

## Occupational Safety of Different Industrial Sectors in Khartoum State, Sudan Part 2: Analysis of Occupational Accidents

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### ABSTRACT

**Background:** Accident analysis is a tool which can be used to obtain accurate information about the combined accident factors that when fixed, prevent recurrence. It includes recording and documenting work-related injuries. It is carried out mainly for identifying unsafe working conditions and establishing program priorities. **Objective:** The study aimed to explore causes, factors, and outcomes of the occupational accidents during 2005-2007 in various industrial sectors of Khartoum State, Sudan. **Methods:** This was a cross-sectional study, the sample of which was selected to include all injured workers during the period from 2005-2007 in the industrial enterprises employing 50+ workers in Khartoum State, Sudan. The data were collected by reviewing accident records of both enterprises and Administration of Industrial Safety and by direct interviewing the injured workers using pre-designed questionnaires. **Results:** The caught in or between things represented the highest accident incidence rate. The machines were the major cause of accidents in Omdurman locality. In addition; machines were the main cause of amputation, crushing and broken bones (86.8%, 44.4% and 33.3%, respectively). Head injuries recorded the highest incidence rates in food and chemical industries. The defective or lack of appropriate equipment/tool recorded the highest percentage accidents in the engineering sector (58.6%). "Using defective equipment" and "failure to use the available equipment/tool" recorded the highest accidents' percentage in oils and soap industry (80%). **Conclusion:** The most frequent type of accident among injured workers in the different industrial sectors was the "caught in or between things" and the main cause of accidents was "machines." Enhancement of occupational safety and health laws and regulations is recommended. **Key words:** Accident analysis, accident type, unsafe acts, unsafe personal factors, unsafe workplace conditions.

### INTRODUCTION

The Health and Safety Executive (HSE) of UK defined an accident as "any unplanned event that resulted in injury or ill health of people, or damage to materials or equipment, plant, environment or a loss of business opportunity." The Occupational Safety and Health Administration (OSHA) recently modified the definitions of work-related injury

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and illness. Using the new definitions, the Bureau of Labor Statistics reported that there were 4.7 million nonfatal injuries and illnesses in private-industrial sectors occurred in 2002. This was equivalent to a rate of 5.3 cases per 100 full-time workers.<sup>(1,2)</sup> Worldwide, the average estimated number of fatal accidents was 350,000 in 1998. Although two-thirds of the global deaths from injuries occur in the developing world consuming substantial health sector resources, lethal occupational accidents are still underreporting in developing countries. They are usually reported by the insurance systems, which provide only partial coverage. Industrial sectors' fatality rate ranged from 13.4 to 26.4 in different regions in the world. In Sudan, this rate was 15.9. The comparison between developing and developed countries might be misleading, since developing countries rates are under estimated. Figures of accidents in developing countries are not based on a

convenient accident recording system. A study in the USA has illustrated that between 33% and 69% of all occupational injuries were missed from the reported injuries. Injuries result in major financial and productivity losses to nations while inflicting tremendous personal burden on the injured and their families.<sup>(3,4)</sup>

A variety of factors have been found to be responsible for accidents, either directly or indirectly. Unsafe acts such as failing to use protective devices or bypassing safety devices have caused most injuries according to National Safety Council. Consequently, safety training and reviewing rules and regulations have been largely effective when enforced. In an effort to reduce work-related injuries, many organizations have implemented behavior based safety processes. Safe working conditions are a part of the normal quality and production management. Providing safe work is an investment in the human resources and skills of the work force at the

enterprise in quality and productivity. Sustainable and cost-effective improvement of working conditions has to be based on cooperation between employers and workers at the enterprise.<sup>(5,6)</sup>

Accident analysis is a tool, which can be used to obtain accurate and objective information about the types and causes of the previous accidents that when fixed, prevent recurrence of similar events.<sup>(7)</sup> The process of recording and documenting work-related injuries, are carried out mainly for the purpose of identifying unsafe and unhealthy working conditions and establishing program priorities.<sup>(8,9)</sup>

The aim of this study was to explore causes, factors, and out-comes of the occupational accidents that occurred during 2005-2007 in various industrial sectors of Khartoum State, Sudan. Data from this study might be a valuable resource to design OSH programs in different Sudanese industries to prevent

recurrence of similar accidents.

## **MATERIAL AND METHODS**

Across- sectional study was used. The sample included all occupationally injured workers in enterprises employing 50+ workers to be sure that the OHS services should be applicable by low Data were collected by reviewing the accident records of the enterprises and of administration of industrial safety and health- Ministry of Manpower. In addition, direct interview with injured workers using a pre-designed questionnaire was carried out. All labor accidents that were recorded in each of the three localities of the Khartoum state (Khartoum, Omdurman and Bahrain) during the period from 2005 to 2007, were investigated. The sample size was 371 injured workers employed in 90 enterprises (28%, n=320) employing 10504 workers (55.6%, n=18878).

A tailor made questionnaire was designed, evaluated and corrected for interviewing injured workers. The questionnaire

included data about the accident such as accident location, time, type, cause, and the injured body part. In addition, data about accident outcome, and management procedures followed were also contained within the questionnaire.<sup>(10)</sup> Verbal consents of the participants were obtained after explaining the research objectives and benefits. Accident incidence rate was calculated using the following equation:<sup>(10)</sup>

$$\text{Accident Incidence rate} = \frac{\text{Number of injured workers}}{\text{Total number of workers}} \times 1000$$

Data were coded, entered and analyzed using Statistical Package for Social Science (SPSS) version 13. The correlation between different variables was tested. Statistical tests used were significance tests and cross tabulation.

## RESULTS

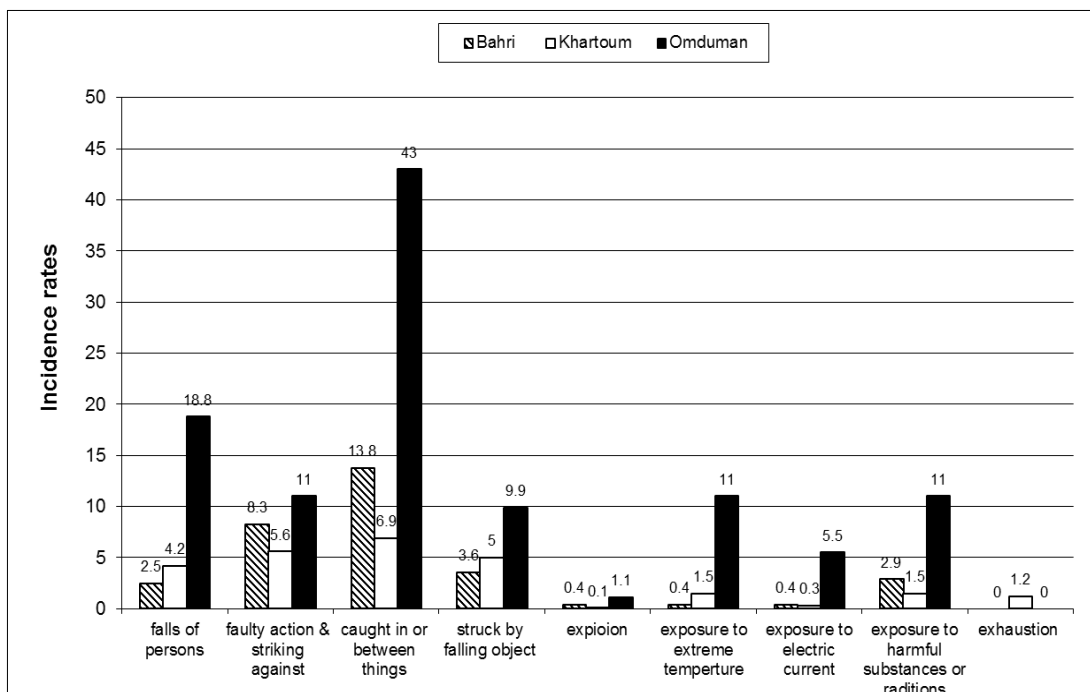
Figure 1 shows the accident incidence rate of the different types of accidents in the three localities. The "caught in or

between things "had the highest incidence rate in Omdurman (43/1000 workers), and Bahari (13.8/1000 workers), while the "falls "had the maximum incidence rate in Khartoum locality (18.8/1000 workers). On the other hand, it was obvious from the distribution of incidence rate according to accident causes in the three localities that accidents caused by machines had the highest incidence in Omdurman (44/1000 workers) and Bahari (18.5/1000 workers) as clear in figure 2.

Table1 shows the distribution of accidents according to their causes and outcome. It is clear from the table that machines were the major cause of amputation, crushing, and broken bones (86.8%, 44.4% and 33.3%, respectively). Transportation was the chief cause of brain concussion, bruises and cuts, lacerations and punctures (100%, 50%, and 30%, respectively). Furthermore, equipment was the main cause of damage to the body system and burns from a heat source

(100% and 50.5%, respectively). Hazardous materials were the key cause of burns from a chemical source, illness and death (100%, 50% and 28.6%, respectively). Finally, environmental conditions, as one of

the chief factors mentioned by injured workers, such as defective lighting and heat were the major cause of sprain and stress (30.3%).



**Figure 1. Distribution of incidence rate according to the type of accidents in different localities**

Table 1. Distribution of accidents according to their outcome and causes

Outcome	Causes <sup>a</sup>				
	Machines	Transportation	Environment	Equipment	Hazardous material
Amputation	86.8	3.9	0.0	4.3	5.0
Broken bone	33.3	18.1	0.2	23.2	10.2
Bruise	10.0	50.0	0.0	10.0	30.0
Heat burn	4.5	23.0	22.0	50.5	0.0
Chemical burn	0.0	0.0	0.0	0.0	100.0
Concussion	0.0	100.0	0.0	0.0	0.0
Crushing	44.4	33.4	0.0	11.1	11.1
Cut, lacer	25.0	30.0	5.6	25.0	14.4
Illness	9.8	7.8	21.6	19.6	41.2
Sprain, Strain	13.3	16.7	30.3	23.3	16.4
Damage to body	0.0	0.0	0.0	100.0	0.0
Death	21.4	21.4	14.3	14.3	28.6

<sup>a</sup>Values are expressed as %

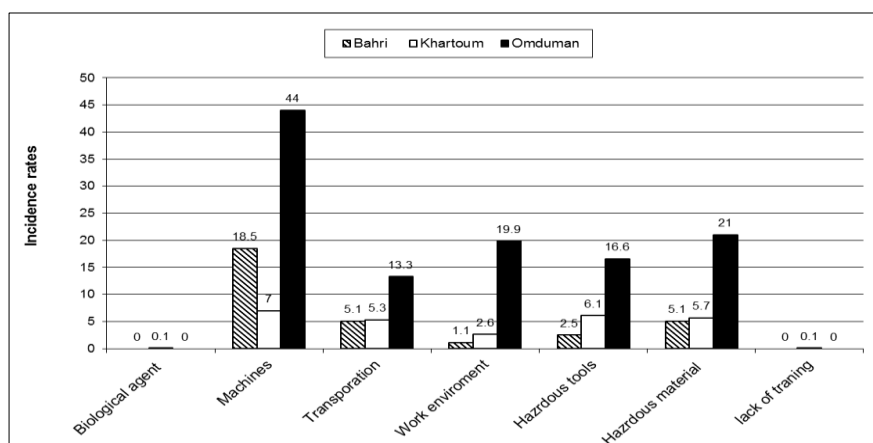
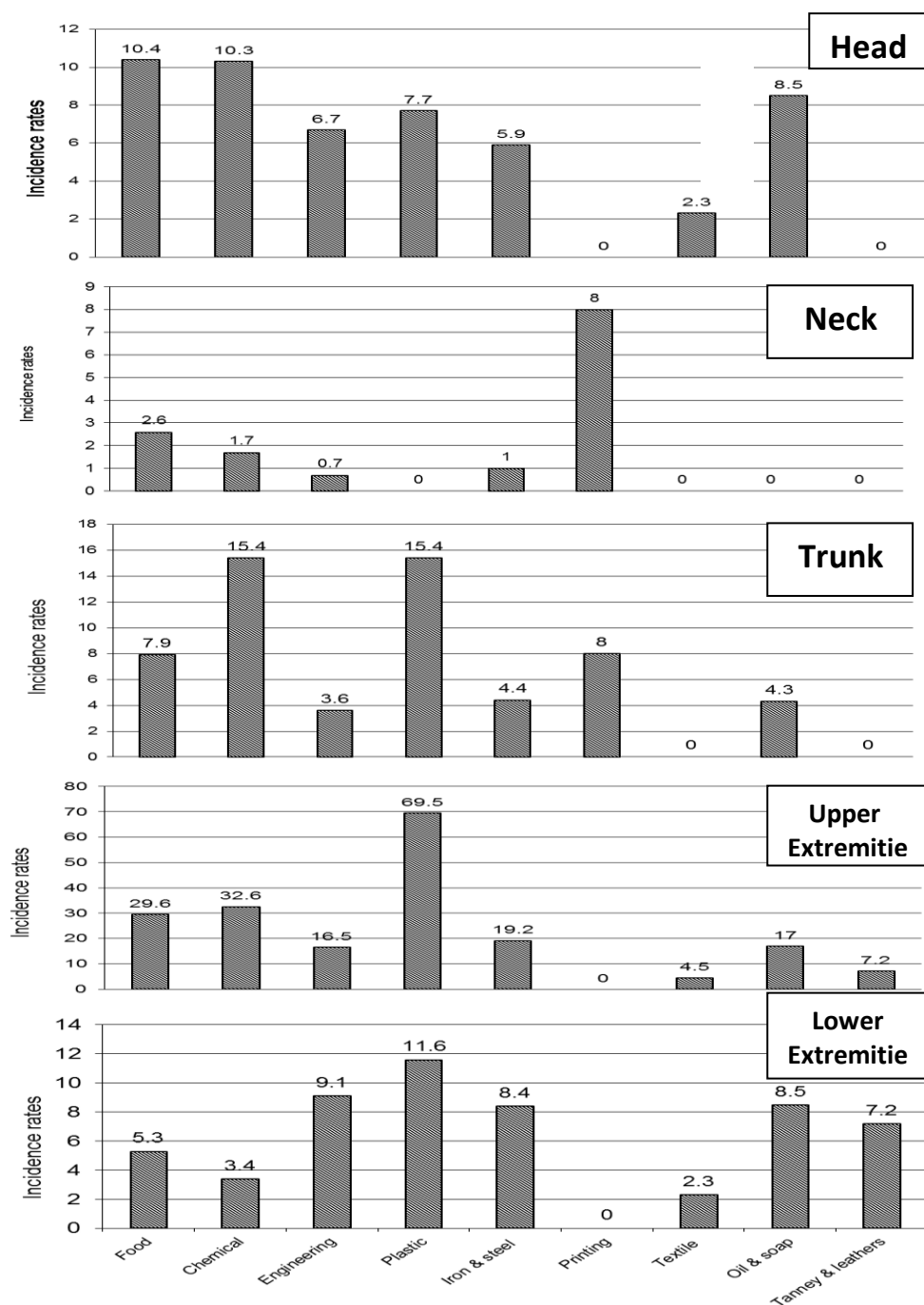


Figure 2. Distribution of incidence rate according to accident causes by localities

The distribution of the incidence rate according to the body location of injury is obvious in figure 3. It is apparent that head injuries had the highest incidence rates in food and chemical industries (10.4 and 10.3, respectively). Neck injuries recorded the maximum incidence rate in printing industry (8), while trunk injuries recorded the uppermost incidence rates in chemical and plastic industries (15.4 each). Finally, the upper and lower extremities' injuries recorded the highest incidence rate in plastic industry (69.5 and 11.6, respectively), figure 3.

The distribution of injured workers according to the accident outcome as related to the type of industry is noticeable

in table 2. The table shows that food industry was of the highest percentage of "amputation" and "broken bones" (28% each). The engineering industry represented the highest percentage of "broken bones" (43%) and "cuts, lacerations and punctures" (33%). Chemical industry had the uppermost percentage of "amputation" and "illness" (20.7% each), while in iron and steel industry, the supreme percentage was for "cuts, lacerations, punctures" (33.8%) and "broken bones" (36.8%). Finally, in oils and soap industry, the highest percentage was for "broken bones" (40%), and "cuts, lacerations and punctures" (33.3%).



**Figure3. Distribution of incidence rate of injured body parts among different industrial sectors.**



**Table 2. Distribution of accidents in different industrial sectors according to the accident outcome**

Sector	No of accidents	Accidents Outcomes <sup>a</sup>											
		(1) (%)	(2) (%)	(3) (%)	(4) (%)	(5) (%)	(6) (%)	(7) (%)	(8) (%)	(9) (%)	(10) (%)	(11) (%)	(12) (%)
<b>Food</b>	93	26* (28.0)	26 (28.0)	2 (2.2)	12 (12.9)	1 (1.1)	0 (0.0)	2 (2.2)	21 (22.6)	17 (18.3)	8 (8.6)	0 (0.0)	4 (4.3)
<b>Chemical</b>	29	6 (20.7)	11 (37.9)	1 (3.4)	1 (3.4)	1 (3.4)	0 (0.0)	1 (3.4)	5 (17.2)	6 (20.7)	3 (10.3)	0 (0.0)	2 (6.9)
<b>Engineering</b>	133	25 (18.8)	57 (43.0)	5 (3.8)	3 (2.3)	0 (0.0)	2 (15.0)	3 (2.3)	44 (33.0)	14 (10.5)	12 (9.0)	0 (0.0)	5 (3.8)
<b>Plastic</b>	15	6 (40.0)	9 (60.0)	2 (13.3)	2 (13.3)	1 (6.7)	0 (0.0)	1 (6.7)	7 (46.7)	3 (20.0)	2 (13.3)	0 (0.0)	1 (6.7)
<b>Iron and Steel</b>	68	12 (17.6)	25 (36.8)	0 (0.0)	4 (5.9)	0 (0.0)	0 (0.0)	1 (1.5)	23 (33.8)	6 (8.8)	4 (5.9)	1 (1.5)	1 (1.5)
<b>Oils and Soap</b>	15	1 (6.7)	6 (60.0)	0 (0.0)	0 (0.0)	3 (20.0)	0 (0.0)	1 (6.7)	5 (33.3)	2 (13.4)	1 (6.7)	0 (0.0)	0 (0.0)
<b>Others</b>	8	0 (0.0)	5 (62.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (37.5)	3 (37.5)	0 (0.0)	0 (0.0)	1 (12.5)
<b>Total</b>	371	76 (20.5)	138 (37.2)	10 (2.7)	22 (5.9)	6 (1.6)	2 (0.5)	9 (2.4)	108 (29.1)	51 (13.7)	30 (8.1)	1 (0.3)	14 (3.8)
		.579	.309	.42	.103	.002*	.683	.662	.382	.111	.985	.390	.275

Fisher's Exact T(1)= (4)=Heat burn. (7)= Crushing Injury. (10)= Sprain, strain.  
 Amputation (5)= Chemical burn. (8) = Cut, laceration, puncture. (11)= Damage to a body system.  
 (2)=Broken bone (3)= (6)= Brain concussion (9)= Illness. (12)= Death  
 Bruise )= Bruise

<sup>a</sup>An accident may have more than one outcome.

Tables 3 A, B and C represent the accident analysis according to the unsafe workplace conditions, unsafe acts and unsafe personal factors, respectively. The unsafe workplace conditions included "inadequate guard," "unguarded hazard," "defective safety device," "defective or lack of tool or equipment," "hazardous workstation layout," "unsafe ventilation or lighting," "lack of personal protective equipment (PPE) and unsafe clothing," and "lack of or insufficient training." In engineering industry, the maximum percentage of accidents was associated with "defective or lack of appropriate equipment/tools" (58.6%); while in chemical industry; it was associated with "hazardous workstation layout" (51.7%). Lastly, accidents related to "lack of needed PPE" recorded the highest percentage in plastic industries (68%) as obvious in table 4 A. The Unsafe acts included "operating without permission," "operating at an unsafe speed," "using defective equipment and failure

to use the available equipment/tools," "unsafe lifting by hands and taking an unsafe position or posture," "distraction, teasing, horseplay," and "failure to wear PPE." Clearly, accidents associated with the "use of defective equipment," and "failure to use the available equipment/tool" recorded the highest percentage in oils and soap sector (80%), as apparent in table 4B. Finally, the accidents associated with workers' attitude as an unsafe personal factor recorded the highest percentage in "iron and steel," and plastic industries (100% for each) as obvious in table 4C. According to accident records, 201 injured workers (54.2%) were subjected to first-aid medical treatment, while 365 injured workers (98.4%) were hospitalized. Furthermore, 346 injured workers (93.3%) had received occupational health services (OHS) before employment. These services included pre-employment medical examination, training on job duties and training on occupational safety and health (OSH) aspects.

Table 4 shows the distribution of injured workers according to the types of available PPE. It had been noticed that protective clothing and gloves recorded the maximum percentage in plastic industry (96%). Safety shoes recorded the upper most percentage in iron and steel industry (83.8%), While respiratory protection recorded the highest percentage in chemical industry (82.8%).

Table 5 represents the distribution of injured workers according to the available OHS services after employment. The first aid box and fire extinguishers were the most commonly available OHS in chemical industry (96.6% each).

**Table 3A: Distribution of injured workers according to Accident Analysis (Unsafe workplace conditions)**

Sector	No of accidents	Unsafe workplace conditions							
		(1) (%)	(2)(%)	(3) (%)	(4) (%)	(5)(%)	(6)(%)	(7) (%)	(8)(%)
<b>Food</b>	93	31 (33.3)	15 (16.1)	11 (11.8)	49 (52.7)	37 (39.8)	10 (10.8)	41 (44)	0 (0)
<b>Chemical</b>	29	10 (34.5)	4 (13.8)	1 (3.4)	12 (41.4)	15 (51.7)	1 (3.4)	18 (62)	0 (0)
<b>Engineering</b>	133	18 (13.5)	24 (18)	10 (34.5)	78 (58.6)	45 (33.8)	4 (3)	79 (59.4)	1 (0.8)
<b>Plastic</b>	25	7 (28)	6 (24)	1 (4)	13 (52)	11 (44)	1 (4)	17 (68)	0 (0)
<b>Iron &amp; Steel</b>	68	8 (11.8)	11 (16.2)	10 (14.7)	24 (35.3)	32 (47.1)	0 (0)	42 (61.8)	1 (1.5)
<b>Oils &amp; Soap</b>	15	2 (13.3)	4 (26.7)	6 (40)	5 (33.3)	3 (20)	1 (6.7)	7 (46.7)	0 (0)
<b>Others</b>	8	2 (25)	0 (0)	2 (25)	4 (50)	3(37)	0 (0)	2 (25)	0 (0)
<b>TOTAL</b>	371	78 (21)	64 (17.3)	41 (11.1)	185 (49.9)	146 (39.4)	17 (4.6)	206 (55.5)	2 (0.5)
<b>P</b>		0.002*	0.927	0.025*	0.032*	0.140	0.081	0.017*	0.822

P: P value based on Fisher exact probability

(1)= Inadequate guard.

(3)= Safety device is defective.

(5)= Workstation layout is hazardous.

(7)= Lack of needed personal protective equipment and unsafe clothing.

\* P < 0.05 (significant)

(2)= Unguarded hazard.

(4)= Tool or equipment defective&Lack of appropriate equipment / tools.

(6)= Unsafe ventilation – Lighting.

(8)= No training or insufficient training.

**Table 3B: Distribution of injured workers according to Accident Analysis (Unsafe acts)**

Sector	No of accidents	Unsafe act					
		(1) (%)	(2) (%)	(3) (%)	(4) (%)	(5) (%)	(6) (%)
Food	93	7 (7.5)	1 (1.1)	52 (55.9)	52 (55.9)	1 (1.1)	7 (7.5)
Chemical	29	1 (3.4)	3 (10.3)	14 (48.3)	13 (44.8)	0 (0)	0 (0)
Engineering	133	6 (4.5)	11 (8.3)	90 (67.7)	59 (44.4)	2 (1.5)	1 (0.8)
Plastic	25	4 (16)	1 (4)	14 ( 56)	13 ( 52)	0 (0)	0 (0)
Iron & Steel	68	5 ( 7.4)	15 ( 22.1)	27 ( 39.7)	28 ( 41.2)	0 (0)	0 (0)
Oils & Soap	15	0 (0)	0 (0)	12 (80)	4 (26.7)	0 (0)	0 (0)
Others	8	0 (0)	0 (0)	4(50)	4 (50)	0 (0)	0 (0)
<b>TOTAL</b>	<b>371</b>	<b>23 (6.2)</b>	<b>31 (8.4)</b>	<b>213 (57.4)</b>	<b>173 (46.6)</b>	<b>3 (0.8)</b>	<b>8 (2.2)</b>
<b>P</b>		<b>0.539</b>	<b>0.001*</b>	<b>0.002*</b>	<b>0.243</b>	<b>0.898</b>	<b>0.071</b>

P: P value based on Fisher exact probability

\* P &lt; 0.05 (significant)

(1)= Operating without permission.

(2)= Operating at unsafe speed.

(3)= Using defective equipment &amp; Failure to use the available equipment/ tools.

(4)= Unsafe lifting by hand &amp; Taking an unsafe position or posture.

(5)= Distraction, teasing, horseplay.

(6)= Failure to wear personal protective equipment.

**Table 3B: Distribution of injured workers according to Accident Analysis (Unsafe acts)**

Sector	No of accidents	Unsafe act					
		(1) (%)	(2) (%)	(3) (%)	(4) (%)	(5) (%)	(6) (%)
Food	93	7 (7.5)	1 (1.1)	52 (55.9)	52 (55.9)	1 (1.1)	7 (7.5)
Chemical	29	1 (3.4)	3 (10.3)	14 (48.3)	13 (44.8)	0 (0)	0 (0)
Engineering	133	6 (4.5)	11 (8.3)	90 (67.7)	59 (44.4)	2 (1.5)	1 (0.8)
Plastic	25	4 (16)	1 (4)	14 ( 56)	13 ( 52)	0 (0)	0 (0)
Iron & Steel	68	5 ( 7.4)	15 ( 22.1)	27 ( 39.7)	28 ( 41.2)	0 (0)	0 (0)
Oils & Soap	15	0 (0)	0 (0)	12 (80)	4 (26.7)	0 (0)	0 (0)
Others	8	0 (0)	0 (0)	4(50)	4 (50)	0 (0)	0 (0)
<b>TOTAL</b>	<b>371</b>	<b>23 (6.2)</b>	<b>31 (8.4)</b>	<b>213 (57.4)</b>	<b>173 (46.6)</b>	<b>3 (0.8)</b>	<b>8 (2.2)</b>
<b>P</b>		<b>0.539</b>	<b>0.001*</b>	<b>0.002*</b>	<b>0.243</b>	<b>0.898</b>	<b>0.071</b>

P: P value based on Fisher exact probability

\* P &lt; 0.05 (significant)

(1)= Operating without permission.

(2)= Operating at unsafe speed.

(3)= Using defective equipment &amp; Failure to use the available equipment/ tools.

(4)= Unsafe lifting by hand &amp; Taking an unsafe position or posture.

(5)= Distraction, teasing, horseplay.

(6)= Failure to wear personal protective equipment.

**Table 3C: Distribution of injured workers according to Accident Analysis (Unsafe personal factors)\***

Sector	No of accidents	Unsafe personal factors		
		Attitude (%)	Inadequate knowledge & inadequate skills (%)	Inadequate supervision (%)
Food	93	89 ( 95.7)	13 ( 14)	21 ( 22.6)
Chemical	29	28 ( 96.6)	4 ( 13.8)	3 ( 10.3)
Engineering	133	126 ( 94.7)	17 ( 12.8)	13 ( 9.8)
Plastic	25	25 ( 100)	4 ( 16)	1 ( 4)
Iron & Steel	68	68 ( 100)	2 ( 2.9)	7 ( 10.3)
Oils & Soap	15	13 ( 86.7)	0 (0)	2 ( 13.3)
Others	8	6 (75)	1 (12.5)	1 (12.5)
<b>TOTAL</b>	<b>371</b>	<b>355 (95.7)</b>	<b>41 (11.1)</b>	<b>48 (12.9)</b>
<b>P</b>		<b>0.017*</b>	<b>0.143</b>	<b>0.086</b>

P: P value based on Fisher exact probability

\* P &lt; 0.05 (significant)

\* More than one of unsafe personal factors has been present in the same accident

**Table 4: Distribution of injured workers according to the available types of PPE**

Sector	injured workers	Available types of PPE <sup>a</sup>							
		(1) (%)	(2) (%)	(3) (%)	(4) (%)	(5) (%)	(6) (%)	(7) (%)	(8) (%)
Food	93	84 (90.3)	4 (4.3)	2 (2.2)	0 (0.0)	80 (86.0)	53 (57.0)	10 (10.8)	52 (55.9)
Chemical	29	27 (93.1)	1 (3.4)	8 (27.6)	0 (0.0)	26 (89.7)	16 (55.2)	0 (0.0)	24 (82.8)
Engineering	133	120 (90.2)	29 (21.8)	35 (26.3)	7 (5.3)	102 (76.7)	101 (75.9)	25 (18.8)	68 (51.1)
Plastic	25	24 (96.0)	0 (0.0)	2 (8.0)	0 (0.0)	24 (96.0)	13 (52.0)	2 (8.0)	20 (80.0)
Iron and Steel	68	63 (92.6)	27 (39.7)	24 (35.3)	4 (5.9)	61 (89.7)	57 (83.8)	7 (10.3)	36 (52.9)
Oils and Soap	15	11 (73.3)	1 (6.7)	1 (6.7)	0 (0.0)	11 (73.3)	4 (26.7)	2 (13.3)	6 (40.0)
Others	8	7 (87.5)	0 (0.0)	1 (12.5)	0 (0.0)	3 (37.5)	3 (37.5)	1 (12.5)	6 (75.0)
Total	371	336 (90.6)	62 (16.7)	73 (19.7)	11 (3)	326 (87.9)	247 (66.6)	47 (12.7)	213 (57.4)
P		0.138	0.000*	0.000*	0.230	0.000*	0.000*	0.115	0.056

<sup>a</sup> More than one type of PPE may be available

(1)= Protective clothing.

(3)= Protective glasses.

(5)= Gloves.

(7)= Ear plugs/muffs.

(2)= Helmets.

(4)= Face shield.

(6)= Safety shoes.

(8)= Respiratory protection

**Table 5: Distribution of injured workers according to available OHS services after employment**

Sectors	No of accidents	Occupational Health & Safety services <sup>a</sup>						
		(1) (%)	(2) (%)	(3) (%)	(4) (%)	(5) (%)	(6) (%)	(7) (%)
Food	93	85 (91.4)	2 (2.2)	85 (91.4)	58 (62.4)	0 (0.0)	40 (43.0)	0 (0.0)
Chemical	29	28 (96.6)	0 (0.0)	28 (96.6)	22 (75.9)	0 (0.0)	13 (44.8)	0 (0.0)
Engineering	133	123 (92.5)	3 (2.3)	123 (92.5)	52 (39.0)	1 (0.8)	42 (31.6)	2 (1.5)
Plastic	25	24 (96.0)	0 (0.0)	24 (96.0)	18 (72.0)	0 (0.0)	9 (36)	1 (4.0)
Textile	4	4 (100.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	3 (75.0)	0 (0.0)
Oils & Soap	15	13 (86.7)	0 (0.0)	13 (86.7)	3 (20.0)	0 (0.0)	9 (60.0)	0 (0.0)
Others	8	7 (87.5)	0 (0.0)	7 (87.5)	0 (0.0)	0 (0.0)	4 (50.0)	0 (0.0)
Total	371	343 (92.5)	5 (1.3)	343 (92.5)	197 (53.1)	1 (0.3)	165 (44.5)	8 (2.2)
P		0.473	0.731	0.993	0.000*	0.731	0.000*	0.114

(1)= First Aid box (2)=Clinic (3)= Fire extinguishers (4)= Emergency Exits (5)= Alarm bells (6)= Bathrooms

(7)= Rest rooms

<sup>a</sup>More than one type of OHS services may be available

## DISCUSSION

It was apparent that Omdurman locality recorded the highest accident incidence rates. The "caught in or between things" and "fall" were the accident types of the maximum incidence rate in Omdurman locality compared with the other two localities. Machines were the major cause of accidents leading to "amputation," "broken and crushed bones." The transportations were the main cause of accidents and resulted in bruises, brain concussion, cuts and lacerations.

"Caught in or between things," "faulty action," and "striking against falling objects" were main types of accidents in all industries. Similar findings were stated in many researches, which indicated that machines were the major cause of work-related accidents (23.9%-29.4%) compared to 36.3% in the present study.<sup>(11-14)</sup>

Head injuries had the highest incidence rate in food and chemical industries. Neck injuries had the highest

incidence rate in printing industry, Trunk injuries had the highest incidence rate in chemical and plastic industries, Upper and lower extremities' injuries had the highest incidence rate in plastic industry, All of these might be due to the unsafe work condition, lack of PPE, and bad housekeeping.

The exposure to temperature in industrial processes in these industries may lead to increase accidents. Observed slippery floors had led to fall of workers. The study conducted in Nigeria reported that the proportion of trunk accidents was high (57.8%), which had been attributed mainly to the unsafe work conditions and lack of PPE<sup>(15)</sup> which was similar to the findings of the present study.

A similar result was obtained in a study conducted in Addis Ababa where the most common body parts affected among eleven industrial sectors were the upper extremities (49%).<sup>(16)</sup>

Amputation, as an accident outcome recorded the highest percentage in the food, plastic and chemical industries. Broken bones recorded the maximum percentage in oils and soap industry. this might be due to lack of training and lack of supervision, especially in engineering, plastic, iron and steel and oils and soap industries. These findings were in agreement with the study conducted in New York in 1974, which reported that the unsafe workplace conditions were the main cause of an accident.<sup>(17)</sup>

The most frequent unsafe acts by workers were using defective equipment and failure to use the perfect equipment/tools, especially in oils and soap, engineering and food industries. This might be due to the lack of regulations of occupational health and safety in Sudan. As regards unsafe personal factors, attitude had the highest percentage in all industrial sectors. This might be due to the bad psychological conditions, including

poor wages. Critical incidents and accidents were caused by a combination of equipment and unsafe personal factors. Several studies revealed that unsafe personal factors constituted the main factors of accidents. Most researchers believed that unsafe personal factors were the key agent for more than 70% of occupational accidents.<sup>(18, 19)</sup>

The first aid box and the fire extinguishers were the services most frequently available in all sectors, except in oils and soap industry. This might be due to the free distribution of the first aid box by some organizations to all factories in Khartoum state, and forcing employers, by the civil defense administration, to fight fire accidents by the provision of the fire extinguishers and training the workers to use them. Protective clothing was available in all industrial sectors, except oils and soap industry. Despite the high availability of PPE in the majority of industrial sectors, it seemed to be of low grade or the workers

were neither enforced to wear them nor trained on their proper usage. This might explain the high injury claims of workers at some industrial sectors at which personal protective equipment was available.

The aforementioned findings might be a valuable resource for designing an occupational health and safety plan in Khartoum State, Sudan. It is worth noting that there is a severe lack of such data in Sudan. This might be due to the primitive manual industrial technology applied at Omdurman locality in comparison to Khartoum Locality.

Khartoum state is the capital of Sudan, which attracts investments due to availability of services and improved technology.

The present study highlighted many pitfalls in accident recording in Sudan, mainly lack of laws and regulations on occupational safety and health in Khartoum State, Sudan. These Pitfalls include, lack of adequate training for safety officials of

occupational safety and health, contributed directly to poor intervention in working environment, the absence of an effective system for recording injuries and accidents, and finally, lack of or improper periodic inspections of establishments and lack of modern equipment for inspection.

## **CONCLUSION**

The most frequent type of accident among injured workers in the different industrial sectors was the "caught in or between things," and the main cause of accidents was "machines" which represented the majority of accident causes.

## **RECOMMENDATIONS**

The enhancement of laws and regulations on occupational safety and health is recommended. Moreover, the coordination between Ministries of Health, Environment, Labor, Industry, and the relevant factories is urgently needed. Training of industrial safety officers and workers, periodic machinery maintenance,



periodic inspections of establishment and pre-employment and periodic medical examination for all workers are also important.

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