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ORIGINAL RESEARCH

A descriptive, cross-sectional analysis of occupational upper limb injuries at a tertiary trauma centre in Dar es Salaam, Tanzania

Running title – Dar es Salaam, Tanzania: Occupational upper limb injuries

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Abstract

Background: The rise of occupational traumatic upper limb injuries, especially in the developing world, has largely been attributed to industrialisation. Inadequate occupational injury reporting systems and occupational health policies in the sub-Saharan region have resulted in limited research and publication on occupational traumatic upper limb injuries. The primary aim of this study was to assess the pattern and presentation of occupational traumatic upper limb injuries that were treated at Muhimbili Orthopaedic Institute, a tertiary hospital in Dar es Salaam, Tanzania.

Methods: This was a descriptive, cross-sectional, hospital-based study. All patients with occupational traumatic upper limb injuries were included. Data were collected using a structured questionnaire. Univariate analysis was used for categorical variables. Mean, range and standard deviation was used to analyse continuous variables. Statistical significance was determined in all relevant associations.

Results: A total of 74 patients were enrolled of whom 94.5% were males. The prevalence of occupational traumatic upper limb injuries in trauma patients was 2.9%. The mean age was 31.2 years. A large proportion (41.9%) of the patients were transport and distribution workers. Motor vehicle crashes were the most common cause of injury (40.5%) followed by heavy machinery injury (25.6%). The hand was the most common site of injury (47.3%). Fractures were the most observed injuries (85.1% of the patients). Heavy machine operators & assemblers were more likely to obtain high grade soft tissue injuries ($p<0.0001$) and suffer traumatic amputations ($p<0.0001$).

Conclusions: Males of productive age group were more affected by occupational injuries, many of whom were in the transportation industry. Heavy machine operators were more susceptible to severe soft tissue injuries with limb loss and thus calling for interventions from occupational safety and health authorities.

Keywords: occupational upper limb injuries, work-related trauma and disease, occupational health, Tanzania

Introduction

Tanzania's economic activities have expanded, increasing occupational injuries among workers in different sectors of the economy [(1)(2)]. In 2014, the total population employed in formal sectors in Tanzania mainland was

approximately 2,141,351 (61.4% males) [3]. Progress has been demonstrated in multiple sectors including, transport, construction and industrialisation [3].

According to the International Labour Organisation, an occupational injury is defined as any personal injury resulting from an occupational accident. Occupational injuries arise from trauma and accidental exposure to occupational hazards such as temperature, blood-borne pathogens, hazardous chemicals, radiation, and occupational burnout [4]. Despite the preventive methods set in place, injuries still occur due to poor ergonomics, manual handling of heavy loads, misuse or failure of equipment and inadequate safety training [4].

Work-related upper extremity injuries include both acute (cuts, fractures and burns) and chronic health problems (carpal tunnel syndrome and tendinitis). They carry personal and communal, medical, and economic consequences, because they mainly affect young workers at productive ages [5] [6]. These consequences lead to deterioration in the health-related quality of life over time [7]. According to the International Labour Organization (ILO), the global mortality in 2008 from fatal occupational accidents was 321,000 [8].

There is little information on work-related injuries and a deficiency of systems to actively and regularly collect data in the sub Saharan region. The relevance of compensation agencies and labour inspectorate authorities in obtaining occupational injury information can't be overemphasized [2]. According to estimates, almost 18,000 workers are killed in work-related accidents in the Southern African region per year, more than 13 million are injured in accidents, and 67,000 contract occupational diseases [9].

The Occupational Safety and Health Authority (OSHA) is responsible for setting and enforcing occupational safety laws and standards in Tanzania [1] [10]. Tanzania's comprehensive nationally coordinated occupational health and safety research strategy has not been very effective [2]. There have been inadequate accident investigations and poor capacity to perform long-term research to support standard setting recommendations [2][10][11]. The main aim of this study was to explore the pattern and presentation of occupational traumatic upper limb injuries in patients managed at Muhimbili Orthopaedic Institute, located in Dar es Salaam, Tanzania.

Methods

Study design, duration and setting

This was a descriptive cross-sectional hospital-based study conducted at Muhimbili Orthopaedic Institute (MOI), the largest orthopaedic and trauma referral centre with a 362 bed capacity, located in Dar es Salaam, Tanzania. The study period was from July 2019 to January 2020.

Study population, sampling method, inclusion and exclusion criteria

Patients aged 18 years and above, who presented with traumatic occupational upper limb injuries at MOI for management and consented to participate in the study were included. Unconscious patients were excluded.

All patients with occupational traumatic upper limb injuries during the study period were included. Kish and Lisle formula (1965) was used to calculate a minimum sample size of 62 patients.

Data collection and management

A structured questionnaire was created using Google Forms (https://google.com/forms/). The researcher interviewed the patients while filling in the questionnaire using an electronic tablet. The questionnaire was tested for four weeks, while making the necessary changes, to determine the validity of the questions. Information was gathered from the patient's history, medical records, radiological images and operation notes.

The Occupational Injury and Illness Classification System [23] was adopted to describe mechanism of the injury, site of injury and source of the injury. Fractures were described by bone involved and pattern observed [24]. The Oestern and Tscherne classification system [25] was used to classify soft tissue injuries.

The data collected was recorded in Microsoft Office Excel (Microsoft Corp., Redmond, WA, USA) and exported to SPSS Statistics for Windows version 25 (IBM Corp., Armonk, NY, USA) for analysis. Univariate analysis and descriptive statistics were used to analyse and present the data. Chi-square, Fischer's Exact test and Relative Risk were used to determine strength of associations between variables. P value <0.05 was considered significant.

Ethical consideration

Ethical clearance was obtained from MOI Ethics Board. Patients' confidentiality was maintained during and after the study, only the researchers had access to patients' information, which was stored in a secure laptop. All patients signed informed consent forms (available in native Swahili and English languages) and were allowed to withdraw at any time with no impact or influence on their clinical management.

Results

1. Socio-demographic characteristics of the patients

Table 1 summarises the socio-demographic characteristics of the patients studied. A total of 74 patients who sustained traumatic occupational upper limb injuries were enrolled. The mean age was 31.2 years (standard deviation 7.8), with a minimum age of 18 years and a range of 40 years. Males were predominant (94.5%), giving a male to female ratio of 17:1. The prevalence of traumatic occupational upper limb injuries among all trauma patients was 2.9%.

2. Occupational characteristics and causes of injury of the patients

As observed in Table 2, the patients worked in the transportation (41.9%), manufacturing (28.3%), construction (18.9%) and security (8.1%) sectors. Most patients (79.7%) were working less than 48 hours per week. Occupation safety training had been given to 53 workers (68.4%). Day shift work was noted in 52.7% of the study subjects and 20.3% worked at night while 27.3% had non-specific working hours.

The common causes of injury included motor vehicle crashes (40.5%), heavy machinery injuries (25.7%), slip and falls from heights (13.5%), assault with weapons (9.5%) and injuries by heavy falling objects (8.1%).

3. Site and pattern of injury of the patients

Table 3 summarises the sites and types of injuries. The hand was the most dominant site of injury, seen in 35 patients (47.3%). The right hand was injured in 54.3% of hand injuries, and right hand dominance was seen in 82.9% of all hand injuries. [*Association significance between the right-hand dominance and right-hand injury was also calculated (Fisher's Exact Test p. value=0.187).*].

There were 58 finger injuries observed, with middle finger injury occurring in 29.3% of these injuries. [*Association significance between hand injury and middle finger injury was also calculated (Fisher's exact test value p. value=0.104).*]

Fractures were the most common types of injuries recorded in 85.1% of the study subjects and the majority were open fractures (65.1%). A total of 104 different fractures were seen in 63 patients, 37.5% occurring on the phalanges (commonest was AO 78.4.2.3C at 10.8%), 21.2 % on the radius (47.4% were AO 2R3C) and 16.3% on the humerus (26.7% AO 12A). Oestern and Tscherne Grade 2 soft tissue injury was dominant in both open fractures (58.6% of the cases) and closed fractures (63.6% of the cases).

Dislocations were encountered in 18 patients, and 66.7% were classified as simple dislocations. The majority of the dislocations were of the shoulder (33.3%), distal radio-ulnar (27.7%) and elbow (16.7%) joints. Traumatic amputations were seen in 10 cases (13.5%), with 80% affecting the fingers. Other serious but infrequent injuries included tendon, de-gloving and crush injuries.

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Open fractures were observed more in plant and machine operators and assemblers [*p<0.001 and relative risk=2.12 (C.I. 1.594-2.818)*], who also had higher grade of soft tissue injuries (Grade 3 and above) [*p<0.001 and relative risk=6.310 (C.I. 2.833-14.050)*]. Traumatic amputations [*p<0.0001, and relative risk=10.095 (C.I. 2.333-43.677)*] and crush injuries [*p=0.017, and relative risk=6.310 (C.I. 1.326-30.026)*] were observed more commonly in this work group.

Discussion

The mean age of the enrolled patients with traumatic occupational upper limb injuries was 31.2 years, with the 20-39 years age group accounting for 86.4% of the study subjects. This is comparable to other studies by Museve et al. [12] and Jin et al. [13] who found the average age of such injured patients to be 34.2 and 32.1 years respectively. The young age group may represent most of the productive workforce of any given society.

The male to female ratio was 17:1. Many studies have similar male dominance. Museve et al. [12] had 94% males, while Al Thani et al. [14] reported males to represent 97% of their study subjects. Studies in a Middle Eastern country and South Africa report similar statistics [13] [15]. This disparity in sex can be explained by the fact that men usually represent the majority of the workforce in developing nations.

Majority of the workers were transporters, plant and machine operators/assemblers, and construction site workers. These are sectors that are taking hold in many developing nations including Tanzania and absorb a significant proportion of the workforce.

In developing countries worldwide, construction and manufacturing occupations are associated with high rates of injury [16]. In Tanzania, the construction industry accounts for 25%-45% of the fatalities [17] while in Kenya, the majority of the injured were in the manufacturing industry [12].

Stewart et al. [15] in South Africa found 34% of occupational injuries in machine operators, 11.4% in general manual labourers and 17.1% affecting construction workers. Jin et al. [13] in China had 85.2% of injuries in the manufacturing industry. In Qatar, Al-Thani[14] reported 42% of the injured workers being labourers involved in industrial work and 18% were in the transport sector.

In the USA, the construction industry in 2017 was leading in the number of fatal work injuries with an incidence rate of 971 per 100,000 workers, followed by transportation and warehousing which had an incidence rate of 882 per 100,000 workers [18]. For the non-fatal work-related injuries, the manufacturing industry lead with an incidence rate of 3.6 per 100 [18].

The causes of injury vary from country to country as dictated by available technologies in work places. In this study many upper limb occupational injuries were sustained in motor vehicle crashes (40.5%), followed by heavy machinery induced injuries (25.6%) and falls from heights (13.5%).

In Kenya, crush injuries from machinery caused 84% of upper limb occupational injuries.[12] Heavy machinery accounted for 28.5% while power tools accounted for 40% of the injuries in the study by Stewart et al. [15] in South Africa. Al Thani et al. [14] however reported falls from heights contributing 51% of injuries. Falling objects and motor vehicle crash contributed 16.6% and 18% respectively. Machine injuries were responsible for 45.2% of upper limb occupational injuries in China.[13]

The hand was the most common site for occupational injuries affecting the upper limb in this study. This is consistent with other studies worldwide [19] [20] [21]. The hand is the most functional, most exposed and most utilized part of the upper limb in almost all occupations and thus more likely to be injured. The right hand was affected in 54.3% in this study and it was the dominant hand in 82.9% of the hand injuries but not statistically significant (*p value = 0.187*).

Museve et al. [12] was able to demonstrate that the right hand was 52% more likely to be injured than the left hand. Contrary to this Jin et al demonstrated that 52.0% of the hand injuries were likely occur in the left hand.[13] The dominant use of the right-handed during work could predispose it to injuries.

In the hand, the sparse soft tissue coverage makes the fingers likely to get open injuries. The middle finger accounted for 29.3% the cases involving digit injuries. Mostafa et al. [22] had the index finger as the most commonly injured finger (40%). In the study by Stewart et al there was an even distribution of injuries among the digits with the index finger 22%, middle 24% and ring finger 22%.[15] The length of the finger may predispose it to a higher likelihood of injury due to more exposure. There was however no significant association seen in this study.

Fractures were the most common injuries encountered making up 85.1% of all cases. Dislocations constituted 24.3% and traumatic amputations 13.5%. In South Africa the authors reported isolated lacerations and fractures to account for 80% and 77% respectively [15] while in Egypt isolated lacerations accounted for 50% of the injuries [22].

Plant/machine operators and assemblers were more than 6 times likely to sustain injuries with extensive soft tissue involvement. They were also 10 times more likely to experience traumatic amputations. Heavy machinery induced injuries are high energy and tend to cause extensive soft tissue damage.

Conclusion

Occupational traumatic upper limb injuries affected mostly young males who are an essential workforce in Tanzania. Motor vehicle crashes were the most common causes of these injury.

The transportation and distribution sector, plant/machine operators and assemblers sustained higher grades of soft tissue injury and traumatic amputations possibly calling for Occupational Safety and Health Authority (OSHA) to be more vigilant.

Study limitations

The study has a short follow up period of the victims missing medium and long term effects of these injuries since amputations could be delayed in some cases.

The study was conducted at one referral centre for orthopaedic and trauma cases, where patients were referred due to the complexity of their injuries and as such excluding other lesser upper limb injuries treated elsewhere. The results of this study may not represent the actual picture of occupational injuries at other hospitals and regions.

A long term study involving multiple trauma centres in different regions may be necessary to determine the implications of occupational injuries on the workforce and the medical and rehabilitation needs of this population in Tanzania.

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Table 1: **Socio-Demographic Characteristics of Occupational Traumatic Upper Limb Injuries**

Variable		Frequency Total =74	Percent (%) Total =100
Age in years	<20	1	1.4
	20-29	32	43.2
	30-39	32	43.2
	40-49	7	9.5
	50-59	7	2.7
Sex	Male	70	94.5
	Female	4	5.5

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Table 2: **Occupations and Causes of Occupational Traumatic Upper Limb Injuries**

Variable		Frequency Total =74		Percent (%) Total =100
Occupation	**Transport & Distribution**		31	41.9
	Motorcyclists (54.8%)	17		
	Auto-rickshaw drivers (22.6%)	7		
	Taxi drivers (12.9%)	4		
	Bus drivers (9.7%)	3		
	Plant & Machine Operators & Assemblers		21	28.3
	Heavy machine operators (71.5%)	15		
	Assemblers (19.0%)	4		
	Technicians (9.5%)	2		
	Construction & Related Trade Workers		14	18.9
	Labourers (78.6%)	11		
	Painters (14.3%)	2		
	Plumbers (7.1%)	1		
	Law Enforcement, Safety & Armed Forces		6	8.1
	Hospitality & Tourism Operators		1	1.4
	Agricultural Workers		1	1.4
Cause of Injury	Motor Traffic Crash		30	40.5
	Heavy Machinery Cut/Crush		19	25.6
	Slip and Fall From Height		10	13.5
	Assault		7	9.5
	Heavy Falling Object		6	8.1
	Animal Bite		1	1.4
	Sharp Light Tool Cut		1	1.4

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Table 3: **Sites and Types of Occupational Traumatic Upper Limb Injuries**

Variable			Frequency Responses	Percent Responses	Percent cases
Site of Injury	Hand		35	39.3	47.3
	Forearm		28	31.5	37.8
	Arm		17	19.1	23.0
	Shoulder		6	6.7	8.1
	Elbow		3	3.4	4.1
	Total		**89**	**100**	
Type of Injury	Fracture	Open	41	39.0	55.4
		Closed	22	21.0	29.7
	Dislocation	Simple	12	11.4	16.2
		Complex	6	5.7	8.1
	Traumatic Amputation		10	9.5	13.5
	Crush Injury		7	6.7	9.5
	Tendon Injury		6	5.7	8.1
	De-gloving Injury		1	1.0	1.4
	Total		**105**	**100**	

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