

The epidemiology of acute occupational hand injuries treated in emergency departments in Foshan City, South China

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ABSTRACT

BACKGROUND: Despite the magnitude of occupational hand injuries, there are no authoritative guidelines for hand injury prevention, and little research has been done to investigate the epidemiology of acute occupational hand injuries in South China or other developing areas. In this study, the epidemiology of acute occupational hand injuries treated in emergency departments (EDs) in Foshan City, South China, was examined and data were supplied to assist with preventive strategies in similar developing regions.

METHODS: A multicenter study was prospectively designed and conducted in 5 large hospital EDs in Foshan City from July 2010 to June 2011. An anonymous questionnaire was designed specifically to collect the data for this study.

RESULTS: A total of 2142 patients with acute occupational hand injury completed the questionnaire within the 1-year study period. Results indicated that most occupational hand injuries were caused by machinery. Hand injury type and site of the injury did not correspond to age, but were related to gender and job category. July and August 2010 were the peak periods of admission to EDs, while January and February 2010 were the trough periods.

CONCLUSION: Epidemiological data enhance our knowledge of acute occupational hand injuries and could play a role in the prevention and treatment of future occupational hand injuries.

Keywords: Emergency department; epidemiology; hand; occupational injury; trauma.

INTRODUCTION

Hand injuries are costly, and a major cause of morbidity in China and around the world. The incidence of occupational hand injury varies across different industries, ranging from 4 to 11 per 100 workers per year. Occupational hand injury is one of the top causes of lost days from work, and it imposes a great economic burden on the country.^[1-6] In the US, the annual cost of treating upper extremity disorders, including hand injuries, was over \$18 billion.^[2] The Center for Disease Control and Prevention reported that an estimated 30% of

occupational injuries treated in US emergency departments (EDs) are hand injuries.^[6]

However, very few papers have been published worldwide on the epidemiology of acute occupational hand injuries treated in the ED in China or other developing regions. Despite the magnitude of occupational hand injuries, there are no authoritative guidelines for hand injury prevention, and little research has been done to investigate the epidemiology of acute occupational hand injuries in South China.

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Foshan City is a major metropolis and typical developing area in South China with substantial industrial activity, and occupational hand injuries are the leading work-related injury.^[7] The purpose of this study was to identify the epidemiology of acute occupational hand injuries treated in EDs in Foshan City, South China, and to provide a series of hand injury prevention suggestions for similar developing areas.

MATERIALS AND METHODS

Setting

Foshan City is located in the mid-south of Guangdong Province, South China. It governs 5 districts: Chancheng, Nanhai, Shunde, Gaoming and Sanshui. The city covers a total area of 3848.49 km² and has a population of at least 5.923 million, including 3.611 million registered permanent residents. The largest hospital EDs in each district are Foshan Hospital of Traditional Chinese Medicine (FSTCM), Foshan Nanhai District Hospital of Traditional Chinese Medicine, Shunde District Longjiang Hospital, Gaoming District People's Hospital and Sanshui District People's Hospital. Approximately 80,000 patients are assessed per year in each ED. A multicenter study was prospectively designed and conducted in these 5 large hospital EDs in the period between July 2010 and June 2011.

Patient Selection

Study participants were those presenting to these hospital EDs with injuries to the fingers, hand, or wrist, including laceration, crush, avulsion, puncture, fracture, contusion, amputation, or dislocation. Informed verbal consent was obtained from eligible participants when they arrived at the ED. Some were unable to provide written consent at admission due to the nature of the injury; however, patients who agreed to participate in the study were provided with the relevant information and gave consent.

Exclusion Criteria

Patients who were younger than 14 years of age or who presented with hemodynamically unstable polytrauma were excluded from the study.

Data Collection

An anonymous questionnaire (Appendix 1) was designed to collect data regarding background demographics, detailed exposure information, assessment of hand injury, and health insurance status. If the hand injury occurred at work, occupational information was recorded, including training record, mechanism of injury, and average salary. Twenty non-medical investigators received a 6-hour investigation training course. These investigators administered the questionnaire in the ED. The document was written in Chinese, in order to avoid misunderstanding.

Ethical Approval

All procedures performed in this study involving human participants were approved by the ethics committee of FSTCM and were conducted in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Statistical Analyses

Study data were entered into a Microsoft Excel (Microsoft Corp., Redmond, WA, USA) database and analyzed using SPSS for Windows, Version 13.0. (SPSS, Inc., Chicago, IL, USA). Descriptive statistics of mean and SD were provided for numerical variables, while categorical variables were given as frequency (n) and percentage. Categorical variables were compared using chi-square test. Differences were considered statistically significant at a level of $p < 0.05$.

RESULTS

Demographics

During the study period, there were 2186 Chinese patients with acute occupational hand injury assessed by physicians in an ED, of which 2142 (98%) met the study criteria (mean age: 31.33 ± 11.00 years, range: 14–71 years; 81.56% male). They were divided into subgroups according to age, medical insurance status, job category, job tenure, education level, and other characteristics. In this study, 1109 (51.78%) patients were between 25 and 44 years of age and 116 (5.42%) patients were minors. Of the total, 1935 (90.34%) had medical insurance, and 856 (39.96%) patients had 1 to 3 years of job tenure. The education level of the majority was graduation from secondary school (1706; 79.64%). The majority had an annual salary ranging from \$3,000 to \$4,000 (1006; 46.97%). Most worked at a private business (1961; 91.54%). Only half of the patients (1076; 50.23%) had safety training before beginning work, a mean of 84.74 ± 39.51 safety training hours. Employees had a mean of 4.11 ± 0.35 days of work training. When the hand injury occurred, they had been working mean of 5.06 ± 1.04 hours without rest. For 1163 (54.30%) patients, the interval from hand injury to ED arrival was less than 30 minutes. Emergency hand surgery was indicated for 1445 (67.46%) patients on admission (Table 1).

Characteristics of Injuries

Most occupational hand injuries were caused by machinery (2112; 99.6%). The most common types of injury were caused by pressing and cutting machinery (42.11% and 29.41%, respectively). Most patients had finger injury (1760; 82.16%). The most commonly injured fingers were the thumb, index, and middle finger, especially on the right hand. There were 26 study participants suffering from injuries to both hands. The hand injury type and the site of the injury were not related

Table 1. General characteristic of the study patients

Characteristics	n	%
Gender		
Male	1747	81.56
Female	395	18.44
Age-group (years)		
<15	8	0.37
15–24	726	33.89
25–44	1109	51.78
45–64	294	13.73
≥65	5	0.23
Health insurance		
Social security insurance	1935	90.34
None	196	9.15
Other insurance	11	0.51
Job category		
Metal-machinery	826	38.56
Food handling	72	3.36
Maintenance/repair	256	11.95
Wood work	104	4.86
Construction	104	4.86
Textile	153	7.14
Printing	73	3.41
Others	554	25.86
Job tenure		
<1 yr	588	27.45
1–3 yr	856	39.96
>3 yr	698	32.59
Experience of safety training		
Yes	1076	50.23
No	1066	49.77
Education level		
Illiterate	25	1.17
Primary school	314	14.66
Secondary school	1706	79.64
Post-secondary and above	97	4.53
Annual wage		
<\$2,000	40	1.86
\$2,000–\$3,000	474	22.13
\$3,000–\$4,000	1006	46.97
\$4,000–\$6,000	492	22.97
>\$6,000	130	6.07
The nature of business		
Private business	1961	91.54
State-owned business	73	3.41
Foreign-funded business	25	1.17
The nature of the business		
Joint venture	47	2.20
Other partnership	20	0.93
Other	16	0.75

Table 1. General characteristic of the study patients (cont.)

Characteristics	n	%
Interval from the injury onset to ED arrival		
<30 min	1163	54.30
30 min–60min	504	23.53
60 min–120min	262	12.23
>120 min	213	9.94
Disposition		
Discharge	664	31.00
Admission	1445	67.46
Transfer to another hospital	29	1.35
Discharge against medical advice	4	0.19
Total	2142	100.00

ED: Emergency departments.

Table 2. Characteristics of occupational hand injuries

Characteristics	n	%
Type of injury (n=2142)		
Cutting	630	29.41
Laceration	35	1.64
Puncture	101	4.72
Amputation	157	7.33
Compression	902	42.11
Contusion	129	6.02
Crushing injury	52	2.43
Fracture	8	0.37
Burning	20	0.93
Unknown mechanical equipment	78	3.64
Non-machine I	30	1.40
Injury site (n=2142)		
Wrist	46	2.15
Hand	191	8.92
Finger	1760	82.16
Multiple	145	6.77
Injury finger (n=1855)		
Thumb	427	23.02
Index	515	27.76
Middle	502	27.07
Ring	143	7.71
Little	213	11.48
Multiple	55	2.96
Injury hand (n=2142)		
Right	1146	53.50
Left	970	45.29
Both	26	1.21

to age, but did correlate to gender and job category. In all, 80.52% of patients were wearing gloves when the injury occurred (Tables 2–4).

Table 3. Comparison of injury site with demographic variables and job category

Variable	Injury site								p
	Wrist (n=46)		Hand (n=191)		Finger (n=1760)		Multiple (n=145)		
	n	%	n	%	n	%	n	%	
Gender									
Male	40	2.29	165	9.44	1422	81.40	120	6.87	<0.001
Female	6	1.52	26	6.58	338	85.57	25	6.33	
Age-group (years)									
<15	0	0.00	0	0.00	7	87.50	1	12.50	0.406
15–24	20	2.75	72	9.92	588	80.99	46	6.34	
25–44	16	1.44	96	8.66	925	83.41	72	6.49	
45–64	10	3.40	23	7.82	236	80.27	25	8.51	
65+	0	0.00	0	0.00	4	80.00	1	20.00	
Health insurance									
Social security insurance	41	2.12	171	8.84	1599	82.63	124	6.41	0.082
None	5	2.55	20	10.20	153	78.06	18	9.19	
Other	0	0.00	0	0.00	8	72.73	3	27.27	
Job category									
Metal-machinery	15	1.82	75	9.08	692	83.78	44	5.32	0.001
Food handling	2	2.78	10	13.89	56	77.78	4	5.55	
Maintenance/repair	1	0.39	27	10.55	218	85.15	10	3.91	
Wood work	1	0.96	9	8.66	85	81.73	9	8.65	
Construction	5	4.81	12	11.54	73	70.19	14	13.46	
Textile	1	0.65	4	2.61	138	90.20	10	6.54	
Printing	1	1.37	6	8.22	62	84.93	4	5.48	
Others	20	3.61	48	8.66	436	78.70	50	9.03	

Perceived Cause of Occupational Hand Injuries

All of the patients were asked about the perceived cause of hand injury. “Distraction” was response selected by 1152 (53.78%) participants, while 330 (15.41%) selected “pure accident,” and 257 (12.00%) selected “no protection” (Table 5).

Peak and Trough Periods in Admission to ED

During the period of July 2010 to June 2011, July and August 2010 was the peak period of admission to the ED, while January and February 2010 was the trough period (Fig. 1). There was no obvious peak period with respect to day of the week (Monday through Sunday) during the entire year (Fig. 2).

DISCUSSION

To the best of our knowledge, this is the first multicenter study to analyze and describe the epidemiology of acute occupational hand injuries in South China. There are no authoritative reports about the epidemiology of acute occupational hand injuries in China. Current occupational safety standards are inadequate, and many employers don't pay attention to

safety management training for work-related tasks. Relevant laws need improvement to protect employees' rights.^[7] The present study provides useful information for the national health service and local labor department to use to develop strategies and decrease the risk of occupational hand injury. The social and economic impact of hand injury on society highlights the importance of prevention of these injuries.^[7–10] Several studies have reported on the epidemiology and prevention of acute occupational hand injury in developed countries.^[11–17] In Chow's study, statistically significant associ-

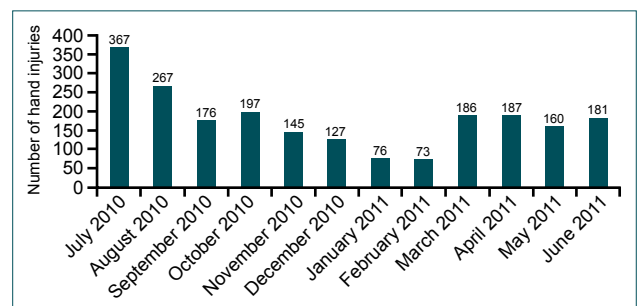


Figure 1. Distribution of occupational hand injuries by month.

Table 4. Comparison of some injury types by sex, age group, and job category

Variable	Injury type												p
	Cutting (n=630)		Puncture (n=101)		Amputation (n=157)		Compression (n=902)		Contusion (n=129)		Other (n=223)		
	n	%	n	%	n	%	n	%	n	%	n	%	
Gender													
Male	533	30.51	63	3.61	138	7.90	726	41.56	107	6.12	180	10.30	<0.001
Female	97	24.55	38	9.62	19	4.81	176	44.56	22	5.57	43	10.89	
Age-group (years)													
<15	1	12.50	0	0.00	1	12.50	5	62.50	0	0.00	1	12.50	0.706
15–24	213	29.33	42	5.79	57	7.85	306	42.15	40	5.51	68	9.37	
25–44	322	29.04	53	4.78	73	6.58	468	42.20	71	6.40	122	11.00	
45–64	91	30.95	6	2.04	26	8.84	121	41.16	18	6.12	32	10.89	
65+	3	60.00	0	0.00	0	0.00	2	40.00	0	0.00	0	0.00	
Health insurance													
Social security insurance	548	28.32	94	4.86	143	7.39	839	43.36	108	5.58	203	10.49	<0.001
None	81	41.33	6	3.06	13	6.63	57	29.08	19	9.69	20	10.21	
Other insurance	1	9.09	1	9.09	1	9.09	6	54.55	2	18.18	0	0.00	
Job category													
Metal-machinery	202	24.45	30	3.63	82	9.93	381	46.13	41	4.96	90	10.90	<0.001
Food handling	50	69.44	1	1.39	1	1.39	7	9.72	1	1.39	12	16.67	
Maintenance/repair	65	25.39	4	1.56	11	4.29	123	48.05	24	9.38	29	11.33	
Wood work	61	58.65	3	2.89	9	8.65	18	17.31	5	4.81	8	7.69	
Construction	32	30.77	22	1.92	9	8.65	43	41.35	10	9.62	8	7.69	
Textile	31	20.26	37	24.18	10	6.54	53	34.64	10	6.54	12	7.84	
Printing	19	26.03	3	4.11	4	5.48	39	53.42	2	2.74	6	8.22	
Others	170	30.69	21	3.79	31	5.60	238	42.96	36	6.50	58	10.46	

ations were found between the incidence of hand injury and exposure to these 7 factors: using malfunctioning equipment/materials, using a different work method, performing an unusual task, working overtime, feeling ill, being distracted, and rushing.^[1] Whether the use of gloves can protect against hand

injury is controversial. Schaub and Chung found that the use of gloves alone in industry has been reported to reduce the risk of hand injury by as much as 60%.^[11] However, Chow found that the use of gloves had insignificant protective effect on the incidence of hand injury.^[1] In 19% of the injuries that occurred while gloves were worn, they did not protect against mechanical energy transferred to the hand. Glove use may reduce the

Table 5. Perceived cause of occupational hand injury

Patient's idea of the cause	n	%
Pure accident	330	15.41
No protection	257	12.00
Faulty machine	47	2.19
Distraction	1152	53.78
Unfamiliar with machine	138	6.44
Poor cooperation	121	5.65
Fatigue	63	2.94
No idea	34	1.59
Total	2142	100

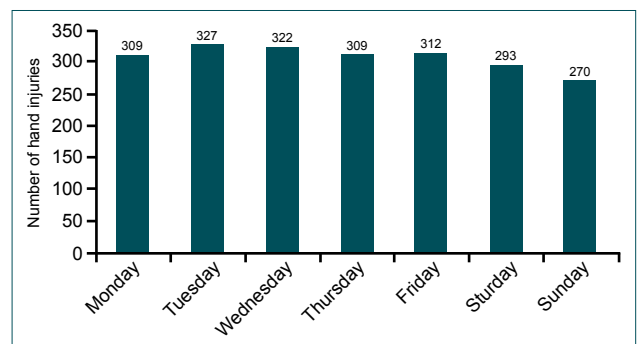


Figure 2. Distribution of occupational hand injuries by day of the week.

risk of laceration and puncture injury, but not crush, fracture, avulsion, or amputation.^[1,10] In this study, 80.52% of the participants were wearing gloves when the hand injury occurred. According to several published articles, other factors found to influence occupational hand injury include using defective materials, presence of cardiovascular disease, extended work hours/lack of sleep, age of less than 25 years, smoking, regular consumption of alcohol, and long work hours. It has also been demonstrated that most occupational hand injuries occur in the morning, with a peak before lunchtime.^[11,18-21]

In our study, most of the patients were young men. Most of the hand injuries were caused by machinery used for cutting and pressing. The treatment of hand injuries is often of long duration, and frequently results in variable but persistent disability. Injuries of this nature can preclude patients from returning to their previous occupation.^[20] Fortunately, most of the patients in this study had medical insurance guaranteed and supported by the government, and could access adequate medical treatment.^[7] However, some patients (9.15%) had no medical insurance due to the economic burden it entails and did not understand the risks of being uninsured. They may have a heavy economic and psychological burden as a result of long-term prognosis of hand injury. In China, some private businesses disobey the law and do not provide any kind of insurance to employees in order to reduce costs. Most of the patients in this study had achieved secondary school education level (79.64%) and were qualified for their job. Most (72.55%) had work experience of more than 1 year. However, half of participants lacked safety training, which has been shown to be a potential risk factor for occupational hand injury.^[10] Most had lower annual wage compared with average income in South China.

As we know, Foshan City is an advanced industrial city with thousands of labor-intensive industrial factories, and is representative of developing areas in China.^[7] Tens of thousands of employees are working on the production assembly line every day. Their jobs are repetitive: performing the same manufacturing process again and again. It's very easy, but boring. Most factories have instituted a series of management programs to improve production efficiency. Workers have limited time for rest. In our study, subjects had been working mean of 5.06 ± 1.04 hours without rest when the hand injury occurred. The main cause of injury was "distraction," according to 53.78% of participants. In this 1-year study period, July and August 2010 were the peak period for admissions to EDs. In Foshan City, most factories are very busy with rush production orders during these 2 months. January and February were trough periods in number of admissions to EDs, due to the Spring Festival holiday. July and August are also the months when the weather is hottest in South China. However, few factories have air-conditioners or adequate fans to cool the work environment. In this uncomfortable situation, workers may be more prone to "distraction" than in other months and make mistakes.

Based on the results of our study, we suggest the following: First, all businesses must provide basic medical insurance for their employees, according to the national law. In China, there is a compulsory social security insurance law. Second, we noticed that about 5.42% of patients in the study were minors. The law prohibits any business from employing workers younger than 16 years of age in China. It is necessary for the national health service and local labor department to improve supervision and see that all businesses strictly follow the law. Third, safety training needs to be emphasized. All workers should regularly complete a series of safety training and education courses. The national health service and local labor department should provide authoritative guidelines for education and create risk assessment tools for occupational safety to identify potential hazards in the workplace. Fourth, business managers should improve the work environment, including providing a work-rest schedule and decreasing rush production orders. Fifth, the country should encourage enterprises to improve technologies and engineering safety devices to further reduce the risk of occupational trauma. The country should also authoritatively publish a series of recommendations on safeguards, design, and proper use of various machines and protective equipment that meet the standards for anticipated hazards.

Our study has some limitations. We analyzed patients with occupational hand injuries treated in EDs, which underestimates the actual incidence of such injuries, since some subjects do not present to an ED. An anonymous questionnaire was designed for collection of study data, and thus, the investigators could not recognize a participant who returned to the ED due to reoccurrence. Patients who visited the ED on multiple occasions for hand injury may have been included in this study. This topic needs further research.

Conclusion

Epidemiological data enhances our knowledge of acute occupational hand injuries and may play a role in the prevention and treatment of future occupational hand injuries, with the end result of reducing lost work time and economic burden.

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ORIJİNAL ÇALIŞMA - ÖZET

Güney Çin Foshan ilinde acil servislerde tedavi edilen mesleksel akut el yaralanmalarının epidemiyolojisi

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AMAÇ: Mesleksel el yaralanmalarının kapsamına rağmen el yaralanmalarını korunmasına ilişkin yetkin kılavuzlar mevcut olmadığı gibi Güney Çin veya diğer gelişmekte olan alanlarda akut mesleksel el yaralanmalarının epidemiyolojisi az sayıda çalışmada araştırılmıştır. Bu çalışmada Güney Çin Foshan ilindeki acil servislerde tedavi edilmiş akut mesleksel el yaralanmalarının epidemiyolojisini araştırdık ve gelişmekte olan benzer alanlarda koruyucu stratejilere ilişkin veriler sağladık.

GEREÇ VE YÖNTEM: Foshan ilinde beş büyük hastanenin acil bölümlerinde ileriye yönelik ve çok merkezli çalışma tasarlanıp yürütüldü. Bu çalışmada verileri toplamak için özellikle tasarlanmış bir adsız anket formu kullanıldı.

BULGULAR: Akut mesleksel el yaralanması olan toplam 2142 denek bir yıllık çalışma dönemi içinde anket formlarını doldurmuştur. Mesleksel el yaralanmalarının çoğuna makineler neden olmuştu. El yaralanmasının tipi ve yaralanmanın yeri yaş farklılıklarıyla değil cinsiyet ve işin kategorisiyle ilişkiliydi. Acil servislere en çok Temmuz ve Ağustos 2010 aylarında en az Ocak ve Şubat 2010 aylarında hasta kabulü olmuştur.

TARTIŞMA: Epidemiyolojik veriler akut mesleksel el yaralanmalara ait bilimizi artırmakta ve gelecekte mesleksel el yaralanmalarının engellenmesi ve tedavisinde rol oynayabilir.

Anahtar sözcükler: Acil bölüm; el; epidemiyoloji; mesleksel yaralanma; travma.

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Appendix I.**Acute Hand Injury Questionnaire - Foshan City**

No: Gender: Age:

I. Date of injury:

Day of the week:

Interval from the hand injury to Emergency Department arrival: minutes

 Disposition:

A. Treatment and release B. Admission C. Transfer to another hospital D. Discharge against medical advice

 2. Cause of injury:A. Traffic accident B. Activity of daily life C. Injured by other people D. Self-injury
E. Occupational injury F. Other 3. Place of injury:

A. At work B. At home C. On streets or roads D. Sports venue E. Other

 4. Place of work (District):A. Chancheng B. Shunde C. Nanhai D. Gaoming E. Sanshui
F. Other 5. Was the patient treated at another hospital?

A. Yes B. No

 6. Handedness:

A. Left-handed B. Right-handed C. Both

 7. Injured hand:

A. Left B. Right

 8. Type of injury:A. Crush B. Cut C. Laceration D. Contusion
E. Other specified (puncture, tear, strain, fracture, burn, compression, amputation) F. Other unspecified 9. Injury site:

A. Wrist B. Hand C. Finger (Multiple choice)

 10. Injured finger(s):A. Thumb B. Index C. Long D. Ring
E. Little (Multiple choice) 11. Education level:

A. Illiterate B. Primary school C. Secondary school D. Post-secondary and above

 12. Social security:

A. Medical insurance B. None C. Other

 13. If the injury is occupational hand injury: 1. Job category:A. Metal-machinery B. Food handling C. Maintenance/repair D. Woodwork
E. Construction F. Textiles G. Printing H. Other:..... 2. Cause of injury:A. Pure accident B. No protection C. Faulty machine D. Distraction
E. Unfamiliar with machine F. Poor cooperation G. Fatigue H. No idea (Multiple choice) 3. Safety training:

A. Yes - Training hours: B. No

 4. When the hand injury occurred, patient had been working hours 5. Work experience: years 6. Nature of enterprise:A. Private B. State-owned C. Foreign-funded D. Joint-venture
E. Other partnership F. Other 7. Annual salary:

A. <\$2,000 B. \$2,000-\$3,000 C. \$3,000-\$4,000 D. \$4,000-\$6,000 E.>\$6,000