealed that even though the correlation between job satisfaction and absenteeism has been found to be rather moderate, the underlying assumption is that absence is at least in part, the result of dissatisfaction on the job [22,23]. It is necessary for the mine management to utilize the behavioral approach to safety management and to create motivation among the workers about the safety at workplaces. Motivation in work is a great factor. Mine management should arrange for some job motivation classes for workers. It will greatly influence the early return to work.

The Cox regression model has also revealed that injury type is associated with the return to work with relative OR = 3.44 (95% CI: 1.57–7.50). Serious injury type is at a higher risk of not returning to work. As the mining methods practised in the mine are longwall and shortwall mining, the workers have to face the challenges of highly demanding jobs at the face area, such as very limited working space, roof fall hazards, problem of coal dust and gas, poor ventilation, slip and fall hazards due to slippery floor and poor housekeeping practices, and operational hazards when the mining equipment is working for the extraction of coal. The workers working in the out-by-face area are also exposed to different types of hazards. The presence of most of these hazards has also been observed by the study team during their field visit. As a result, the workers in the mine experience large injuries (24% of total injuries) of serious injuries as recorded by the mine authority during the 10-year period.

There are some potential confounders in this study. However, the multivariate analyses results based on several model runs of the Cox's regression analyses, including backward stepwise procedure, have clearly revealed that there is no significant effect of the potential confounders on the other independent factors considered in this study. There are a few limitations in this study.

Severity of an injury is considered in this study based on the DGMS classification system which requires all the mines in India to report to the DGMS the following types of injuries: fatal, serious, reportable and minor injuries. As the injury data used in this study was collected based on the search from the accident registry of the mine which recorded only serious and reportable injuries; as a result, minor injuries could not be considered in this study. Moreover, the study did not consider the severity of injuries based on "less severe" non-hospitalized injuries and "severe" hospitalized injuries.

The data was collected based on face-to-face interviews during the 6-month study period in 2010 which may result in the recall bias for some of the factors considered in this study. Specifically, there may be a recall bias among the injured workers about the factors job satisfaction and job stress. However, efforts were made to reduce the recall bias. The workers were instructed to recall their pre-injury exposure status about the risk factors which were considered in this study. Moreover, the recall bias would be small as all the workers were working in the same working condition and environment for

a longer period, especially during the 10-year period considered for injuries, as observed by the study team based on mine specific records and discussions with the mine management for further verification about the face-to-face interviews and recorded information.

Another limitation of this study is that it has been conducted in only one underground coal mine and it has been limited to a small sample size. As a result, the findings from this study may not be generalized for other mines which are having the similar mining methods and other mining conditions and environment.

CONCLUSIONS

This study sheds light on the role of multiple factors associated with the delayed return to work after injury. The Cox regression analysis has revealed that the significant risk factors which influence miners' return to work include presence of disease, job satisfaction and injury type. These pre-injury factors may be controlled through interventions. Specifically, work-related diseases may be controlled through direct interventions of occupational physicians, safety officer, and mine manager. Efforts should be made by the occupational physicians to detect and monitor various diseases.

The mine management should take immediate action to eliminate the occupational hazards at the face area and out-by-face area through the rigorous implementation of risk assessment based safety management plan. The risk assessment safety management system will allow the mine management to identify and quantify various physical and individual hazards at workplaces and then these may be properly controlled or eliminated by direct intervention of supervisors personnel who are responsible for the safety of the workers and workplaces. Increased awareness about the severity of injury in the mine is also necessary especially for miners experiencing serious injuries to help the workers for the early return to work. Mine management may also consider the option of introducing special compensation for injured persons in the case of the early return to work after injury.

Mine management should also implement the policy of proper matching of jobs to the workers based on ergonomics, which will increase the job satisfaction of the worker. The current practice in the mine ignores application of ergonomic approaches for assignment of specific jobs to workers according to their skills and other individual factors including anthropometric body dimensions.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the contribution of Mr. Soumitra Kumar Mondal in this field based study. The support from the management, staff and workers of the case study mine is gratefully appreciated.

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Publisher / Wydawca: Nofer Institute of Occupational Medicine, Łódź, Poland