Original Article
http://mjiri.iums.ac.ir

Medical Journal of the Islamic Republic of Iran (MJIRI)
Iran University of Medical Sciences

Factors associated with the severity of fatal accidents in construction workers

Farideh Khodabandeh[1], Elaheh Kabir-Mokamelkhah*[2], Mahsa Kahani[3]

Received: 8 October 2016 Accepted: 10 December 2016 Published: 28 December 2016

Abstract

Background: Construction work (building houses, roads, workplaces, and repairing and maintaining infrastructures) is a dangerous land-based job. This includes many hazardous tasks and conditions such as working at the following conditions: Height, excavation, noise, dust, power tools and equipment.
Construction work has been increased in developed and underdeveloped countries over the past few years. Occupational fatalities have increased with an increase in this type of work. Occupational fatalities refer to individuals who pass way while on the job or performing work related tasks. In the present study, to identify the factors, personal characteristics and work-related factors associated with fatal occupational mortality were assessed using data for Tehran, Iran, 2014-2016.

Methods: We conducted a retrospective study, using 967 postmortem reports from fatal occupational injuries collected through postmortem investigations during 2014-2016. A sampling frame of 967 postmortem reports from fatal occupational injuries was used to draw a total sample of 714 fatal construction accidents for this cross-sectional study. Pearson $\chi 2$ test and Kruskal-Wallis tests were used for statistical analysis.

Results: Based on the results of this study, male gender (n=714; 100%), age range of 30-39 years (n=183; 25.6%), secondary educational level (n=273; 38.2%), being married (317; 44.4%), causal employee (n=389; 54.5%), unskilled performance (389; 54.5%), no insurance coverage (472; 66.1%), and daytime duty work (287; 40.2%) were identified as risk factors for fatality in the event of construction fatal injury. A significant relationship was found between the type of injury and sociodemographic and work related variables.

Conclusion: Workers' characteristics such as age, gender, experience, and educational background, and work related variables such as skill training, safety measurement, and close monitoring could be used to discriminate among different severity levels of occupational fatal accidents.

Keywords: Construction, Accidents, Fatality, Forensic Hall.

Cite this article as: Khodabandeh F, Kabir-Mokamelkhah E, Kahani M. Factors associated with the severity of fatal accidents in construction workers. *Med J Islam Repub Iran* 2016 (28 December). Vol. 30:469.

Introduction

Construction work is a dangerous land-based job. Some construction site jobs include building houses, roads, workplaces, and repairing and maintaining infrastructures. This work includes many hazardous tasks and conditions such as working with height, excavation, noise, dust, power tools, and equipment (1). Construction work has increased in developing and underdeveloped countries over the past few years, and with an increase in this type of work, occupational fatalities have increased. Occupational fatalities occur when individuals pass way while on the job or performing work related tasks (2). The leading safety hazards at construction sites include falls, caught between objects, electrocutions, and struck by objects (3).

All four types of mentioned hazards cause injuries and deaths at construction sites worldwide. Failure in hazard identification is often due to limited or improper training and supervision of the construction site workers (4). Falls from heights are the most common cause of in-

[1]. MD, Associate Professor, Forensic Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran. f_khodabandeh@sbmu.ac.ir
[2]. (**Corresponding author**) MD, Assistant Professor, Occupational Medicine Research Center (OMRC), Iran University of Medical Sciences, Tehran, Iran. kabir.e@iums.ac.ir
[3]. MD, General Physician, Iran University of Medical Sciences, Tehran, Iran. mahsa13682001@yahoo.com

jury in the construction industry (5). This is particularly a concern for elder and untrained construction workers (6).Within 2014, the United States had 4,679 fatal occupational injuries, with the incidence rate of 3.3 per 100,000 full-time employed workers (3). In the same year, fatal work injuries in construction and extraction occupations increased by 5%. One in every five workers death in 2014 was due to construction related deaths. Construction workers constituted about 6% of total American workers, but 17% of the fatalities - the largest number of fatalities reported for any industry sector (1).

In 2002, there were 22,453 industrial accidents in Hong Kong, of which 6,239 accidents were construction related (7). In the United Kingdom, the construction industry is responsible for 31% of the fatalities at work and 10% of major workplace injuries (8). In Australia, the construction industry experienced 5.6 fatalities per 100,000 employees which are more than twice the average for all the industries in 2007–2008 (5). In South Africa, there are 150 fatalities and approximately 400 injuries each year related to construction sites (9). In Brazil, the incidence rate for all occupational fatalities is 3.6 per 100,000 (10). Little to no information could be found regarding construction fatalities in Asia, South American, Africa, and Antarctic.

In the Occupational Safety and Health Administration (OSHA) Handbook (29 CFR) used by the United States, fall protection is needed in areas including but not limited to the following: ramps, runways, and other walkways, excavations, hoist areas, holes, form-work, leading edge work, unprotected sides and edges, overhand bricklaying and related work, roofing, precast erection, wall openings, and residential construction, and other walking/working surfaces (11). Other countries have regulations and guidelines for fall protection to prevent injuries and deaths. Therefore, it is of prime importance to ensure that construction sites are as safe as possible for the workers. This research aimed at assessing the relationship between different personal characteristics as well as work-related factors with fatal occupational injury among constructive workers within 2 years, 2014-2016, in Tehran, Iran.

Methods

This was a retrospective study conducted on the workers lost to occupational accidents using routine data collection through postmortem investigations during 2014-2016. Data were obtained from postmortem reports and ancillary documentation including police reports and hospital records. The study protocol was approved in ethical research committee of occupational medicine research center. A Sampling frame of 714 deceased workers was utilized from 967 postmortem reports of fatal occupational deaths. Fatal occupational accident was determined based on police reports. In addition to diagnostic information, and sociodemographic data, we recorded the consequence of the incident, the hour (time of day), the main causes of the accident (falls from height, stuck by thrown, projected or falling objects/heavy equipment fall over, electrocutions, building/structure collapse, explosion/burn), the type of construction site, occupation (trade), the job or activity at the time of the accident, and the responsible parties. Accident causes were classified according to International Classification of Diseases, the current version of ICD-10 (International Statistical Classification of Diseases and Health Related Problems).

Statistical Analysis

SPSS statistical software package Version 13 was used for data analysis. The associations between the frequencies of the participants with fatal injuries from falls at construction sites, the demographics, and work-related variables were analyzed. The statistical analysis included Pearson χ^2 test, and Kruskal-

Wallis tests. Significance level was set at $p< 0.05$.

The following variables were evaluated in terms of their distribution and completeness: The outcome (fatal injury type), dependent, sociodemographic characteristics (sex, age, level of education), type of employment (full time: regular work more than 36 hours/week, part time: regular work less than 36 hours/ week, causal; has no guaranteed hours of work and usually works irregular hours, fixed term, employed for a specific period of time or task, shift worker: works shifts and gets an extra payment for working shift hours), and occupation place at the time of the occupational injury, insurance state. The dependent versus the outcome variables were plotted to identify outliers and trends in the data. Categorical and ordinal variables were derived where appropriate. The categories of the cause and nature of injury variables were collapsed to group the least frequently occurring categories.

Results

During a two-year study, out of 967 worker fatalities in the calendar year 2014-2016, 73.8% (714) occurred in construction. The sociodemographic profile of the study participants is displayed in Table 1.

The subjects were all male adults (≥16 years), aged 18-64 years, with the mean ±SD age of 33.2±2.5 years. The most frequent occupational injuries occurred in workers aged 30-39 years (47.9% and 72.3%, respectively). Most of the deceased were married, 44.4% (317), with secondary school educational level, 30.5% (218).

With respect to nationality, some of the workers were Afghan, but the majority of the deceased workers were Iranian (91.2%). A significant relationship was found between type of injury and age group (p≤005), educational level (p≤005), marital status (p≤005), and nationality (p≤005).

Considering work- related factors in Table 2, most of the workers were unskilled (389; 54.5%) and were categorized as casual employees (54.5%). Unknown employment status accounted for 8%. Most of the accidents occurred among the simple workers due to nonstandard (unskilled) work. Most of them did not have job insurance (66.1%). In the majority (55.2%) of the cases, accidents occurred at the workplace and during day duty time (morning shift), mainly in the mornings

Table 1. Sociodemographic Characteristics of the Study Population

Characteristics	Category	n	%	Mean±SD
Age (year)				
	≥16	54	7.6	
	18-24	168	23.5	
	25-29	112	15.7	
	30-39	183	25.6	33.2±2.5
	40-49	103	14.4	
	≥50	94	13.2	
Educational level				
	Illiterate/ primary school	29	4.1	
	Secondary school	273	38.2	
	High School	218	30.5	
	≥Diploma	46	6.4	
Marital state				
	Single	215	30.1	
	Married	317	44.4	
	Widow/Separate	10	1.4	
	Unknown	172	24.1	
Nationality				
		651	91.2	
	Iranian	63	8.8	
	Afghani			

Table 2. Work Related Factors of the Study Population

Variable	Category	n	%
Age (year)			
	≥16	54	7.6
	18-24	168	23.5
	25-29	112	15.7
	30-39	183	25.6
	40-49	103	14.4
	≥50	94	13.2
Educational level			
	Illiterate/ primary school	29	4.1
	Secondary school	273	38.2
	High School	218	30.5
	≥Diploma	46	6.4
Marital state			
	Single	215	30.1
	Married	317	44.4
	Widow/Separate	10	1.4
	Unknown	172	24.1
Nationality			
	Iranian	651	91.2
	Afghani	63	8.8

Table 3. fatal Accident Profile

Variable	Category	n	%
Accident type			
	Fall from Height	423	59.2
	Stuck by Thrown /Projected or falling Objects/Heavy Equipment Fall Over	151	21.1
	Building/Structure Collapse	69	7.9
	Expulsion /Burn	24	3.4
	Electrocution	47	6.6
Post Mortem Injury Findings			
	Head &Neck	469	65.7
	Upper Extremities Injuries/ Fracture	82	11.5
	Lower Extremities injuries/Fracture	24	3.4
	Trunk &Back	51	7.1
	Multiple Trauma	72	12.3

(40.2% and 37.4%, respectively). A significant association was found between construction-related fatal accidents and employment status (p≤005) and performance (p≤005), event place (p≤0.05), event time (p≤0.05), and work eligibility (p≤0.05).

Table 3 demonstrates the details of the fatal accidents, which are as follows: Falling from the height (59.2%), stuck by thrown/projected or falling objects/heavy equipment fall over (21.1%), building/ structure collapse (9.7%), expulsion/ burning (3.4%), electrocution/Burn (6.6%).

With respect to the characteristics of the injury described following postmortem examination and according to frequency, they included head and neck (65.7%), upper extremities trauma including fracture (11.5%), lower extremities trauma including fracture (3.4%), trunk and back (7.1%), and multiple trauma (12.3%). The main cause of death declared by the forensic specialist was head injury in 56.9%, and multiple trauma and its complications in 43.1% of the workers.

Discussion

This study found statistically significant relationships between certain sociodemographic variables such as: sex, age group, educational level, marital state, nationality and work related factors such as work eli-

gibility, work time duty, and the possibility of death in the event of constructive work injury.

Being male represented a higher risk of death in the event of an occupational injury, which could be explained by their occupations having a higher level of exposure to risks than women's occupations (12,13). This is because male employment is still clustered in certain occupations such as heavy industry and construction, where workplace dangers are the greatest (14,15).

The population under the study consisted of deceased construction workers aged older than 16 years. This shows that teenagers without required professional skills and experience are also working in construction workshops due to the lack of supervision by the related legal organizations, leading to an increase in construction occupational accidents and casualties.

Although Chau et al. found the same age distribution in their French study (16) in the European Risk Observatory Report 2006, it was reported that the accident rate for 18 to 24 year olds was higher (17). In our study, there was no trend for younger construction workers to be injured more frequently. Our population was different from those of the comparable studies. Many other studies have reported that age groups from 25 to 44 years have a higher proportion of fatal injuries, similar to our study (18,19).

The frequency of occupational injury among the married construction workers were higher than single ones, which might be attributed to mental and family problems. According to Niles (20), the main causes of human errors are complexity, stress, work environment, fatigue, education, and experiences. Stress and fatigue can be higher among the married workers than the single ones because of more responsibilities in life, leading to more unsafe actions resulting in accidents. This result conforms the findings of the researches done in Iran and in other countries (21).

According to other studies, a significant inverse relationship was obtained between unsafe behaviors and level of education. In the present study, statistical analysis revealed a higher proportion of fatal injury among the construction workers with secondary school level of education. The reason may be due to the inadequate proportion of the cases with lower educational level in this study, and considering this possibility, our results would be the same as those of other studies (22,23).

With the increasing levels of education, unsafe actions are reduced. High rates of unsafe actions among people with low literacy could be due to the following reasons: Low levels of knowledge and lack of awareness about unsafe actions and being given difficult and dangerous tasks.

In the present study, the proportion of construction injuries among unskilled and casual workers was higher, which was as consistent with the finding of other studies (24,25). Although in this study, there was a lack of information on the workers' years of experience; it seemed that some factors such as lack of workers' knowledge or absence of training material, especially in the safety topics, had been responsible for the higher frequency of mortality among construction workers (26-28).

With respect to the employment status of the victims of occupational injury, in this study, the association of fatal injury with causal type of employment caused higher possibility of death, as found in other researches (29,30).

This could be explained by the perception of low experience and awareness about risks associated with job, low confidence, and lack of enough working time spent for training (31). Another aspect to be noted is the high percentage of fatal injury in constructive workers while working in daytime duty. This is because active work is mostly performed in daytime.

Because of a positive skewness in the nationality distribution in this study (Ira-

nian vs. Afghani), it can be concluded that fatal accident was more common in the Iranian nationality in this study. Our statistics covered fatal accidents mainly in workplaces. Work place was the main site of majority of the fatal construction accidents in other papers (32). The number of fatal accidents taking place at the construction sites is quite alarming, and the major cause was found to be fall of persons from height and through openings (33).

The findings of the present study revealed that “falling from a height” formed the most frequent cause of fatal injury. Furthermore, the highest rate of accident consequences belonged to injuries and fractures followed by the accidents leading to death. This shows that the severity and intensity of the injuries are induced by building accidents, which is consistent with the findings of other studies (34,35). With respect to postmortem examination to determine the cause of death, head injury was the most fatal cause in this study, being mostly associated to falling from height, similar to other studies (36,37).

Conclusion

Considering the results of the current study as well as the importance of construction industries in countries such as Iran, more emphasis on preventive measures such as training the workers and using standard safety tools plus surveillance of the employers can effectively reduce the burden of such injuries. Such preventive strategies are obviously less expensive for the employers, the workers, and the society.

References

1. United States National Institute for Occupational Safety and Health 2007.
2. Das S. Occupational fatalities in the construction sector: A medico-legal viewpoint. Med Leg J 2015;83(2):93-7.
3. Census of Fatal Occupational Injuries Summary 2014 [Available from: www.bls.gov.
4. Kines P, Andersen LP, Spangenberg S, Mikkelsen KL, Dyreborg J, Zohar D. Improving construction site safety through leader-based verbal safety communication. J Safety Res 2010;41(5):399-406.
5. Yi Man R, Sun Wah P. Construction Safety: Springer; 2013.
6. Xiuwen Sue D, Xuanwen W, Christina D. falls among older construction workers6. Human Factors 2012;54(3):303-15.
7. Francis W, Chan A, Yam M, Wong E. A Study of the Construction Safety in. Occupational safety and health statistics bulletin 2003.
8. HSE. Construction Industry Statistics". Health and Safety Executive. Retrieved 2015-04-17.
9. Robbie. "Deaths and accidents in the construction industry can be reduced". www.protectin.co.za. Retrieved 2016-03-15.
10. Mendeloff J. Occupational Safety and Health in Brazil; 2015.
11. OSHA. Regulations (Standards- 29 CFR) 2016 [Available from: www.osha.gov.
12. Sears JM, Bowman SM, Silverstein BA, Adams D. Identification of work-related injuries in a State Trauma Registry. J Occup Environ Med 2012;54(3):356-62.
13. Messing K. Physical exposures in work commonly done by women 2004:139-56.
14. Breslin C, Koehoorn M, Smith P, Manno M. Age related differences in work injuries and permanent impairment: a comparison of workers' compensation claims among adolescents, young adults, and adults. Occup Environ Med 2003; 60(9):E10.
15. Salminen S. Have young workers more injuries than older ones? An international literature review. J Safety Res 2004;25:513-21.
16. Chau N, Gauchard GC, Siegfried C, Benamghar L, Dangelzer JL, Francais M, et al. Relationships of job, age, and life conditions with the causes and severity of occupational injuries in construction workers. Int Arch Occup Environ Health 2004;77(1):60-6.
17. Work EAfSaHa. Young workers – facts and figures: European Risk Observatory Report; 2006.
18. Hong Tu N, LM A. Occupational injuries and prevention activities in Vietnam. Asian-Pacific Newslett Ocup Health Saf 2008;15:7-10.
19. Mehrdad R, Seifmanesh S, Chavoshi F, Aminian O, Izadi N. Epidemiology of occupational accidents in iran based on social security organization database. Iran Red Crescent Med J 2014;16(1):e10359.
20. Niles T. Human error risk assessment. Prof Saf 1998;36(8):42-3.
21. Mohamadfam L. Evaluation Of Occupational Accidents and Their Related Factors in Iranian Aluminum Company in 1999. Scientific Journal of Kurdistan University of Medical Sciences 2001; 5(3):18-23.
22. Mirzaei R, Ansari H, Ansari-Moghaddam A, Kamalian L, Nourafshan M. Effective Causes of

Work-Related Accidents Among Mashhad Workers in a 3-Year Period (2004-2007). Health Scope 2012; 1(2):80-3.

23. Work-related Traumatic Injury Fatalities, Australia 2010-11, Australia 2013;2013.

24. Garduño M, Pulido M, Delgado G. Accidentes de trabajo atendidos en una Institución para población abierta Salud Trab Maracay 2008;16:5-16.

25. Sarmiento R, López P, Marín I, Godínez A, Haro L, Salinas S. Factores de riesgo asociados a losaccidentes de trabajo en la industria de la construcción del Valle de México. Gac Méd Méx 2004;140(593-597).

26. Dudarev AA, Karnachev IP, Odland JO. Occupational accidents in Russia and the Russian Arctic. Int J Circumpolar Health 2013;72:20458.

27. Farrow A, Reynolds F. Health and safety of the older worker. Occup Med (Lond) 2012;62(1):4-11.

28. Leigh JP, McCurdy SA, Schenker MB. Costs of occupational injuries in agriculture. Public Health Rep 2001;116(3):235-48.

29. Konstantinidis A, Talving P, Kobayashi L, Barmparas G, Plurad D, Lam L, et al. Work-related injuries: injury characteristics, survival, and age effect. Am Surg 2011;77(6):702-7.

30. Velázquez Y, Medellín J. La percepción de riesgos como factor causal de accidentes laborales. SegurSalud En El Trab 2013;71:20-5.

31. Salim C. Analysis of work related accidents in the mining sector 2000–10: the case of Minas Gerais State, Brazil. Occup Environ Med. Salim C 0152 2014:71-9.

32. Ho DS, Kwan J, Ming F. Site safety management in Hong Kong. Journal of Management in Engineering 2000;16(6):34-42.

33. Kulkarni G. Construction industry:more needs to be done. Indian Journal of Occupational and Environmental Medicine 2007;11(1):1-2.

34. Colak B, Etiler N, Bicer U. Fatal occupational injuries in the construction sector in Kocaeli, Turkey, 1990-2001. Ind Health 2004;42(4):424-30.

35. Halvani G, Ibrahemzadih M. Epidemiological Study and Estimating of Accidents Distribution in Construction Industry Workers in Yazd City by Appling Time Series until 2011. Int J Occup Saf Heal 2012;2(1):26-30.

36. Crawford JO, Graveling RA, Cowie HA, Dixon K. The health safety and health promotion needs of older workers. Occup Med (Lond) 2010;60(3):184-92.

37. Rubiales E, Agudelo A, López M, Ronda E. Diferencias en los accidentes laborales en Españasegún país de procedencia del trabajador. Salud Publica Mex 2010;52:199-206.