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Occupational injuries and associated factors among cement factory workers in the city of Chlef, Algeria

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Even though accident rates in cement industry tend to be higher than in other manufacturing sectors and significantly contribute to overall worker disabilities and illnesses, they are reported poorly. The aim of our cross-sectional study was to assess occupational injuries and associated factors among cement factory workers in the city of Chlef, Algeria using a questionnaire distributed to 200 workers who agreed to participate in the study. We found that 53 participants working in a cement mill (26.5 %) reported having 64 occupational injuries, which mostly affected their hands (44 %) and feet (38 %). Machinery accounted for 39 % of all injuries, while falls accounted for 27 %. Multivariate analysis revealed that work in a quarry, lower education, and longer working years were significantly associated with higher injury rates. Long-term exposure to risks, rather than just inexperience, highlights the need for a reassessment of ongoing safety training and monitoring for experienced workers. Future research should also explore how organisational factors such as workload, work hours, job stress, and the state of machinery contribute to the risk of occupational injuries. An approach combining quantitative and qualitative data from workers and management across cement plants in Algeria and the region could provide an even more comprehensive view of occupational risks and safety practices and help contextualise these findings for policy improvements.

KEY WORDS: cement mill; cross-sectional study; falls; hands; feet; machinery; OSH training; personal protective equipment; safety practices; workplace accidents

Although there have been notable advancements in the advocacy for health and safety in the workplace, occupational injuries remain a significant public health concern and a leading cause of disease, disability, and death globally (1, 2). According to recent estimates, about 2.6 million people die each year from occupational diseases and some 330,000 from occupational accidents. In addition, about 395 million workers suffered non-fatal work injuries in 2019 alone (3).

Risk factors for occupational injuries generally vary around the world. There are significant differences between high, middle, and low-income countries, as work in middle and low-income countries is associated with 20 times greater risk of occupational injury owing to less advanced technology, poorer working conditions, and limited rehabilitation services (4). According to one theory (5, 6), the key role in this is played by proximal and distal factors. Proximal factors encompass sociodemographic and individual characteristics, such as working years, age, adherence to personal protection protocols, and exposure to occupational hazards, which directly influence the probability of injuries. Distal factors, in turn, involve managerial and organisational elements, including income, working hours, and health safety measures, which influence the probability of workplace injuries indirectly (6).

Studies of occupational injuries in North Africa indicate that workers in various industries face significant risks, with a high prevalence of injuries reported across multiple sectors and significant associations found between injuries and factors such as working environment (physical and psychological), tools/machinery used, and neglect to use personal protective equipment (7–9, 10, 11). Male workers, particularly those in lower-paying and more hazardous jobs like mechanics and welders, are at higher risk of injuries. The use of personal protective equipment and adherence to safety protocols have been shown to mitigate these risks to some extent (7–9). In Algeria, the Institute for Occupational Risk Prevention (INPRP) reported about 50,000 work-related accidents per year in various industries between 2000 and 2019 (12). In 2018, there were 48,000 occupational accidents, of which 529 were fatal (12). A 2023 report by Djaballah et al. (13) shows that as many as 55 % of workers at NOVER, a glass and abrasives company, had occupational accidents.

Cement manufacturing is one of these industries. Due to its widespread use, the health effects on both workers and the environment have raised great concern (14, 15). Several studies in Africa have shown that the cement industry is responsible for a wide range of injuries, fractures and falls in particular, which often require hospitalisation, increase healthcare burden, and lower productivity (16). Many cement plants lack the necessary resources and policies to prevent workplace injuries (15).

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As research in the Algerian cement industry is scarce, the aim of our study was to address this gap by evaluating and describing the most common occupational injuries and associated factors in cement factory workers in Chlef, a city west of the nation's capital, Algiers. We hoped that our findings would help to improve knowledge of current occupational safety and promote health and safety of workers beyond Algeria.

PARTICIPANTS AND METHODS

To do that, we collected ten years' worth of data (2014–2024) from 200 of 204 invited workers (98 % response rate) in the Entreprise des Ciments et Dérives d'Ech-Cheliff (Chlef Cement and Derivatives Company, ECDE) across areas of operations including technical, electrical, machinery, maintenance, mechanical, shipping, quarry, and supervision.

The instrument used for this purpose combines concepts, models, and a standardised questionnaire developed based on previously published studies, slightly modified for our purpose (15). It contains an introduction describing the objectives and two main aspects of the study: respondent information and accident information. The first includes information about the participants, including age, marital status, education level, working years, and specific occupation. The second focuses on information about the number, time, and cause of accidents, the severity and location of injuries, duration of sick leave, and use of protective equipment and preventive measures. The questionnaire was administered in Arabic and English. Before administration, it had been tested on 5 % of the sample size to check comprehension and was modified based on the collected feedback.

All participants gave their verbal consent after having been fully informed about the study and its importance. All the information given by the respondents was used for research purposes only, and confidentiality of the information was maintained by omitting their names and other identifying information. The study was approved by the University of Chlef, Department of Mechanical Engineering (approval no. 21/2025).

Statistical analysis

Occupational injury was treated as dependent variable, while demographic, social, and behavioural factors and working environment as independent variables. Occupational injury refers to any injury sustained by a worker while doing their job in the cement factory and resulting in hospitalisation, sick leave, or impairment. Each reported injury was verified against clinical records to ensure accuracy.

Data are expressed as frequencies, percentages, means, and standard deviations. The statistical distribution of all parameters was normal. The relationship between occupational injury (as dependent variable) and independent variables was analysed with multivariate binary logistic regression, and P-value of <0.05 set as significant. Key statistical measures included asymptotic significance (AS), adjusted odds ratio (AOR), and crude odds ratio (COR) with a 95 % confidence interval (CI). These were utilised in multivariable analysis to evaluate the presence and strength of associations (15).

All statistics were run on SPSS version 21 software (IBM, Armonk, NY, USA).

RESULTS

Table 1 shows their sociodemographic data. All participants were male, most older than 45 years, employed for over 10 years, and married. As many as 44 % held a university degree.

Fifty-three respondents (26.5 %) reported having been injured at work over the last 10 years, of whom 49 reported one and the rest two or more injuries over that time, totalling 64 injuries. The most common were hand and foot injuries (82 %) (Figure 1) and were most often caused by machinery (39 %) and falls (27 %) (Figure 2).

Table 2 summarises health and safety practices adopted at the workplace. Most respondents reported having received health and safety training, and nearly all having regularly used protective equipment. In addition, nearly all considered that training improved their behaviour in terms of occupational health and safety practices.

Table 1 Socio-demographic characteristics of the cement factory workers in Chlef, Algeria (N=200)

Variables		Frequency (N)	Percent (%)
Age	20–30	7	3.5
	31–45	91	45.5
	>45	102	51.0
Marital status	Married	181	90.5
	Not married	19	9.5
Education	University level	88	44
	Primary school	67	33.5
	Secondary school	45	22.5
Working years	<10	38	19
	>10	162	81

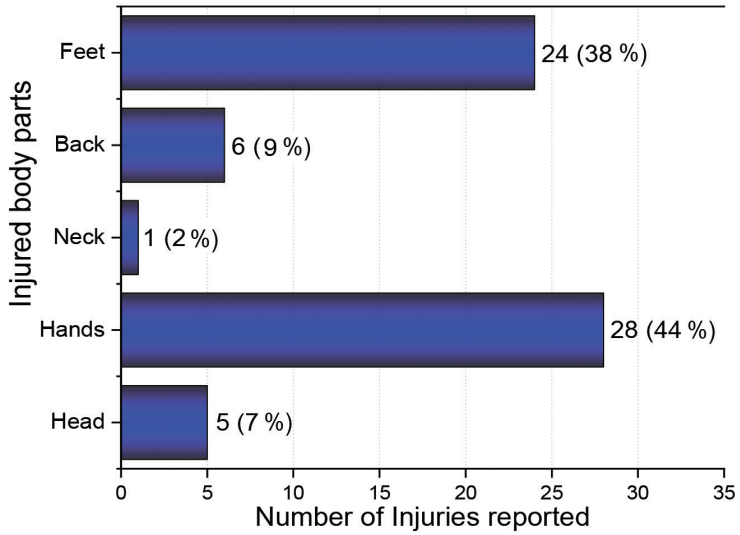

Figure 1 Prevalence of injuries (N=64) by body parts reported by Chlef cement factory workers (N=53)

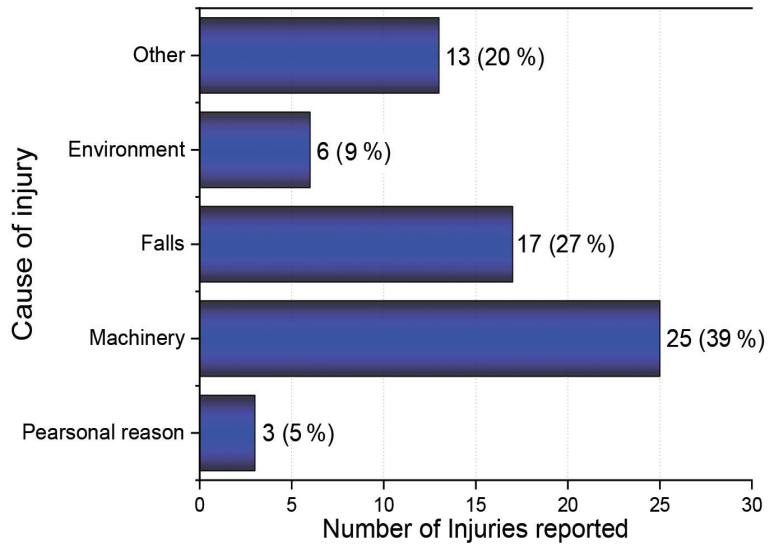

Figure 2 Distribution of causes of injuries (N=64) by causes reported by Chlef cement factory workers (N=53). *Environment* relates to poor lighting and extreme temperatures. *Personal reasons* include fatigue, inattention, or improper handling of equipment. *Other* includes co-worker errors, transportation incidents within the factory, and unforeseen hazards not classified under other categories

Table 2 Workplace health and safety measures reported by for cement factory workers in Chlef, Algeria (N=200)

Variables		Frequency (N)	Percent (%)
Had health and safety training	Yes	197	98.5
	No	3	1.5
Personal protective equipment usage	Never	0	0
	Regularly	198	99
	Occasionally	2	1
Behaviour change after training	Improved	195	97.5
	No change	5	2.5

Table 3 shows that higher education, more than ten years of work, and work in the quarry were significantly more associated with work-related injuries than lower education, shorter working years, and work in other operation areas (grinding, kiln, shipping, and storage).

DISCUSSION

Our respondents had lower prevalence of occupational injuries compared to those working at a cement plant in Ethiopia (48.9 %) in 2020 (15) but higher than reported for cement plant workers in Nigeria (19.6 %) in 2011 (17). This variation may be owed to differences in participants' socio-demographic characteristics, working environments, and study designs across this time span. Unfortunately, we could not compare our findings with other reports of occupational injuries in cement industry in Algeria, as there are none available.

Our cement plant workers with secondary education were more likely to sustain work-related injuries than those with higher education, which suggests that education may increase risk awareness and adherence to safety protocols. However, even though workers with more than ten years of experience would be expected to better follow safety practices, they seem to be significantly more likely to experience injuries than those who had worked for less than years. This finding points to other contributing factors, most notably associated with long-term risk exposure.

Hands and feet were the most commonly injured body parts, which is consistent with the nature of physical labour in a cement factory and with other similar reports from the wider region (18, 19).

Our study has also identified machinery and falls as the most frequent causes of occupational injuries, which is in line with other similar studies (11, 18).

The analysis revealed that workers in the quarry area were more likely to sustain work-related injuries than workers in grinding, at the kiln, or in shipping and storage. Work at the quarry involves hazardous operations such as drilling, blasting, and extraction of raw material, and the rate of serious injuries in this area is alarmingly high, 26 %. This finding underscores the urgent need to improve safety measures in this high-risk environment.

In contrast, our respondents report a commendable level of occupational safety practices: 98.5 % had received safety training,

Table 3 Associations between independent variables and occupational injuries in cement factory workers in Chlef, Algeria (N=200)

Independent variable	Occupational injury		COR (95 % CI)	AOR (95 % CI)	P-value
	No	Yes			
Marital status					
Married	131	50	1	1	
Not married	16	3	0.49 (0.14–1.76)	1.28 (0.30–5.43)	0.73
Age					
>45	53	38	1	1	0.07
20–30	10	1	4.30 (2.13–8.69)	0.68 (0.05–8.68)	0.77
31–45	84	14	0.60 (0.07–5.06)	0.39 (0.18–0.87)	**0.02**
Education					
Primary school	42	25	1	1	0.09
Secondary school	36	9	2.16 (0.1.06–4.39)	0.35 (0.13–0.92)	**0.03**
University level	69	19	0.91 (0.37–2.21)	0.51 (0.21–1.24)	0.14
Working years					
<10	52	2	1	1	
>10	95	51	0.07 (0.02–0.031)	9.65 (1.73–53.95)	**0.01**
Use of PPE at work					
Always	145	51	1	1	
Sometimes	2	2	0.35 (0.05–2.56)	3.63 (0.29–45.49)	0.32
Area of operations					
Grinding	10	7	1	1	0.31
Kiln	9	2	3.50 (0.33–236.86)	0.31 (0.04–2.27)	0.25
Quarry	115	42	1.11 (0.08–15.53)	0.27 (0.08–0.96)	**0.04**
Shipping	8	1	1.83 (0.21–16.09)	0.17 (0.02–1.95)	0.16
Storage	5	1	0.63 (0.03–12.41)	0.21 (0.02–2.66)	0.23

AOR – adjusted odds ratio; CI – confidence interval; COR – crude odds ratio; PPE – personal protective equipment

99 % had regularly used personal protective equipment, and 97.5 % found their workplace behaviour improved after safety training. These findings indicate that despite the nearly universal adoption of safety training programs and the use of personal protective equipment the high prevalence of occupational injuries may be owed to other factors at both the worker and company level. These factors warrant further investigation to develop a more comprehensive approach to injury prevention in cement factories.

Study limitations

This research has certain limitations. The cross-sectional design might introduce recall bias, leading to possible misreporting of events. Furthermore, the data were collected from a single site and may not be generalised, especially considering the lack of similar research in cement factories in Algeria.

Additionally, the study did not assess the general health status of participants, including musculoskeletal diseases and previous injuries, which could increase the risk of occupational injury.

CONCLUSION

Regardless of its limitations, our study has identified key factors increasing the risk of occupational injuries in cement industry, at least in the Chlef factory, namely education, working years, and quarry operations. Quite expectedly, it has also identified upper and lower extremities as most at risk of injury. Moreover, long-term exposure to risks, rather than just inexperience, appears to be a significant contributor to workplace accidents, highlighting the need for a reassessment of ongoing safety training and monitoring for experienced workers.

Future research should explore how organisational factors such as workload, work hours, job stress, and the state of machinery contribute to the risk of occupational injuries. A mixed-method approach incorporating quantitative data and qualitative insights from workers and management could provide a more comprehensive view of occupational risks and safety practices. Expanding research to several cement plants in Algeria and other regions would also help contextualise these findings and guide policy improvements.

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Profesionalne ozljede i s njima povezani čimbenici u radnika tvornice cementa u alžirskom gradu Chlef

Iako je učestalost nezgoda u cementnoj industriji obično veća nego u drugim industrijskim granama i premda one značajno utječu na ukupnu invalidnost i oboljenja radnika, o njima se nedovoljno izvještava. Cilj našega presječnog istraživanja bio je procijeniti profesionalne ozljede i s njima povezane čimbenike u radnika tvornice cementa u gradu Chlef u Alžiru. U tu smo svrhu podijelili upitnik, na koji je odgovorilo 200 radnika koji su pristali sudjelovati u istraživanju. Utvrdili smo da su 53 radnika cementare (26,5 %) pretrpjela profesionalne ozljede, ponajviše na rukama (44 %) i nogama (38 %). Strojevi su prouzročili 39,6 % svih ozljeda, a padovi 26,4 %. Multivarijantna analiza pokazala je da su rad u kamenolomu, niži stupanj obrazovanja i duži radni staž značajno povezani s učestalosti ozljeda. Dugotrajna izloženost rizicima, a ne samo neiskustvo, upućuje na potrebu za revizijom obuke iz sigurnosti na radu i nadzora nad iskusnim radnicima. Buduća istraživanja također bi trebala odgovoriti na pitanje kako organizacijski čimbenici, kao što su radno opterećenje, radno vrijeme, stres i stanje strojeva, utječu na rizik od profesionalnih ozljeda. Pristup koji kombinira kvantitativne i kvalitativne podatke dobivene od radnika i uprava tvornica cementa u Alžiru i regiji mogao bi dati potpuniji uvid u profesionalne rizike i provedbu zaštite na radu te pomoći u boljem razumijevanju rezultata radi poboljšanja politike zaštite na radu.

KLJUČNE RIJEČI: cementara; nezgode; noge; osobna zaštitna oprema; padovi; presječno istraživanje; ruke; strojevi; zaštita na radu