

## Work-Related Hand Injuries: Type, Location, Cause, Mechanism and Severity in a Tertiary Hospital

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### ABSTRACT

**Introduction:** Work-Related Hand Injuries (WRHIs) may result in disability and diminished productivity and cause economic impacts not only to the individual, worker's families and industries, but to the local community as well. **Objectives:** To determine the prevalence of severe Work-Related Hand Injuries (WRHIs) and factors associated at a tertiary hospital. **Methods:** A pre-tested validated questionnaire was used to obtain data. All patients 18 years and above with WRHIs seen at a tertiary hospital between January 2010 and June 2010 were included in the study. Data was analysed using SPSS version 18. **Results:** Out of the 297 industrial accidents, 74 (24.9%) were WRHIs. Among those with WRHIs, (47.3%) of them had severe hand injuries. The overall mean age of the respondents was 30.36 ( $\pm$  9.54 SD) years. Majority (82.5%) of the injuries occurred between Mondays to Friday. Majority (70.1%) of hand injuries were caused by machine and 48.6% of the hand injuries occurred when the hand was caught in the operating part of the machine. Majority (62.1%) of the respondents had fingers' injuries and 32.4% had open fracture. Bivariate analysis showed that there was significant association between severity of WRHIs and locations of injury, mechanisms of injury, sources of injury and sectors of industry ( $p < 0.05$ ). Logistic regression analysis showed that WRHIs was significantly associated with source of injury and sector of industry. Respondents with hand injury resulted while operating on mechanical machine was 26 times more likely to report severe WRHIs than those with other sources of their hand injury like (sharp tool, heavy door, and wet floor). Respondents working in metal-machinery industries were eight times more likely to report severe WRHIs than those who working in other sectors of industry like (wood-furniture, confection, food preparing, service and automotive). **Conclusions:** WRHIs contributed to 24.9% of all industrial accidents seen at the emergency department and orthopaedic clinic and 47.3% of the respondents with WRHIs had severe hand injuries. Severity of WRHIs was significantly associated with sources of injury and sectors of industry.

**Keywords:** Prevalence, Severe, Work-Related Hand Injuries

### INTRODUCTION

Hands play an important role in performing everyday activities. The hand is the most common anatomical site to be injured at work and constitutes 30% of all occupational accidents received at emergency department [1-3]. Work-Related Hand Injuries (WRHIs) occur most commonly in jobs that involve intensive hand activity like manufacturing, construction and food-preparing factories [2]. WRHIs may result in disability and diminished productivity and cause economic impacts not only to the individual, worker's families and industries, but to the local community as well [4]. Risk factors associated with occurrence of WRHIs can be categorized into injury-related factors, work-related factors, workplace-related factors, medical history, social habits and those related to socio-demographic characteristics [5]. Most severe hand injuries commonly occur among the machine operators and machine maintenance workers [6]. Sorock (2002) reported that machines accounted for 37% of WRHIs [7]. Despite the fact that WRHIs contribute to a significant workload at the emergency rooms and orthopaedic clinics, information about WRHIs is lacking in many countries. The aim of the study was to determine the prevalence of severe WRHIs and its factors associated at a tertiary hospital.

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## MATERIALS AND METHODS

### *Study design/Study Location*

This hospital based cross sectional study was carried out in a tertiary Hospital.

### *Study population*

All accidents (i.e. industrial and non-industrial) cases aged 18 years and above, seen at the emergency room, the orthopaedic ward, the general surgery ward and the orthopaedic outpatient clinic in tertiary Hospital between January 2010 and June 2010 were included in this study.

### *Instruments and procedures*

A pre-tested validated questionnaire was used to obtain data. The questionnaire was pretested on 30 patients not included in the sample. The outcome variable was WRHIs and the independent variables were age, gender, ethnicity, marital status, types of injury, location of injury, mechanisms of injury, hand activities at the time of injury, causes of injury and time of injury, source of injury, types of injury, location of injury and mechanism of injury.

### *Modified Hand Injury Severity Score (MHISS) <sup>[8]</sup>*

MHISS was used to determine the severity of hand injury through evaluating the four hand components i.e. Integument, Skeletal, Motor and Neurovascular bundles (ISMN) and quantify injuries to hand, wrist and forearm. MHISS was chosen for use in this study because MHISS is a standardized tool that provides quantifiable and comparable measures of hand injury severity <sup>[9]</sup>. It has been devised based on the previously-described HISS scoring system <sup>[10]</sup>, with the advantages that MHISS permits quantification of both hand and forearm injuries by assuming that the hand, wrist and forearm are one functional unit. In addition, MHISS quantifies injuries to the neurovascular bundles rather than only the nerve in the HISS scoring system. Each ISMN component contains both absolute scores and scores which are weighted according to the functional importance of the affected ray. Table 1 shows the individual digit weighting factors <sup>[10]</sup>. For instance, thumb injuries are given a greater weighting than little finger injuries. The total score for each component is doubled by the presence of additional factors such as wound contamination, a compound fracture, crush or avulsion. In amputations, all missing structures are scored as damaged. The overall MHISS is the total of the scores for each ISMN component. The MHISS score is grouped into four categories: Minor, Moderate, Severe or Major Injury, as described for the HISS by Campbell and Kay <sup>[10]</sup> (MHISS <20 = minor, MHISS 21–50= moderate, MHISS 51–100= severe and MHISS 101 and more = major). In the present study, the respondents were categorised into two levels of injury severity using MHISS. Those with MHISS of more than 50 were classified as ‘with severe hand injuries’. Those respondents with a score of 50 or less than 50 were classified as ‘with not severe hand injuries’.

**Table 1.** The individual digit weighting factors

Digit	Weighting factors
Thumb	x 6
Index	x 2
Middle	x 3
Ring	x 3
Little	x 2

\*(Campbell & Kay, 1996) <sup>[10]</sup>

### *Statistical analysis*

Statistical analysis was carried out using SPSS version 18. Categorical variables were presented as frequencies and percentages. Continuous variables were presented as means with their 95% confidence interval (CI). The Pearson's chi-square test ( $\chi^2$ ) test was used to determine the associations between categorical variables. Independent sample t-test was used to compare means between two groups. Binary Logistic regression was used for multivariate analysis. A *p*-value of < 0.05 was considered as statistically significant.

*Ethical Approval*

Approval from the Faculty of Medicine and Health Science, University Putra Malaysia human research committee and approval from the Ministry of Health National Institutes of Health were received before commencement of the study. Informed consent was also obtained from the each respondent before data was collected.

**RESULTS**

A total of 297 industrial-related accidents were seen at the tertiary hospital (emergency room, orthopaedic ward, general surgery ward, and orthopaedic outpatient clinic) from January 2010 to June 2010. Of these 297 industrial-related accidents, 74 (24.9%) were WRHIs. Table 2 shows the prevalence of severe WRHIs by age. Out of the total 74 respondents with WRHIs, 35 respondents had severe WRHIs giving a prevalence of 47.3%. The overall mean age of those respondents with severe WRHIs was  $30.20 \pm 10.66$  years and of those respondents with not severe WRHIs was  $30.50 \pm 8.54$  years. This difference in the mean age was not statistically significant ( $t = 0.14$ ,  $df = 72$  and  $p = 0.89$ ).

**Table 2.** Prevalence of severe WRHIs by age

Age group (years)	Severe (%)	Not severe (%)	Total (%)
18-25 yrs	15 (57.7)	11 (42.3)	26
26-35 yrs	10 (34.5)	19 (65.5)	29
36-45 yrs	5 (50.0)	5 (50.0)	10
46 yrs and above	5 (55.6)	4 (44.4)	9
Total	35 (47.3)	39 (52.7)	74

**Table 3.** Types and locations of WRHIs by severity

Variable	Severe (%)	Not severe (%)	Total (%)
<b>Types of injury</b>			
Open fracture	10 (41.7)	14 (58.3)	24 (32.4)
Closed fracture	2 (46.7)	10 (83.3)	12 (16.2)
Crush hand	11 (68.6)	5 (31.4)	16 (21.5)
Amputation	10 (100.0)	0 (0)	10 (13.5)
Laceration	1 (20.0)	4 (80.0)	5 (6.8)
Finger tips injury	0 (0)	3 (100.0)	3 (4.1)
Degloving injury	1 (33.3)	2 (66.7)	3 (4.1)
Avulsion	0 (0)	1 (100.0)	1 (1.4)
Total	35 (47.3)	39 (52.7)	74 (100.0)
<b>Locations of injury</b>			
Multiple fingers	14 (87.5)	2 (12.5)	16 (21.6)
Forearm	4 (25.0)	12 (75.0)	16 (21.6)
Index finger	7 (46.7)	8 (53.3)	15 (20.2)
Thumb	4 (57.3)	3 (42.7)	7 (9.5)
Little finger	2 (33.4)	4 (66.6)	6 (8.1)
Ring finger	2 (40.0)	3 (60.0)	5 (6.8)
Middle finger	1 (25.0)	3 (75.0)	4 (5.4)
Palm of the hand	1 (33.4)	2 (66.6)	3 (4.1)
Back of the hand	0 (0)	2 (100.0)	2 (2.7)
Total	35 (47.3)	39 (52.7)	74 (100.0)

*Injury characteristics*

## Types and locations of the injuries

Table 3 shows the types and locations of the injuries. Open fracture injuries constituted 32.4% of all injuries. This was followed by crush hand injuries (21.5%), closed fracture (16.2%), amputation (13.5%), laceration (6.8%), finger tips injuries (4.1%), skin flap (4.1%) and avulsion (1.4%). Only 21.6% of the injuries was multiple fingers injury. Other site of injury were forearm (21.6%), thumb (9.5%), and palm and back of the hand (6.8%).

*Sources of injury, occupational categories and sectors of industry, mechanisms of injury and hand activities at the time of injury by severity of WRHIs*

**Table 4.** Sources of injury, occupational categories and sectors of industry, mechanisms of injury and hand activities at the time of injury by severity of WRHIs

Variable	Severe (%)	Not severe (%)	Total (%)
<b>Sources of injury</b>			
Machine	31 (59.6)	21(40.4)	52 (70.1)
Wet floor	1(7.7)	12 (92.3)	13 (17.6)
Heavy door	2 (40.0)	3 (60.0)	5 (6.8)
Sharp tool	1 (25.0)	3 (75.0)	4 (5.5)
Total	35 (47.3)	39 (52.7)	74 (100.0)
<b>Occupational categories</b>			
Machine operators	15(51.7)	14(48.3)	29 (39.1)
Manual materials handlers	2(20.0)	8(80.0)	10 (13.5)
Carpenters	6 (66.6)	3 (33.4)	9 (12.2)
Construction workers	3 (33.3)	6 (66.7)	9 (12.2)
Machinery maintenance workers	4 (66.7)	2 (33.3)	6 (8.1)
Food preparers	1 (25.0)	3 (75.0)	4 (5.4)
Sheet metal workers	3 (75.0)	1 (25.0)	4 (5.4)
Welders	1 (25.0)	2 (75.0)	3 (4.1)
<b>Sectors of industry</b>			
Metal-machinery	22(55.0)	18(45.0)	40 (54.1)
Wood-furniture	7(70.0)	3 (30.0)	10 (13.5)
Construction	3(33.4)	6 (66.6)	9 (12.1)
Food preparing	3 (42.9)	4 (57.1)	7 (9.5)
Services	0 (0)	6 (100.0)	6 (8.1)
Automotive	0 (0)	2 (100.0)	2 (2.7)
<b>Mechanisms of injury</b>			
Hand caught inside machine	22 (61.4)	14 (38.6)	36 (48.6)
Cutting	8 (50.0)	8 (50.0)	16 (21.7)
Hand hit by hard objects	4 (28.9)	10 (71.1)	14 (18.9)
Fall	0 (0)	6 (100.0)	6 (8.1)
Piercing	1 (50.0)	1 (50.0)	2 (2.7)
<b>Hand activities at the time of injury</b>			
Working on machine	22 (53.8)	19 (46.2)	41(55.4)
Handling objects	5 (31.4)	11 (68.6)	16 (21.5)
Lifting objects	1 (14.5)	6 (85.5)	7 (9.5)
Working on powered hand tool (circular saw)	5 (100.0)	0 (0)	5 (6.8)
Carrying objects	2 (50.0)	2 (50.0)	4 (5.4)
Working on non-powered hand tool (knife)	0 (0)	1 (100.0)	1(1.4)

**Table 5.** Association between severity of WRHIs and risk factors

Variable	WRHIs			$\chi^2$	df	P values
	Severe (%)	Not Severe (%)	Total			
Locations of injury						
Finger injuries	26(56.5)	20(43.5)	46	4.15	1	0.042*
Other sites of injury	9(32.1)	19(67.9)	28			
Sources of injury						
Machine	31(59.6)	21(40.4)	52	9.05	1	0.003*
Other sources	4(18.2)	18(81.8)	22			
Mechanisms of injury						
Hand caught inside machine	22(61.1)	14(38.9)	36	4.342	1	0.037*
Other mechanisms	13(34.2)	25(65.8)	38			
Sectors of industry						
Metal-machinery	22(55.0)	18(45.0)	40	7.807	2	0.020*
Wood-furniture	7(70.0)	3(30.0)	10			
Other industry sectors	6(25.0)	18(75.0)	24			
Types of injury						
Open fracture	10 (41.7)	14 (58.3)	24	3.77	2	0.152
Crush hand	11(68.8)	5(31.2)	16			
Other types of injury	14(41.2)	20(58.8)	34			
Hand activities at the time of injury						
Working on machine	22(53.7)	19(46.3)	41	2.319	2	0.314
Handling objects	5(31.2)	11(68.8)	16			
Other hand activities	8(47.1)	9(52.9)	17			
Day of the week						
Working days	28(45.9)	33(54.1)	61	0.046	1	0.83
Weekend	7(53.8)	6(46.2)	13			
Time of injury						
8.00 am- 12.00 pm	13(43.3)	17(56.7)	30	0.44	2	0.803
12.00 pm- 2.00 pm	5(45.5)	6(54.5)	11			
After 2.00 pm	17(51.5)	16(48.5)	33			
Occupation categories						
Machine operators	15(51.7)	14(48.3)	29	3.457	2	0.178
Manual materials handlers	2(20.0)	8(80.0)	10			
Other occupations	18(51.4)	17(48.6)	35			

\*p is significant when  $p < 0.05$

**Table 6.** Logistic regression analysis

Predictors	$\beta$	Adjusted OR	95% CI	p value
Sources of injury				
Other causes		1		
Machine	3.25	25.84	1.69 - 393.37	0.019*
Sectors of industry				
Other sectors		1		
Metal-machinery	2.12	8.36	1.22 - 57.23	0.031*
Locations of injury				
Other site of injury		1		
Fingers	0.91	2.47	0.58 - 10.60	0.22
Types of injury				
Other types of injury		1		
Open fracture	-1.06	0.34	0.09 - 1.38	0.13
Mechanisms of injury				
Other mechanisms		1		
Hand caught inside machine	0.53	1.7	0.38 - 7.62	0.48
Time of injury				
12.00 pm-2.00 pm (Lunch break)		1		
8.00 am- 12.00 pm	-0.95	0.39	0.04 - 3.60	0.4
After 2.00 pm	-0.77	0.46	0.05 - 4.51	0.51
Day of the week				
Weekend		1		
Working days	-0.63	0.53	0.09 - 3.25	0.49
Hand activities at the time of injury				
Other activities		1		
Working on machine	-2.1	0.12	0.01 - 1.88	0.13
Handling objects	-1.75	0.17	0.01 - 2.54	0.2
Occupational categories				
Other occupations		1		
Machine operators	-2.44	0.12	0.01 - 1.87	0.13
Manual materials handlers	-2.19	0.17	0.01 - 2.54	0.2
Nationality				
Others		1		
Malaysian	-1.54	0.21	0.04 - 1.09	0.06
Marital status				
Married		1		
Single	0.09	1.09	0.29 - 4.11	0.89

significant level  $p < 0.05$

Table 4 shows the sources of injury, occupational categories and sectors of industry, mechanisms of injury and hand activities at the time of injury by severity of WRHIs. Majority (70.1%) of the respondents had injuries resulting during operation on mechanical machine. Only 39.1% of respondents were machine operators. Other occupational categories affected were manual material handlers (13.5%), carpenter (12.2%), construction workers (12.2%), machinery maintenance workers (8.1%), food preparers (5.4%), sheet metal workers (5.4%), and welders (4.1%). Majority (54.1%) of the respondents were working in metal-machinery industry. Other sectors of industry were represented by wood-furniture (13.5%), construction (12.1%), food preparing (9.5%), services (8.1%) and automotive (2.7%).

Only (48.6%) of the hand injuries occurred when the hand was caught inside the machine. Other mechanisms of injury occurred by cutting mechanism (21.7%), when (the hand hit by hard objects) mechanism (18.9%), and fall and piercing mechanisms of injury constituted (10.8%). The results also show that the majority (55.4%) of the hand injuries occurred while workers were working on the machine, and as hand activity at the time of injury. Other activities represented by handling objects (21.5%), lifting objects (9.5%), working on powered hand tool (6.8%), carrying object (4.1%), and working on non-powered hand tool (1.4%).

#### *Day of the week and time of accident of WRHIs by severity*

The day of the week and time of accident of WRHIs by severity was also examined. The majority (82.5%) of the injuries occurred during working days. Only (44.6%) of the WRHIs occurred between 2.00 pm and 8.00 am, (40.5%) of the WRHIs occurred after 8.00 am and before 12.00 noon, while (14.9%) of the WRHIs occurred between 12.00 noon and 2.00 pm.

#### *Factors associated with severe WRHIs*

Bivariate analysis showed that there was a significant association between severity of WRHIs and locations of injury, mechanisms of injury and sources of injury.

#### *Logistic regression analysis*

Table 6 shows the logistic regression. Only two independent variables showed significant contribution to the model (sources of injury and sectors of industry). The strongest predictor of reporting severe WRHIs was sources of injury. Respondents with hand injury resulted while operating on mechanical machine was 26 times more likely to report severe WRHIs than those with other sources of their hand injury like (sharp tool, heavy door, and wet floor). The results also showed that respondents working in metal-machinery industries were eight times more likely to report severe WRHIs than those who working in other sectors of industry like (wood-furniture, construction, food preparing, service and automotive).

## **DISCUSSION**

Work-Related injuries represent significant rates of acute hand injuries seen in emergency services<sup>[2,11,12]</sup>. Therefore, the concept of hand injury severity assessment is focused on Work-Related injuries. The influence of multiple risk factors has been associated with severity of hand injuries. This study shows that severity of the hand injury is significantly related to the presence of a risk or a protective factor.

In our study, only 74 patients had WRHIs (24.9%) from a total of 297 industrial-related accidents seen at the tertiary hospital. However, these findings were different from Serinken study at tertiary hospital in Western Turkey who found that (32.7%) of occupational injuries were WRHIs<sup>[3]</sup>. The finding of this study shows that, the proportion of severe WRHIs is (47.3%) from all WRHIs. These findings are consistent with that of severe WRHIs among workers reported by Urso - Baiardia in United Kingdom<sup>[8]</sup>. In the present study, the majority (62.1%) of injuries that occurred to the fingers either single or multiple were associated with severe WRHIs. Meanwhile, the majority (67.9%) of other sites of injuries, like injury to forearm, thumb and back and palm of the hand were found to be associated with non-severe WRHIs. However, these findings are not in agreement with Sorock (2002) who reported that, majority of injuries that occurred to the fingers have been associated with non severe WRHIs<sup>[7]</sup>. Using of MHISS allows classification of injuries according to the hand components involved into lacerations, open fracture (comminuted fracture), closed fracture, crush hand injuries and amputations (complete or partial)<sup>[8]</sup>. In the present study, 32.1% of the respondents presented with open fracture and 17.0% presented with lacerations, finger tips injuries and avulsions. However, the findings of this study did not support the previous research by Serinken *et al.*, (2008) who reported that lacerations, finger tips, cuts and abrasions were found to be the most frequent types of hand injuries (40%) of all WRHIs. Hand and fingers caught inside operating machine was the main mechanism (48.6%) responsible for fingers injuries. In contrast, injuries to the forearm and palm or back of the hand tend to be caused by mechanisms like (when hand hit by heavy object, fall, cutting and piercing), which have been found to be associated in the majority (65.8%) with non severe WRHIs. Working on mechanical machine was the most common source of WRHIs. The respondents with injuries

resulted while operating mechanical machine were 26 times more liable to have severe WRHIs than the respondents that had injuries resulted by (sharp tool, wet floor and heavy door). The findings of this current study were consistent with previous studies [6, 7 & 13], who found that all the WRHIs cases resulted while operating machines, were of severe cases. In this study, the highest frequency (43.4%) of WRHIs occurred after 2.00 pm inclusive of respondents who worked at night shift. However, 41.5% of the WRHIs occurred between 8.00 am and 12.00 noon, and 15.1% occurred between 12.00 noon and 2.00 pm. However, these findings were not in agreement with the findings of the previous studies, which reported that the highest frequency of hand injuries occurred in the first four hours of working from 08.00 am to 12.00 pm [3, 14 & 15]. However, these studies reported the time of patient's admission to the emergency room, while this current study depended on the actual time of accident. Workers belonging to the metal-machinery industries sector were eight times more likely to be associated with severe WRHIs than other workers belonging to sectors of industry like; wood-furniture, construction, services, food preparing and automotive. However, these findings do not support the previous research by Serinken *et al.* (2008) who reported that, only 41.1% of the injuries happened in metal-machinery industries [3]. This difference in sectors of industry can be attributed to the types of industries found in the area of study.

### CONCLUSION

WRHIs contributed to 24.9% of all industrial accidents seen at the emergency department and orthopaedic clinic and 47.3% of the respondents with WRHIs had severe hand injuries. Severity of WRHIs was significantly associated with sources of injury and sectors of industry. Respondents with hand injury resulted while operating on mechanical machine was 26 times more likely to report severe WRHIs than those with other sources of their hand injury like (sharp tool, heavy door, and wet floor). Respondents working in metal-machinery industries were eight times more likely to report severe WRHIs than those working in other sectors of industry like; wood-furniture, construction, food preparing, service and automotive.

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