Epidemiology of injuries among Construction Workers: A prospective study in northeastern Thailand

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EXECUTIVE SUMMARY

Construction is a high-risk industry. Injuries had long been recognized as the major cause of mortality and morbidity among construction workers. Statistics in several countries showed occupational mortality and morbidity rates were higher in constructions than to other industries. These rates were much higher in developing countries than developed ones. However, there have been few studies describing epidemiology of injuries of the workers, especially in developing countries such as Thailand. None have been done in Northeastern Thailand where it was the poorest and largest region of the country. The number of construction workers in this region were also increasing while the existing information system was severely inadequate.

This study was a 6 month follow-up study of injuries among construction workers conducted during late 1996 to early 1997 at the two large construction sites in a Northeastern province of Khon Kaen. It observed 50,387 worker-days from 966 workers. There were 815 episodes of injuries, 660 episodes were the injuries where these injured workers stopped working for at least half an hour and 162 episodes where the workers stopped working for a day or more. Incidence density of the total injuries was 1.54 per 100 worker-days (95%CI: 1.38 - 1.72), the lost-time injuries was 1.28 per 100 worker-days (95%CI: 1.14 - 1.43), and the lost-work-day injuries was 0.33 per 100 worker-days (95%CI: 0.27 - 0.40). The rates were more than 10 times as compared to what was found in a previous cross-sectional survey conducted at the same province two years prior to the present longitudinal study.

Important characteristics of injuries, from a total of 815 episodes investigated at the workplace, were described in several aspects. There were 653 out of 815 (80.1%) injuries the worker stopped working for less than one day and needed only first-aid medical care. There were 152 (18.7%) injured workers who stopped working for at least one day (lost work-day injuries) but were not hospitalized. Only 10 (1.2%) injured workers were hospitalized and, of course, lost work-day. This is the tip, visible part, of the iceberg - the fraction of injuries that can be recognized by routine health information

system. The ratio of lost-time injuries plus medical only cases : lost work-day injuries : hospitalized injuries is equal to 65 : 15 : 1.

Almost half of all injuries, 374 (46%), were due to being struck against objects followed by being struck by objects (22%) and steps on sharp objects (15%). There was less than one quarter of all injuries, 100 (12.3%), caused by falling objects. Among these, 14 were head injuries alone which was aimed to protected by using helmets. It accounted for only 1.7% of a total of 815 injuries.

The majority of injuries were laceration (42%), followed by abrasions (21%) and cuts or puncture wounds (20%). Contusion, abrasion and laceration were common among all body region whereas cut or puncture wound was found mostly injury of the limbs. There were 506 (62%) injuries which resulted in blood loss - laceration and cut or puncture wound combined. Two workers, classifying among those with abrasions, received eye injuries. One worker lost his finger (classified as cut or puncture wound). There was a worker who broke his leg. No one die. Almost all injuries involved just one part of the body. The most common injuries were to the hands and the right feet for all type of injuries. All the head injuries resulted in lost-time and 20% resulted in lost work-day. Almost all of the feet injuries (99.2%) resulted in lost-time and resulted the highest proportion of lost work-day (26.7%), regardless multiple sites injuries. Almost half the 815 injuries, 347 (42.6%), were related to assembling or removing wooden frame for concrete formation. Transporting of mixed concrete from the mixer to the working location ranked the second which involved 12% of all injuries. However there were about half (44.2%) of injuries which related directly to the activities being performed at the time of the injury. The remaining were indirect to the job being performed which mostly caused by other surrounding environments (52.2%) and the act of other workers (3.6%). This imply that skill of the workers is as important as working conditions. Epidemiological investigation of each injury provided details about its immediate cause. There were three main causes reported - tools, nails, and steel left out of concrete. Hammers and lifting bars are essential tools for carpenters and mostly used for assembling and disassembling the concrete frame which was the job most commonly associated with injuries.

For 71% of the 815 injuries the workers reported they were exhausted at the time of the injuries. Approximately one tenth of them said they were drunk. The main causes of the injuries according to the injured workers themselves were their own carelessness or ignorance (39.1%) followed by unexpected events (19.3%) and events which were unavoidable (14.2%). In their opinions 66.5% of the injuries could be classified as preventable (all except the unexpected and unavoidable events). On the other hand, the investigation by the researcher (author) identified the main causes of injuries were unsafe acts of the workers, including not using any personal protective equipment (74.2%), unsafe working conditions (19.0%) and lack of skill, including being physically or psychologically unwell (6.8%). Alcohol-related injuries was classified in the last category. All were preventable injuries.

Only 5.7% of all injured workers worked overtime, only 1.8% reported that they were not assigned to the right jobs. Thus these two factors probably played little role in injuries. On the other hand, most injured workers 645 (79.1%) did not use any personal protective devices, including those only footwear was slippers.

Factors found to significantly increase risk of injuries included working at the construction site where the work was intense, being carpenters, male workers, young workers, less working year of experience, being forced to work, lived with relatives house, and perceived that working as currently did will cause no injuries. These factors were also significantly related to lost work-time injuries except place of living whereas only type of work, age and working experience were they significantly associated with the lost work-days injuries.

It is concluded that generally suggest that promoting used of personal protective devices, particularly safety shoes, would effectively reduce occurrence of injuries. Appropriate design of non-power hand tools such as lifting bar with hand protection and nail holders should be made available. Special attention is needed among young workers, carpenters, and those who were lack of experience in construction work.

Key Words: injuries, epidemiology, construction workers, prospective study

บทสรุปสำหรับผู้บริหาร

การก่อสร้างจัดเป็นอุตสาหกรรมที่มีความเสี่ยงอันตรายประเภทหนึ่ง เป็นที่ทราบกันมานานว่า การบาดเจ็บเป็นสาเหตุที่สำคัญของการเจ็บป่วยและการตายของคนงานก่อสร้าง สถิติจากหลายประเทศแสดงให้เห็นว่าอัตราการเจ็บป่วยและตายจากการประกอบอาชีพในคนงานก่อสร้างนั้นสูงกว่าในคนงานของอุตสาหกรรมประเภทอื่นๆ อัตราดังกล่าวในประเทศกำลังพัฒนาพบสูงมากกว่าในประเทศที่พัฒนาแล้ว อย่างไรก็ตามงานวิจัยเกี่ยวกับระบาดวิทยาของการบาดเจ็บในคนงานก่อสร้างมีน้อยมากในประเทศที่กำลังพัฒนาเช่นประเทศไทย เฉพาะอย่างยิ่งในภาคตะวันออกเฉียงเหนือซึ่งเป็นภาคที่ใหญ่ที่สุดและยากจนที่สุดของประเทศนั้นไม่มีการวิจัยดังกล่าวเลย นอกจากนั้นจำนวนคนงานก่อสร้างในภาคนี้ได้เพิ่มสูงขึ้นในขณะที่องค์ความรู้ทางด้านนี้ยังขาดอยู่มาก

การศึกษานี้เป็นการศึกษาการบาดเจ็บของคนงานก่อสร้างโดยติดตามไปข้างหน้าเป็นระยะเวลา 6 เดือน ดำเนินการ ณ สองสถานก่อสร้างขนาดใหญ่ในจังหวัดขอนแก่นระหว่าง ตุลาคม 2539 ถึง มีนาคม 2540 ได้มีการสังเกต 50,387 วันทำงาน จากคนงานทั้งหมด 966 คน พบว่ามีการบาดเจ็บเกิดขึ้น 815 ครั้ง จากจำนวนนี้มี 660 ครั้งที่เป็นที่ต้องมีการหยุดทำงานเป็นระยะเวลาอย่างน้อย 30 นาที ในจำนวนนี้มี 162 ครั้งที่ต้องหยุดงานอย่างน้อยหนึ่งวัน อัตราอุบัติการของการบาดเจ็บรวม (total injuries) คิดเป็น 1.54 ต่อ 100 วันทำงาน (95%ช่วงเชื่อมั่นอยู่ระหว่าง 1.38 ถึง 1.72) อัตราอุบัติการของการบาดเจ็บที่สูญเสียเวลาทำงาน (lost-time injuries) คิดเป็น 1.28 ต่อ 100 วันทำงาน (95%ช่วงเชื่อมั่นอยู่ระหว่าง 1.14 ถึง 1.43) และ อัตราอุบัติการของการบาดเจ็บที่ต้องสูญเสียวันทำงาน (lost-work-day injuries) คิดเป็น 0.33 ต่อ 100 วันทำงาน (95%ช่วงเชื่อมั่นอยู่ระหว่าง 0.27 ถึง 0.40) เฉพาะอัตราอุบัติการของการบาดเจ็บที่ต้องสูญเสียวันทำงานนี้พบว่าสูงเป็น 10 เท่าของที่พบจากการศึกษาภาคตัดขวางในพื้นที่เดียวกันเมื่อสองปีก่อนหน้าการศึกษาไปข้างหน้าในครั้งนี้

จากการสอบสวนทางระบาดวิทยา ณ สถานที่เกิดเหตุของการบาดเจ็บทั้งสิ้น 815 ครั้ง พบว่า 653 ครั้ง (80.1%) ที่ต้องหยุดงานน้อยกว่า 1 วันนั้น มาขอรับการปฐมพยาบาลจากเสมียนก่อสร้างภายในสถานก่อสร้าง มี 152 (18.7%) ครั้งของการบาดเจ็บที่ต้องหยุดงานอย่างน้อย 1 วันนั้นมาขอรับเพียงการปฐมพยาบาล และอีก 10 (1.2%) ครั้งของการบาดเจ็บที่ต้องหยุดงานอย่างน้อย 1 วันนั้นเข้ารับรักษาพยาบาลจากโรงพยาบาล จำนวนนี้คือยอดของภูเขาน้ำแข็ง กล่าวคือ เป็นสัดส่วนของการบาดเจ็บที่ได้รับการเก็บรวบรวมโดยระบบข้อมูลข่าวสารสาธารณสุขในปัจจุบัน อัตราส่วนการบาดเจ็บที่สูญเสียเวลาทำงานน้อยกว่า 1 วัน : การบาดเจ็บที่สูญเสียเวลาทำงานอย่างน้อย 1 วัน : การบาดเจ็บที่เข้ารับรักษา ณ โรงพยาบาล เท่ากับ 65 : 15 : 1.

เกือบครึ่งหนึ่งของการบาดเจ็บทั้งหมด (46%) เกิดจากการชนกระแทกกับวัตถุ รองลงมาคือวัตถุชนกระแทก (22%) และเหยียบของมีคม (15%) พบว่าประมาณหนึ่งในสี่ของการบาดเจ็บทั้งหมด (12.3%) เกิดจากวัตถุหล่นทับ พบว่า 14 ครั้งยังผลให้เกิดการบาดเจ็บที่ศีรษะ คิดเป็น 1.7% ของการบาดเจ็บทั้งหมด นี่เป็นสัดส่วนการบาดเจ็บที่สามารถป้องกันได้โดยการสวมหมวกนิรภัย

การบาดเจ็บส่วนใหญ่เป็นแผลถลอกมีเลือดไหล (42%) ตามด้วยผิวถลอก (21%) และแผลตัด บาด แทง (20%) ผลที่เป็นรอยฟกช้ำ ผิวถลอก และแผลถลอกมีเลือดไหลพบได้บ่อยจากการบาดเจ็บในทุกส่วนของร่างกาย ส่วนแผลตัด บาด แทงนั้น ส่วนมากพบได้จากการบาดเจ็บที่แขนหรือขา การบาดเจ็บที่เป็นเหตุให้ต้องสูญเสียโลหิต (แผลถลอกมีเลือดไหล และ แผลตัด บาด แทง) มีจำนวน 506 ครั้ง (62%) โดยที่การบาดเจ็บที่ตา 2 รายก็จัดอยู่ในกลุ่มนี้ คนงาน 1 รายนิ้วขาดจัดอยู่ในกลุ่มแผลตัด บาด แทง และ อีกหนึ่งรายในกลุ่มเดียวกันนี้กระดูกขาหัก ไม่มีการเสียชีวิต การบาดเจ็บเกือบทั้งหมดเป็นการบาดเจ็บที่ส่วนเดียวของร่างกาย ทุกประเภทการบาดเจ็บ ส่วนมากเป็นการบาดเจ็บที่มือและเท้าขวา การบาดเจ็บที่ศีรษะทั้งหมดยังผลให้ต้องเสียเวลาทำงาน โดย 20% ของทั้งหมดยังผลให้ต้องหยุดงานอย่างน้อย 1 วัน เกือบทั้งหมดของการบาดเจ็บที่เท้า (99.2%) เป็นการบาดเจ็บที่ต้องสูญเสียเวลาทำงาน และยังเป็นการบาดเจ็บที่มีสัดส่วนสูงที่สุดในบรรดาการบาดเจ็บที่ต้องสูญเสียวันทำงาน (26.7%) ทั้งนี้ไม่นับรวมการบาดเจ็บที่มากกว่าหนึ่งส่วนของร่างกาย เกือบครึ่ง (42.6%) ของการบาดเจ็บทั้งหมดเกี่ยวข้องกับการประกอบหรือ.คลื่อนย้ายไม้แบบคอนกรีต รองลงมาคือการเคลื่อนย้ายคอนกรีตจากเครื่องผสมปูนไปยังตำแหน่งที่ทำงาน (12%) อย่างไรก็ตาม เกือบครึ่ง (44.2%) ของการบาดเจ็บทั้งหมดเกี่ยวข้องโดยตรงกับกิจกรรมที่คนงานกำลังทำในขณะที่ได้รับบาดเจ็บ ที่เหลือทั้งหมดเกี่ยวข้องโดยอ้อมกับงานที่กำลังทำ ซึ่งส่วนมากเกิดจากสภาพแวดล้อม (52.2%) และการกระทำของคนงานอื่น (3.6%) สิ่งนี้ชี้ให้เห็นว่าทักษะการทำงานมีความสำคัญพอ ๆ กันกับสภาพแวดล้อมการทำงานในการก่อให้เกิดการบาดเจ็บ สาเหตุอันเป็นข้อสรุปจากการสอบสวนทางระบาดวิทยา ณ ที่เกิดเหตุมี 3 สาเหตุหลัก ได้แก่ เครื่องมือ ตะปู และเหล็กที่ยื่นจากผิวคอนกรีต เครื่องมือที่พบว่าเกี่ยวข้องกับการบาดเจ็บส่วนมากคือฆ้อนตีตะปูและเหล็กชะแลง เครื่องมือทั้งสองชนิดนี้เป็นเครื่องมือที่สำคัญของช่างไม้ที่ใช้สำหรับประกอบแบบคอนกรีตและรื้อแบบคอนกรีตเมื่อเสร็จสิ้น

จาก 815 ครั้งของการบาดเจ็บ 71% บอกว่ารู้สึกอ่อนเพลีย ประมาณหนึ่งในสิบบอกว่าเมาสุรา จากความคิดเห็นของคนงานที่บาดเจ็บ สาเหตุที่สำคัญของการบาดเจ็บคือความสะเพร่าและประมาทของเขาเอง (39.1%) ตามด้วยเป็นเหตุการณ์ที่คาดไม่ถึง (19.3%) และเป็นเหตุการที่เลี่ยงไม่ได้ (14.2%) ความคิดเห็นของคนงานที่บาดเจ็บ 66.5% บอกว่าการบาดเจ็บของเขาสามารถป้องกันได้ ในส่วนของผู้วิจัยที่ได้สอบสวนการบาดเจ็บนั้น พบว่าสาเหตุหลักของการบาดเจ็บคือพฤติกรรมที่ไม่ปลอดภัยของคนงานก่อสร้าง (รวมถึงการไม่สวมเครื่องป้องกันอันตรายส่วนบุคคล) คิดเป็น 74.2% รองลงมาคือสภาพแวดล้อมการทำงานที่ไม่ปลอดภัย คิดเป็น 19.0% และ การขาดทักษะการทำงาน

และสภาพร่างกายที่ไม่พร้อม คิดเป็น 6.8% กลุ่มสุดท้ายนี้หมายรวมถึงการเมาสุราขณะทำงานด้วย ดังนั้นผู้สอบสวนการบาดเจ็บสรุปว่า การบาดเจ็บทั้งหมดสามารถป้องกันได้

ในจำนวนคนงานที่บาดเจ็บทั้งหมด มีผู้ทำงานล่วงเวลาคิดเป็น 5.7% คนงานที่บอกว่าตนเองได้รับมอบหมายงานที่ไม่ตรงตามความสามารถคิดเป็น 1.8% ดังนั้นทั้งสองเรื่องนี้จึงมีบทบาทน้อยมากต่อการบาดเจ็บ ในทางตรงข้าม คนงานส่วนมาก (จำนวน 645 ราย คิดเป็น 79.1%) ไม่สวมเครื่องป้องกันอันตรายส่วนบุคคลใด ๆ เลย ทั้งนี้รวมถึงผู้ที่สวมเฉพาะรองเท้าแตะด้วย

ปัจจัยที่พบว่าเพิ่มความเสี่ยงต่อการบาดเจ็บอย่างมีนัยสำคัญได้แก่ การทำงานในสถานก่อสร้างที่เร่งรัดการทำงาน ช่างไม้ เพศชาย อายุน้อย ขาดประสบการณ์ ถูกบังคับให้มาทำงาน พักอาศัยกับญาติ และผู้ที่มีความคิดเห็นว่าการทำงานเช่นที่ทำอยู่ในปัจจุบันนี้จะไม่ได้รับการบาดเจ็บ ปัจจัยเหล่านี้มีความสัมพันธ์อย่างมีนัยสำคัญกับการบาดเจ็บที่ต้องสูญเสียเวลาทำงานด้วยเช่นกันทุกปัจจัยยกเว้นการ พักอาศัยกับญาติ ในขณะที่ปัจจัยที่มีผลอย่างมีนัยสำคัญกับการบาดเจ็บที่ต้องสูญเสียวันทำงานมีเพียงประเภทของงาน (ช่างไม้) อายุ (คนงานอายุน้อย) และประสบการณ์ (ระยะเวลาทำงานก่อสร้างสั้น)

การส่งเสริมให้คนงานสวมใส่เครื่องป้องกันอันตรายส่วนบุคคล เฉพาะอย่างยิ่งรองเท้านิรภัย ตลอดจนการออกแบบชะแลงให้มีที่ป้องกันมือและที่คีบตะปูเวลาตอกไม้ จะสามารถลดจำนวนการบาดเจ็บลงได้อย่างมีประสิทธิผล ทั้งนี้ควรมุ่งเน้นคนงานที่อายุน้อย คนงานที่ด้อยประสบการณ์ และช่างไม้

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CHAPTER 1

INTRODUCTION

This Chapter describes rationale and background of the study. Justification of the study was also provided.

1.1 Rationale

Construction is one of the most dangerous industry. It has major fatality problems relating several events such as falls from heights, electrical contact, reversing vehicles, trench wall collapses, and workers being struck by falling or moving objects. Serious-injury problems relate to housekeeping, manual materials handling, direct installation activities, and on- site in-transit activities. They vary from one construction trade to another and from one type of project to another (McVittie, 1995). In many industrialized countries, a number of studies have demonstrated this fact. A study by Rossignol and Pineault (1993) at the Canadian province of Quebec for the period 1981 through 1988, showed that the construction sector, compared to the other occupational areas, had the largest number of deaths. Similarly, Feldman and Gerber (1990) reviewed a total of 16,193 deaths from death certificates for residents of Nassau County, New York dying between 1980 and 1982, of which 2,286 (14.1%) were related to occupation and they concluded that the construction industry was associated with the majority of occupation-related deaths. Stone (1993), reviewed death certificates in South Carolina between 1989 and 1990, found that construction industries had the highest fatality rates compared to all other industries and one of the leading causes of death was injuries from falls. Focusing on accidents on construction sites that are a major cause of occupational mortality and morbidity, the incidence and mortality rate are much higher in construction industry as compared to the other industries. A study by Sorock, Smith and Goldoft (1993) showed that work in the construction industry involves about a threefold increased risk of fatal injury compared with all industries combined. Kisner and Fosbroke (1994) also studied traumatic occupational injuries in the construction industry in the United States and found that the lost work-days was 10.1 per 100 full-time workers per year, which was nearly 2.5 times the rate for all industries combined. The construction industry had an overall fatality rate of 25.6 per 100,000 full-time workers per year. This rate was more than 3.5 times the occupational fatality rate for all industries in the United States for the same period. Many other authors such as Guidotti (1995), Wang et al. (1995), Burkhart et al. (1993), Howell et al. (1990), and Bell et al. (1990) have demonstrated the similar high risk of working in the construction industry. In the United Kingdom, the construction industry is considered to be the most dangerous of all industries and has recorded fatality rate of about 10 per 100,000 workers over the past decade (Snashall, 1990). In Germany, between 1992 and 1994, Arndt et al. (1996) studied 4958 employees in the German construction industry, aged 40-64 years, who underwent standardised routine occupational health examinations in 1986 to 1988. The study indicated that compared with white collar workers, the construction workers showed a 3.5 to 8.4 fold increased rate of disability ($P < 0.05$ for all occupational groups) and a 1.2 to 2.1 fold increased all cause mortality.

In developing countries, on the other hand, few studies have been focused on this target population. A study conducted in Hong Kong found that the fatality rate of occupational injuries in construction industries ranged from 79 to 89 per 1000,000 workers during the period from 1986 to 1990 - about eight times higher than the corresponding rate reported in the UK (Wong, 1994). In Thailand the corresponding rate was152 per 100,000 in 1990 (Department of Labour, 1991) - about two times higher than that of Hong Kong and about 15 times higher than that of the UK.

Compared to other Asian countries, Thailand had relatively more problems of work-related injuries. Ong et al. (1984) conducted a survey in Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Sri Lanka and Thailand on occupational injuries during the years 1975-1980. The number of work accidents rose rapidly during this period in all the 8 countries studied. In the case of Thailand, the total number of work injuries increased four folds from 1975 to 1978, whereas, in Singapore it almost doubled in 6 years. The number of permanent disabilities nearly trebled in Korea and the Philippines for the years 1967-1980. The largest percentages of accidents in all the 8 countries are lost-time injuries, the injuries that lead to time off work. During the study period, Thailand had three fold increase in lost-time injuries whilst in Hong Kong the figure doubled. In six out of the 8 countries indicated that the building construction industry had the largest proportion of fatal accidents, followed by the manufacturing industry.

The construction industry has grown rapidly with the economical development in Thai society. This has caused great demand on the construction labour force. The survey of population employment status conducted by the National Statistical Office of Thailand from February 1986 to February 1989 revealed that the number of construction workers increased from 764,500 in 1986 to 1,000,000 in 1989. The average rate of increase was about 11.2 per year (Phandhuratana and Thongpasook, 1989). A survey of employment conducted by the National Statistical Office of Thailand indicated that there was a total of 3,125,374 construction workers in 1996 (Labourforce Statistics Section, 1996). More than one third (1,113,038) were the natives of northeastern region of Thailand. The average rate of increase in the construction labour force was about 13% per year. Some of the construction work force was local residents. However the majority of construction workers, especially in big cities such as Bangkok, had migrated from the other regions of Thailand. Most of them were from the Northeastern region and were previously farmers.

Compared to other groups of labourers, the employment status of construction workers in Thailand is less secure. The work force must move from place to place following the construction projects. Housing for these workers is always temporary and usually un-hygienic. For example, the workers have to share toilets and washing areas since it is too expensive to set up these facilities to all temporary houses for the workers. Thus they are vulnerable to gastro-intestinal infections. The mobility of residence is also likely to be an important barrier to obtaining good education for the children and health service of the family.

Construction workers are at high risk for many diseases. Data from the Ministry of Interior in 1991 reveals that the number of construction workers with work-related injuries was 15,628 or 180 injuries per 1,000 worker-years. There were 132 deaths, 5 complete and 312 partially permanent disabilities from work or 3.7 permanent disabilities per 1,000 worker-years in 1990 (Table 1.1). These rates are the highest among all groups of workers in the country. The death rate from injuries was 14 times and the disability rate was 3.4 times the average for workers in manufacturing industries, for example.

Table 1.1 Statistics on work-related injuries in 1990

Type of industry	Number		Population	Rate per 1,000	
	Deaths	Dis-abilities		Deaths /1,000	Dis-abilities /1,000
Mining	21	9	19,542	1.07	0.46
Manufacturing	200	1,894	1,767,828	0.11	1.07
Food & beverage	*70*	*240*	*	*	*
Textile & garment	*20*	*130*	*	*	*
Wood	*25*	*277*	*	*	*
Paper & printing	*7*	*49*	*	*	*
Chemicals	*19*	*208*	*	*	*
Mineral products	*23*	*82*	*	*	*
Metal industry	*11*	*129*	*	*	*
Machinery	*25*	*258*	*	*	*
Other manufacturing	*0*	*21*	*	*	*
Electricity, gas & water	22	26	116,710	0.19	0.22
Construction	**132**	**317**	**86,704**	**1.52**	**3.66**
Trade, restaurant & hotel	83	75	1,257,281	0.07	0.06
Transport, storage	94	47	215,286	0.44	0.22
Service	113	58	331,259	0.34	0.18

Note: ** Data are not available*
Source: *Compiled from Annual Report of the Department of Labour, Minstry of Interior (1991) Chapter 6, page 113-129*

The trend of the health problem is also increasing- the percentages of construction workers injured due to accidents were 6.8%, 7.7%, 10.4%, and 15.2% in 1988, 1989, 1990, and 1991 respectively (Chawalitnitikul, 1991, quoted by Sasithorn, 1993).

For the death rate, the occupational injury experience of the U.S. and Australian construction industries for 1988-1991 was compared by Ore and Stout (1996). There were 4,158 deaths in the U.S. and 264 in the Australian construction industries. Workers in both countries, particularly laborers, were at high risk, with mean annual rates of 13.8/100,000 and 11.6, respectively, more than double the national averages. Whilst the corresponding rate for Thailand at the same period was 152/100,000 (recalculated using data from Table 1.1). It was more than 10 times as high as the two developed countries.

Although there has been an extensive review of occupational health in Thailand in 1991, and a summary of work-related injuries (Division of Techniques and Planning, 1990), these reports did not focus specifically on the high risk group of construction workers.

Findings from the cross-sectional survey conducted at two northeastern provinces in late 1994 revealed the mortality and morbidity rate from injuries among construction workers as shown in Table 1.2 (Thinkhamrop et al., 1996). The morbidity rates were quite small as compared to the rate obtained from routine reporting system and almost the same as that from developing country such as The United States.

Table 1.2 Mortality and morbidity rate (per 100 worker-days) from injuries among construction workers, Khon Kaen (KK) and Nongkhai (NK) as compared to all over country of Thailand and The United States

Indices	Large sites		Small sites	
	Rate	95%CI.	Rate	95%CI.
Mortality rate				
KK+NK	0.000245	$3.02x10^{-5}$ - $8.81x10^{-4}$	0	0
Morbidity rate				
KK+NK	0.026	0.016 - 0.039	0.030	0.014 - 0.057
Thailand[(1)]	0.05			
The United States [(2)]	0.03			

Note: *[(1)] From the Ministry of Interior of Thailand (1991)*
[(2)] From Kisner and Fosbroke (1994)

There were several issues to discuss about these results. The data about fatal injuries were obtained from the foremen while data for non-fatal injuries were from interviewing the workers who were working on the day of the survey. Both sources of information were of questionable validity. The size of the population at risk and the duration of exposure which are needed for the estimation of mortality rates or incidence rates were not obtainable by the cross-sectional survey. To identifying all fatal injuries it is necessary to seek information from other sources rather than just the foremen. The interviews were conducted with workers who were healthy enough to be working during the data collection period. This could lead to under estimation of the incidence rate of injuries. The workers' perception of injury was different from that of the researchers. We noticed that even if their thumbs were swollen, they still reported that they were not injuries. Injuries in their opinion were only the severe ones.

This longitudinal study provided an insight picture of injuries among construction workers from the perspective of occupational exposure. It covered several issues: the incidence of injuries, the distribution of injuries according to the demographic characteristics of the workers, type of work, shift work, time of occurrence, type and cause of injuries, predictors of injuries and so on. The injuries included not only those which required hospitalization but also the milder injuries that caused absence from work.

1.2 Background

1.2.1 Occupational injuries among construction workers

Several studies had demonstrated that injury is a major cause of morbidity and mortality in construction industries such as Stone (1993), Sorock, Smith and Goldoft (1993), Kisner and Fosbroke (1994), Guidotti (1995), Wang et al. (1995), Burkhart et al. (1993), Howell et al. (1990), and Bell et al. (1990). Several causes of the injuries have been identified. Readers are referred to the following sources (Table 1.3):

Table 1.3 Summary sources of studies relating to injury among construction workers

Causes of injury	Authors
Electrocution	Jones et al. (1991), Centre for Disease Control, USA. (1992), Suruda and Smith (1992) Ore and Casini (1996)
Fall	Waller, Payne and Skelly (1985), Department of Labour (1991), Sorock, Smith and Goldoft (1993), Rosenberg, Gerhart and Whiteneck (1993), Hunting et al. (1994), Mosenthal et al. (1995), Cattledge et al. (1996)
Spinal cord injury	Tator and Edmonds (1979), Ekong and Tator (1985)
Shattering annealed glass	Evans (1979)
Nail gun	Wu, Tham and Oon (1975), Barber (1989), Kenny, O'Donaghue and Haines (1993)

Causes of injury	Authors
Falling objects	Rosenb erg, Gerhart and Whiteneck (1993)
Steel bar penetrating the skull	Ossoff (1982)
Eye injury	Blomdahl and Norell (1984), Chiapella and Rosenthal (1985)
Deaths from trench cave-in	Suruda, Smith and Baker (1988)
Concrete impaction of the external auditory canal	Cuomo and Sobel (1989)
Vibration-related injury	Jinadu (1980), Shields and Chase (1988), Samuelson, Jorfeldt and Ahlborg (1989), Wos, Svensson and Norlander (1991), Brismar and Ekenvall (1992), Miyashita et al. (1992), Stenlund et al. (1992), Stenlund et al. (1993)

In addition to the unsafe environment of the work place, several studies have shown that lack of knowledge of proper ways to prevent accidents, as well as sex, age, marital status, perceptions and carelessness are also associated with accidents (Watt, 1990 and Donald, 1964, quoted by Sasithorn (1993). Factors that the workers felt contributed to their accidents included: working too fast (22%); careless work (12%); using equipment improperly (12%); being upset, under stress, or tired (7%); not paying attention (6%); and co-worker activity (4%) (Payton and Robio, 1991). Following is the table summaries the studies which were closely related to the longitudinal study conducted by the author in addition to those mentioned above (Table 1.4).

Table 1.4 Summary of studies relating to injury among construction workers

Authors/Place	Setting	Main findings
Aekplakorn (1995) / Chonburi, Thailand	Cross-sectional study of 400 workers at 20 building sites in 1994	- Overall incidents of non-fatal injuries = 9.5/100 worker-months - Labourer had the highest rate followed by carpenters, steel workers and masons (rate per 100 worker-months = 19.3 : 14.6 : 7.3 : 4.8 respectively). - 52% of injuries were to lower extremities and 32% were to upper extremities. - 48% of injuries caused by sharp objects followed by falling objects for 33%

Authors/Place	Setting	Main findings
Hunting et al. (1994)/ Washington, USA.	Reviewing 592 medical records, 1990-1992	- Lacerations were the most commonly treated injuries followed by strains and sprains, contusions and eye injuries. - Injuries were most commonly caused by sharp objects (n = 155, 26%), falls (n = 106, 18%) and falling objects (n = 70, 12%). - Thirty-five percent of injuries were to the hands, wrists or fingers.
Wong (1994)/ Hong Kong	Hospital-based matched case-control of 122 pairs in 1990	- 80% of cases had only single injuries - Injuries for 49% were external, 26% involved either the upper or lower extremities, and 11% were spinal injuries - Significant risk factors include no formal education (OR=4.0), no safety training (OR=2.5) and current smokers (OR=3.1)
Buskin and Paulozzi (1987) / Washington, USA	Reviewing 231 death certificates, 1973-1983	- Average annual mortality rate of 27.5 per 100,000 workers. - Falls, cave- ins, and electrocutions resulting from heavy equipment (boom type) contacting overhead power lines together accounted for 45.4% of the fatalities. - There was a significant trend towards increasing mortality with decreasing company size (p = 0.03). - Drilling machine operators, welders, flamecutters, reinforcing-iron workers, and heavy-equipment operators had the highest proportionate mortality ratios (PMRs). - PMRs for workers generally increased with age. - Many of these fatal construction injuries would not have occurred had existing safety regulations been observed

Payton and Robio (1991) stated that the workers themselves play a large and important role in this problem - 90% of accidents were due to unsafe acts by workers, workers' negative attitudes toward safety were a major factor in the occurrence of accidents. Unsafe acts by employees accounted for 7 times the number of accidents caused by unsafe site conditions. The study indicated that environmental factors account for 5% of all industrial accidents. The authors categorized causes of injuries into three main groups: i) Direct causes e.g., unsafe acts, unsafe site conditions; ii) Indirect causes e.g., tool defects, weather, visibility or control problems, breakdown of safety procedure, problems of terrain, poor eyesight, lack of training, exhaustion, stress and physical or emotional conditions; and iii) Contributing factors e.g., inadequate standards, lack of effective company safety policy, inadequate supervision, faulty design, inadequate maintenance and poor enforcement.

Thus the modes of failures in safety were categorized as - i) human failure, ii) technical failure, iii) organization failure, iv) material failure, v) natural phenomena, and vi) work-related motor vehicle accidents.

Once injuries have occurred, their costs, involving both direct and indirect costs, are of interest. For example, the cost of injuries in a study showed that the ratio between the indirect to the direct cost was 4.2 for the medical only cases and 20.3 for injuries resulting in lost work days (Hinze and Appelgate, 1991). This suggests that besides the loss of life, injuries also cost a very large amount of money. These losses are unnecessary. Nearly all the injuries and deaths are preventable (Ringen Seegal and Englund, 1995). The safety and health problems are tied largely to the construction industry's organization and how the work is performed. Trent and Wyant (1990) showed that almost all injuries could be prevented by application of existing standards for safe work practices.

Hinze and Appelgate (1991) had well illustrated a large amount of indirect loses. However it concerned more in cost related to productivity. In the other words, it was in the perspective of the employers rather than the employees. Thus, the amount of loses would be much more than that had been described if we add the costs of loses buy the workers themselves such as they will be cared by their relatives when they stay home resulting from their illness.

The gain, on the other hand, form being effectively preventing the problems among this group of population was well illustrated by a recent study in the United States by Ringen and Stafford (1996). In 1989, the National Institute for Occupational Safety and Health to develop a national labor-management initiative to improve occupational safety and health throughout the construction industry. The aim was to remedy a lack of research on construction occupational safety and health. The first years were spent on surveillance to characterize construction safety and health problems, development of awareness about safety and health issues among decision makers in the industry, and some limited interventions. A second phase was initiated in 1994, which focuses on intervention activities. Results from this joint program include a growth in annual federal construction safety and health research expenditure from $300,000 in 1989 to $12 million in 1995, a research network that now encompasses more than 30 institutions, a national conference that established an agenda to change construction safety and health, four regional conferences to develop coalitions and implementation strategies, and the development of a feasible goal to reduce fatality and injury rates by 80%. The program may already be having an impact. According to the Bureau of Labor Statistics, lost-time injury rates for construction for the three most recent years of reporting declined by 20%. This made clear that effective preventive measures need to be complemented with sufficient and accurate information.

1.2.2 Methodology regarding the longitudinal study of injuries

There has been very little systematic research focused exclusively on injuries among construction workers, as opposed to other workers. Literature mentioned previously describing magnitude of injuries was mostly assessed using the secondary sources of data (Table 1.5).

Table 1.5 Sources of data for the studies relating to injury among construction workers

Sources of data	Authors
Death certificates	Jones et al. (1991), Mosenthal et al. (1995), Lerer and Myers (1994), Stone (1993), and Wen, Tsai, and Tsai (1992)
Hospital records	Bell et al. (1990), Robinson and Shor (1989), and Waller, Payne, and Skelly (1989)
Worker's compensation claims	Schnitzer and Bender (1992), Rossignol and Pineault (1993), Cheadle et al. (1994)
Multiple data sources	Sorock, Smith, and Goldoft (1993) and Burkhart et al. (1993)
Observations and interviewing the workers	Mattila (1989)

Waller and Payn (1989) made the following interesting point:

> *"... Comment should be made about prior research concerning construction-related injuries. Most of the researchers deal with injuries resulting in hospitalization or fatality, or present data from patients seen at*

> *trauma centers without distinguishing between those patients receiving primary care and those referred from elsewhere. In both cases, because of selection biases, the resulting analysis is unable to provide an accurate picture of the distribution of injuries. For example, such studies are likely to miss injuries of the back and upper or lower extremity that are relatively minor concerning threat of life, but that nonetheless accrue prolonged disability."*

Magnitude of the problems is best described by the incidence. The accuracy of estimation of the incidence of injuries based on the secondary sources of information is questionable. Rael et al. (1996) pointed out that calculation rates of occupational injury claims is essential to identify groups at high risk, yet limitations of denominator data have often restricted our capacity to do this. Schnitzer and Bender (1992) complied data on occupational injury fatalities in Alaska for the period 1980-85 using workers' compensation claims and death certificates as the sources of information. These data yielded an average annual fatality rate of 5 times higher than the Bureau of Labour Statistics estimate that was based on notifications by construction companies. Lerer and Myers (1994) found that unreported deaths accounted for 25% of all fatal occupational injuries in the construction industry. Besides that, Waller and Payne (1989) found that majority of injuries was minor and only 6% resulted in hospitalization.

Mild injuries that are mostly not hospitalized are also of interest. Waller and Payne (1990) studied mild injuries and found that during the six months after the injury, patients averaged 11.6 days of absence from work, 10.3 days of reductions in home activities, and 13.1 days of reductions in recreation.

Although injury was the leading cause of illness among construction workers, it was never been studied in Thailand. Findings from cross-sectional survey was questionable as it was obtained only from healthy workers. Profound knowledge of injury including its magnitude, its distribution by time of onset, place of occurrence and workers characteristics, and its risk factors could lead to formulating effective preventive measures. Therefore the longitudinal study was planned. Details of the study was provided in Chapter 8.

1.3 Justification

Payton and Robio (1991) argued that the reduction of work place accidents and injuries starts with the fundamental understanding of why and how they occur. Once we have that knowledge, we can address the causes of those accidents. Without the basic information, we cannot find effective methods of accident prevention.

In Northeastern Thailand, several characteristics of the construction labor force, as well as the construction sites, are different from those in other areas mentioned above. For example, there are many small subcontractors within a site. Most of them are unskilled, temporary and local residents, and have no any insurance. The Labour Legislation is not fully enforced. Thus differences in several aspects of injuries are to be expected in this setting compared to those reported in the international literature.

Additionally, as data were from secondary sources, most studies provided only the crude estimates of incidence of injuries. Few studies provided details of the characteristics of injuries. In other words, the epidemiology of injuries in the construction industry is not clearly documented. No study has ever been conducted in Thailand documenting such information.

This was a longitudinal study aimed to provide an insight picture of injuries among construction workers from the perspective of occupational exposure. It covered several issues: the incidence of injuries, the distribution of injuries according to the demographic characteristics of the workers, type of work, shift work, time of occurrence, type and cause of injuries, predictors of injuries and so on. The injuries included not only those which required hospitalization but also the milder injuries that caused absence from work.

As reported by Howell, Brown and Atkins (1990), lack of a comprehensive and reliable surveillance method is a major obstacle in assessing the occupational injury problem. Thus the study also aimed to estimate the magnitude of under reporting of injuries if only secondary sources of information were used. This study may also pave the way for planning the establishment of a surveillance system for injuries in the construction industry.

CHAPTER 2

METHODOLOGY

This Chapter describes methodology of the study. Statistical methods had been provided in more detail than what is usually found in ordinary study. The purpose of this was to make it useful for future study of the same kind in addition to inform readers of this study.

2.1 Objectives

This study aimed to describe the epidemiology of injuries among construction workers. The specific objectives include i) to estimate the incidence of the injuries such as Total Incidence Rate, Lost-time Injury Rate, and Lost work-days Injury Rate; ii) to describe the distribution of injuries by type of injuries classified by body part and the source of injuries, by the workers' characteristics (e.g. age, sex, education, marital status, type of work, type of employee, work experience, health status, use of personal protective devices, etc.), by time of onset (e.g. time of the day, day of the week, and day of the month), and by environment (where the injuries occurred such as the floor of the building, scaffolding, roof, etc.); and iii) to determine factor affecting injuries.

2.2 Population and sample

The target population was all construction workers in urban areas of the northeastern Thailand who work on the construction sites with 200 or more workers. All construction workers at two large scale construction sites in Khon Kaen formed the study population.

2.3 Sample size

For sample size determination, the general characteristics of the workers as well as the working environment were relatively homogeneous among the sites. No matter which sites or where they were employed, most of the workers were similar- unskilled, employed temporarily, and local residents. The injury rate found in the study in Khon

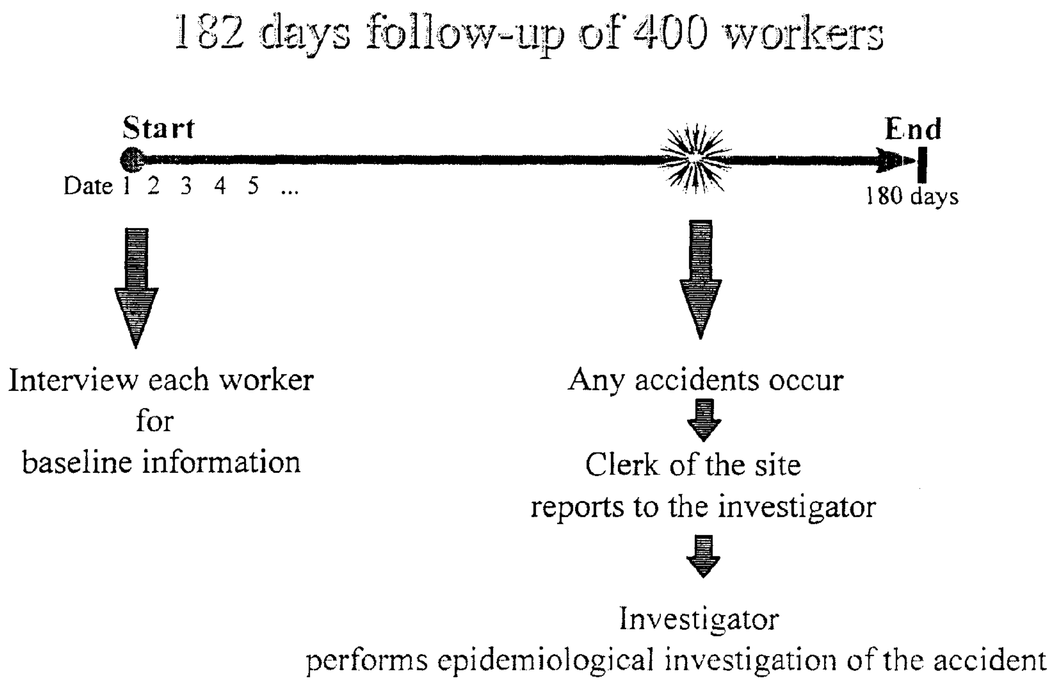
Kaen in 1995 was 0.03 per 100 worker days. This figure was, believed to be an underestimate because it was obtained retrospectively. Moreover, only those injuries which caused the worker to stop working were of interest. A pilot study carried out at a construction site of 150 workers for 5 days prospectively yielded the incidence rate for all injuries, both mild and severe, of 0.6 per 100 worker days. Therefore, the sample size of 400 workers followed for 180 days, resulting a total of 72,000 worker-days, would be expected to detect approximately 400 injuries. This was sufficiently large to estimate crude incidence rates to within plus or minus 0.00001 per 100 worker days (95% confidence interval). For estimation of proportions describing the distribution of injuries, the size of 400 injuries would yield a proportion to within plus or minus 0.01 (95% confidence interval).

2.4 Design of the study

This is a prospective study. All the construction sites where the average number of workers per day was 200 or more and which agreed to participate in the study formed the sampling frame. There were a total of 23 building sites of this kind on the day of establishing the sampling frame. Two sites were randomly selected from the frame.

All workers at the study sites were followed on daily basis (Fig. 2.1). The duration of the study was 182 days (1 October 1996 to 31 March 1997). The baseline characteristics of the workers were collected using the Form 1 (Appendix 3) and interviews with all workers. This form was used only once, at the beginning when the workers entered the cohort. The clerks of the sites were asked to record all injuries which occurred within the sites using Form 2 (Appendix 3) and first aids attendance of the workers using Form 3 (Appendix 3). They were trained to perform this activity. It was an additional responsibility, aside from their routine job of recording the hours worked by each worker everyday. It required some skill asking the workers a few questions about who was injured on the previous day. Also a well trained Research Assistant (RA) went to each site everyday in the afternoon to examine Form 2 (Appendix 3) and note the names of any workers who were injured on the previous day and to interview them using the injury investigation form in Form 4 (Appendix 3). The interviewing were conducted on the site for the mild cases. For those who had to stop working, the RA went to their place of residence or the hospital where they sought care to collect the data required for the injury investigation form.

Fig 2.1 Design overview



Various information was obtained from the workers themselves as to what jobs they were assigned each working day as well as the job at the time of injuries. It provided task-specific data for describing the event leading to injuries. Details of the circumstances of injuries were obtained through observation of the place of occurrence and interviewing the injured workers and their colleagues at the work sites. Data collection form was adapted from a standard format of epidemiological surveillance notification form designed by the Division of Epidemiology, Ministry of Public Health of Thailand.

The present study used the same language as the workers with respect to the definition of injuries. This is important for Thai people since the term "injuries" in their sense means more serious one. We applied the phrase commonly used in the Northeastern local language to cover minor injuries so that these were also documented.

2.5 Study variables

The variables to be studied include: 1) baseline information of the workers (demographic characteristics, working experience, and perception on accident and injuries); and 2) epidemiology of injuries (time of onset, job at the moment of injuries, body region being injured, type and results of the injuries, place of the incidence, time lost, and environment related to the incidence including tool used).

2.6 Statistical methods

Regarding statistical methods, measurement of injury frequency is one of the main interest. A dichotomous outcome (injured / not injured) was recorded daily, for each worker, for a period of 182 consecutive days. However, the cohort was not fixed. That is, not all workers were observed each day since a number of them, through out the study period, were absent from work for variety of reasons including injuries. Thus the number of workers observed each day varied widely. Additionally those who were not at work were not at risk of work-related injury. Therefore the number of worker-days is the appropriate denominator and the episodes of injury is the appropriate numerator for estimating the incidence. This ratio was called the incidence density by Miettinen (1976) but is referred to as the Incidence Rate (IR) through out this report.

The author adopted the definition of the incidence rate for injuries from the Bureau of Labour Statistics (BLS), USA (Payton and Robio, 1991). There were 3 main categories:

i) Nonfatal injuries where the workers sought medical treatment only but not lose any days off work. The incidence rate obtained was "Medical only injuries IR".
ii) Injuries which cause the worker to lose some time off work, but not whole days. The incidence rate obtained was "Lost-time injuries IR". In this study, lost-time injuries refers to the injuries that caused the workers to stop working for at least half an hour but less than one whole day. We use the duration of 30 minutes as the cut point since the employers applied this in counting the duration for wage payment - working more than 30 minutes will considered 1 hours and none otherwise.

iii) Injuries which cause the workers to lose whole days off work. The incidence rate obtained was "Lost work-day injuries IR". This rate based on absence status. Absence was defined as non-attendance at work by an employee when attendance was expected by the employers. Workers who were absent for any days after an the injury were asked about the reasons the first day they came back to work. This information was used to determine lost work-day injuries. From the day after the incident, each injured worker was followed for 1 week to ascertain any absences and the reasons. Lost work-day injuries were then identified as those where the injured workers were absent at least one day due to the injuries.

In this study data were collected prospectively and active case finding was performed, so the number of cases could include injured workers who did not seek any treatment, who used self care only, and who required only first aid treatment at the construction sites. Since it was found that injuries without time lost were not only minor but also severe injuries (see discussion in Chapter 12) and the injuries with time lost is difficult to identify, the total incidence rate was then estimated in place of category (i) - the medical only injuries. This was also facilitate comparison with other studies which such estimation was a common practice for the study of injuries in Thailand. The IR for category (ii) and (iii) were well adopted and estimated.

Another main interest is determining factors affecting injury. Statistical methods for this need to consider the nature of the data.

All workers were followed daily at the construction. Some days there were as many as three shifts - 8.00 am. to 5.00 pm., 5.00 pm. to 11.00 pm., and 12.00 pm. to 06.00 am. Thus the usual daytime shift lasted for 8 hours and the two extra shifts, if any, lasted for 6 hours each. Not all workers came to work every day, some worked both usual shift plus one or two extra shifts -some worked overtime, and some work only one or two extra shifts but not the daytime one. To simplify interpretation of findings, one shift of work was considered as one worker-days. This is also the principle of counting workdays for wages estimation by the construction company. One calendar day the worker attend the work was considered as one occasion of observation. Thus one occasion per one worker could have at least 1 worker-day and no more than 3 worker-days.

There were a total of 966 workers involved in the 182 days of the study period. The number of worker-days for each worker ranged from 1 to 185 (median = 37). There were a total of 50,387 worker-days observed on 49,649 occasions. Among these a total of 815 injuries occurred. Of 48,930 worker-days there was no injury occurred. One episode per worker-day was found at 722 workers-days, two episode per worker-day found at 20 workers-days, and three episode per worker-day found at 1 worker-day.

Note that the workers were at risk of being injured only if they came to work while they can stop working at any day as they were temporary workers. Thus time spacing between each occasion was not of interest. Time trend is also not the goal of the study and it was rather short period for such analysis.

From the nature of data, the outcome of interest was the number of injury. The number of injuries is a count variable that follows the Poisson distribution. It can have Poisson distribution or Negative Binomial distribution if there is more variation than would expected were the Poisson. Thus the general framework of the Poisson regression model for grouped cohort data would appropriate (Frome 1983, Frome 1985).

There are a number of statistical methods suit this data as well as the research questions. Few and the most suitable ones were discussed here. For the concept of analysis of longitudinal data and generalised linear models, readers are refered to Zeger and Liang (1992), Dobson (1990), and McCullagh and Nelder (1989), Hosmer and Lemeshow (1989),

Firstly the Multilevel modeling was considered (Goldstein 1991). It is possible to analyse the data taking all 49,649 occasions as level 1 of the model, and 966 workers as level 2 (Woodhouse 1996 page 100). However, there were 9 workers who had only 1 occasion (singletons). Sixty-four workers, 6.6%, had occasions of 4 or less which will cause difficulty in parameter estimation (Woodhouse 1996 page 18). Additionally, the level 2 variation that can be efficiently well determined by this method is not important for the research question - determining risk factors of the outcome. Thus a simpler method was considered.

Secondly the generalised linear model (GLM) was considered. For cross-sectional time-series data as in this report, the GLM with generalised estimating equation (GEE) approach was approprate (Liang and Zeger, 1986) This is simpler than the former and also suitable with the research question. Thus the author chose this method.

For a thorough introduction to GEEs in estimation of GLM, see Zeger and Liang (1986), Liang and Zeger (1986), Zeger, Liang, and Albert (1988), Liang and Zeger (1989), Zeger (1988), Zeger and Liang (1992), and Lipsitz et al (1994).

For the present study, the response variable was a counts of injuries for individual worker at each occasion. Identification number of individual worker was the variable that contains the series of observations - the occasions, and the calendar date was the time variable. Number of worker-days was an offset. The GLM setting was that the family as Poisson and log as the link function. The correlation structure was initially examined by fitting the model with unstructured correlation. It was found to be no pattern. Thus it was assigned to be exchangeable. This assigned correlation structure is well acceptable under the GEE framework. However robust estimation - the Huber/White/sandwich estimator of variance was used in place of the traditional calculation. This alternative produced consistent standard error even if the residuals across individual workers are not identically distributed or the correlation within workers are not hypothesized by the specified correlation structure (see StataCorp 1977 - Reference P-Z page 579).

Computations were performed using STATA Statistical Software version 5.0. The command for GLM using GEE is "xtgee". Readers are referred to StataCorp, 1977 - Reference P-Z, page 596-627 for more details. Note that the computer program used for the analysis has been updated on 14 October 1997 to deal with groups containing one observation(singletons)correctly (see http://www.stata.com/support/updates/index.html).

There were two main parts of data analysis - univariate and multivariate. For the first part, incidence rate per 100 worker-days were calculated for each selected variable. These were adjusted for clustering within worker. Then relative risks and their 95% confidence intervals were estimate using univariate GLM using GEE. Thus all estimates were adjusted for clustering.

The second part, all independent variables whose p-value was 0.25 or lower were considered to be put in the initial model. The initial model also contained clinical and biological meaningful interaction terms. Backward elimination was applied as the model fitting strategy which was more appropriate than Backward Stepwise method where the modeling was the risk assessment rather than the predictive one (Klienbaum, 1994). Interaction terms were assessed by removing out the term with the highest p-value for the Wald statistic, one at a time, followed by the main effect. The effect of each term to the model was examined using the difference in deviance between the models with and without the term being assessed. The p-value was obtained by comparing that figure with Chi-square distribution with N-P degree of freedom, where N is the number of parameters in the model with the variable being assessed and P is that of the model without such variable (Frome 1983).

The statistical methods for determining factors affecting injury mentioned above were not only applied for all type of injuries but also for the lost-time injuries and lost workday injuries. This was done based on empirical knowledge that the cause of each type of injuries may differ. Findings of this analysis were presented in Chapter 5.

CHAPTER 3

BASELINE CHARACTERISTICS OF THE COHORT

This Chapter describes selected baseline characteristics of both the study construction sites and the workers participated in the study. All findings for this Chapter are summarised in tables shown in Appendix 1.

3.1 Characteristics of the study construction sites

The study was conducted at two large construction sites managed by two different companies. Site A was a building for government offices. It was a 7-floor building with the highest point of 22 metres from the ground level and the usable area of 14,896 square metres after completion. The construction was planned to be completed within 24 months. The cost of construction was 75.9 million Bahts. Site B was a residential building. It was a 6-floor building with the highest point of 21 metres from the ground level and the usable area of 8,186 square metres after completion. The construction was planned to be completed within 24 months. The cost of construction was about 64.9 million Bahts.

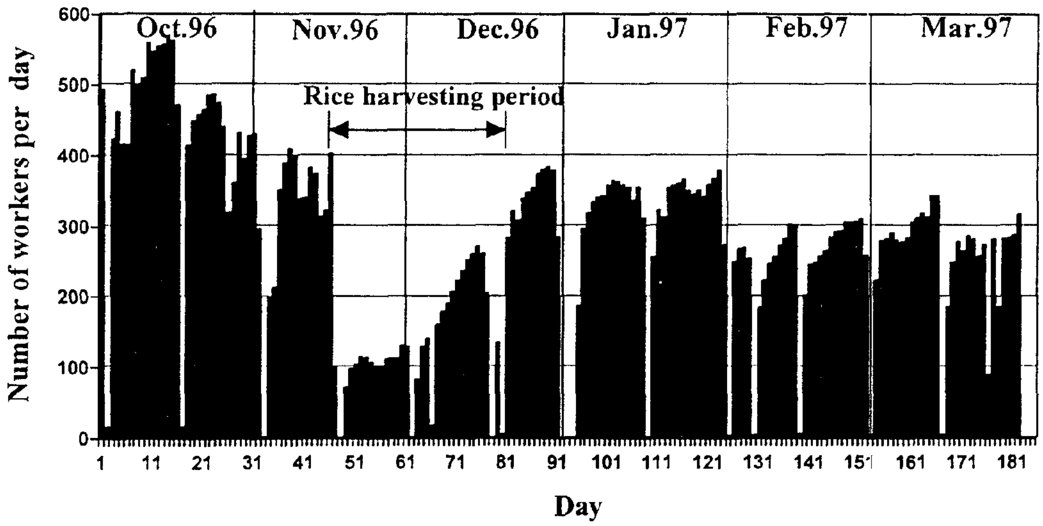
At the first of October 1997 when the study started, the construction had been going on for 9 months at Site A and 7 months at Site B. Both sites were working at the 3rd floor. Site B had started later than planned due to financial reasons. At the 31st of March when the study ended, the roof of the building had been completed at both sites. During the study period the construction jobs covered all jobs performed by labourers, carpenters, masons and steel workers. The jobs involved working at the ground level, above the ground level at various heights, in or outside the buildings such as working at the scaffold, and on the roof of the buildings. The remaining jobs after the study were mainly masonry such as plastering and grinding the floor, plumbing, electrical work and all other interior decoration.

Thus the sites were similar in most characteristics. The sampled sites was also similar to most of the sites found during the previous survey conducted at the same province in late 1995 by the author. This type of construction site employed more than 80% of all construction workers.

3.2 Number of workers per day

During the study period of 182 day, there were 17 days when Site A was totally closed and 19 days when Site B was closed. Each site closed for the day after each payment day, two days a month, giving a total of twelve days. The remaining days of closure were public holidays. The maximum number of workers per day for Site A was 323 and for Site B was 244. Median number of workers per day for Site A was 145 and for Site B was 143 (Figure 3.1). Apart from the days when the sites were closed, there was an obvious pattern of fluctuation of number of workers per day. The number of workers per day sharply decreased between mid November and mid December. This was the usual harvesting period for Thai rice. The variability in the number of workers per day was because most of construction workers were also farmers and absence from work was common.

Fig. 3.1 Number of workers per day working at the two study sites



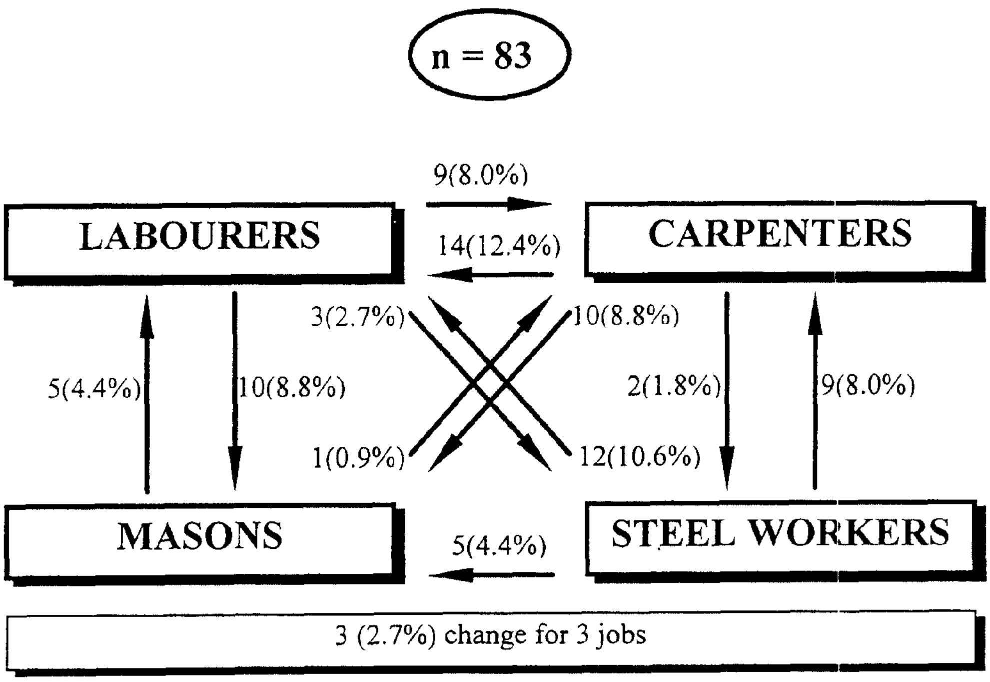
3.3 Total number of workers during the study period

There was a total of 1,077 workers during 182 days study period. One hundred and one workers, 10.3%, were excluded from the cohort: 15 were the company employees whose daily work attendance was not available, 70 were assigned to jobs not of interest in this study (such as painters, plumbers, or electricians) and 26 refused to participate. Thus there were a total of 966 workers for the cohort, 549 from site A and 417 from site B.

3.4 Changing job within the site

During the study period, most of the workers, 91.4%, were assigned to only one type of job - either labourer, carpenter, mason or iron worker. However there were 83 (8.6%) workers who were assigned to more than one jobs in different period (Figure 3.2). This had to be taken into account when measuring duration of exposure to particular jobs.

Fig. 3.2 Workers who were assigned to more than one job (data from both sites)



Changes of job was not at random (Exact test for symmetry p-value = 0.0002). The highest proportion of the changes was among those who were initially assigned as steel workers - 26 out of 173 (15%) of them changed to other jobs. The remaining type of workers changed their job less than 10%. No workers was found in both sites.

3.5 General characteristics of the study workers

3.5.1 Demographic characteristics

There were no statistically significant differences between the two sites in any of the baseline characteristics (data not shown). Therefore data are presented for the two sites.

Among the total of 966 workers, 59.7% were males and 40.3% were female (male:female ratio = 1.5 : 1, Table A1.1). Their ages ranged from 13 to 64 years old (median = 28). Most of them were married (66.4%), had primary school education (82.6%), and were farmers as their main occupation (52.2%). More workers, 53.5%, lived in their original homes than lived in the camp sites, 45.5%.

3.5.2 Occupation

At the beginning of the study most of the workers were labourers (37.6%) or carpenters (30.0%) (Table A1.2). Most of them had less than 1 years experience of construction work before working at the current site. Almost half (49.4%) were newly employed and could be considered as lacking experience. Additionally there were 26.8% of workers who were assigned to the different jobs that they had had before. These workers can also be classified lacking experience. Thus there was a total of 76.2% of the 966 workers lacking experience. However 63.7% of the workers reported that they have been trained for the current job before working (either formally or informally). This reflects their opinion as 85.6% said they were skillful in their current jobs. Sixty-three percent preferred to work as construction workers although more than one quarter said they were forced to work by others.

3.5.3 Workers' perceptions of accident

Perceptions of the workers about accidents from construction work are shown in Table A1.3. Almost all of them perceived that construction workers have a high risk of being injured (96.1%) and that injuries can be prevented (95.5%) although 61% of them thought that accidents were due to chance. Most of them, 77.4%, perceived that working as currently did could lead to injuries and they, (86.8%), needed to be brave to challenge dangerous circumstances. Most of them (76.4%) agreed that accident prevention is their own responsibility and that even the minor injuries still be important (59.4%).

Three quarters of the workers perceived that accident prevention is their own responsibility. Those who perceived that using personal protective devices (PPDs) show they are cowardly was only 6.6%. However, 39.1% of them agreed that the risk is not change even if one does wear helmets. Almost all of them (96.1%) perceived that there is a high risk of getting injured in construction work. Thus 86.8% of them said they need to challenge any dangerous circumstances. About one fifth (22.4%) of them believed that they will not get injuries even if they are working as they currently do.

Most of the workers believed that the most important cause of injuries was carelessness or ignorance of the workers themselves (80.3%). Nobody mentioned the lack of PPDs as a cause of accidents.

Almost half of the workers reported that the person who always warns them to work carefully was the foreman.

CHAPTER 4

CHARACTERISTICS OF INJURY

This Chapter provides information about the nature of the injuries experienced by the construction workers. The information related to the distribution of injury according to the time of onset, characteristics of workers, and characteristic of place of occurrence. Since this Chapter emphasizes the nature of the injury, it deals with the episodes of injury rather than the individual injured workers.

4.1 Magnitude

There was a total of 889 injuries investigated during 182 days study period. Seventy-seven episodes were excluded as they did not occur in the study workers (64) and or were not occupational injuries (7). Therefore 815 injuries were included in the analysis.

Among the cohort of 966 workers, most of them did not work full time (Table 4.1). They worked a few days, for example, 539 out of 966 (55.8%) worked less than one and a half month. There were 632 workers (65.4%) who free from injury and 334 (34.6%) injured at least once. More than half [179 (53.6%)] of the injured workers experienced more than one injury. The proportion of those who had 1 or 2 injuries increased as the number of work-days increased. The largest proportion of injured workers (68%) was among those who worked for 121 - 135 work-days. The number of work-days could exceed 182 because they worked overtime. However there were a number of workers with fewer than 182 work-days who also worked overtime.

Table 4.1 Number of workers by number of injuries and their total number of work-days.

Number of work-days	n	Number of injuries													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
1 - 15	244	232	10	2											
16 - 30	172	137	27	6	1		1								
31 - 45	123	96	20	3		3				1					
46 - 60	76	44	13	11	3	2		2							1
61 - 75	66	28	17	7	5	5	2	2							
76 - 90	69	28	14	11	6	2	7							1	
91 - 105	58	17	10	10	4	6	5	3	1	2					
106 - 120	60	20	12	10	6	2	4	2	1	2		1			
121 - 135	49	13	16	8	4	3	2	1	1	1					
136 - 214	49	17	15	4	5	2	3				1		2		
Total	**966**	**632**	**155**	**71**	**34**	**25**	**24**	**10**	**3**	**6**	**1**	**1**	**2**	**1**	**1**

Among 334 injured workers - 155 (46.4%) injured only once and 179 (53.6%) injured more than one occasion during the follow-up period (last row of Table 4.1). The maximum number of injuries per workers was 13 while the median was 0.

Some workers appeared to be prone to injuries. We reviewed the data for workers who had more than 5 injuries. There were 25 (7.5%) workers in this category where the total number of episodes of injuries were 195 (24% of the total 815 episodes). These workers had worked for at least 42 days and as high as 145 days (median = 101 days) constituting a total of 2477 worker-days. Thus the incidence rate for this injury-liable group was 7.9 per 100 worker-days (95%CI; 6.8-9.0). Among these 25 workers, 23 were male, 16 were aged less than 30 years, 19 were carpenters, and 21 worked at Site B. Most of them (21) were either new construction workers or had been just assigned to the jobs which were different from their previous ones. Six of them were found to be drunk on the day of at least one episode of injury.

We conducted in-depth interviews of 6 workers who were injured on 9 or more occasions three months after the study period. These 6 most injury-prone workers contributed a total of 66 episodes of injuries (8% of the total 815 episodes). All of them were male, 5 carpenters and 1 labour, 2 at Site A and 4 at Site B. Five were new construction workers whereas the remaining one was just assigned to the job which was different from what he ever done. Four of them were found to be drunk on at least one occasion of injury.

Among a total of 50,387 worker-days observed there were 815 episodes of injuries. There were 660 episodes of injuries where these injured workers stopped working for at least half an hour. Among this, 162 episodes where the workers stopped working for a day or more. Incidence rate of injuries were given in Table 4.2. It can be expect at least 6 injured workers per day for building site where there were 400 workers. About 5 of them were lost-time injuries and 1 of them was lost work-day injuries.

Table 4.2 Incidence rate (per 100 worker-days) of injuries by type of the rate

Type of the indices	**Crude**		**Adjusted***	
	Rate	**95%CI.**	**Rate**	**95%CI.**
Total incidence	1.62	1.51 - 1.73	1.54	1.38 - 1.72
Lost-time injuries	1.31	1.21 - 1.41	1.28	1.14 - 1.43
Lost work-day injuries	0.32	0.27 - 0.37	0.33	0.27 - 0.40

*Note: *The rates were adjusted for clustering on workers*

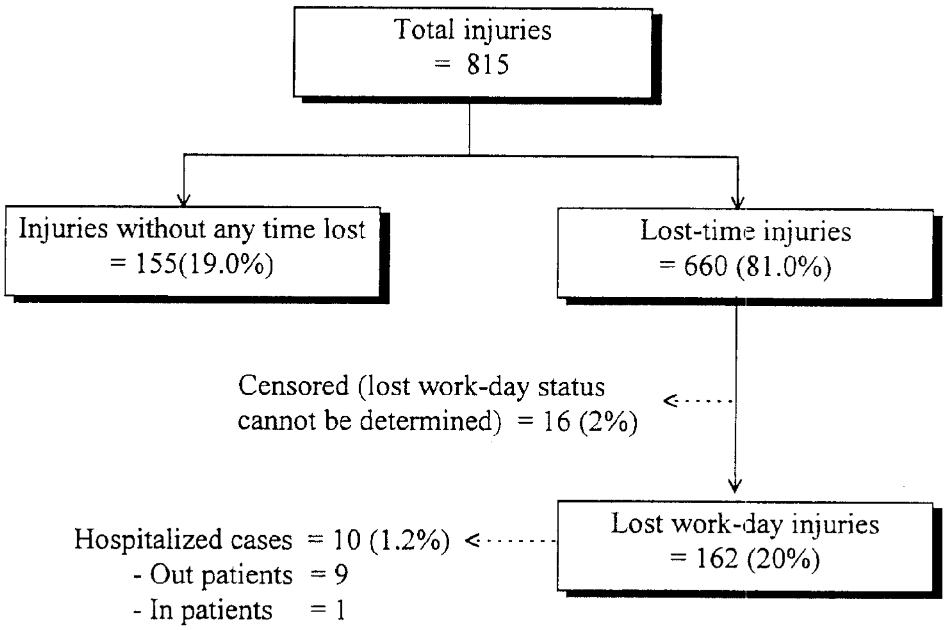
4.2 Iceberg phenomenon of the injury

Among the total of 815 injuries, for 653 (80.1%) the worker stopped working for less than one day and needed only first-aid medical care. There were 152 (18.7%) injured workers who stopped working for at least one day (lost work-day injuries) but were not hospitalized. Only 10 (1.2%) injured workers were hospitalized and, of course, lost work-day. This is the tip, visible part, of the iceberg - the fraction of injuries that can be recognized by routine health information system. The ratio of lost-time injuries plus medical only cases : lost work-day injuries : hospitalized injuries is equal to 653 : 152 : 10. In other words, we will expect 80 injuries for every 1 hospitalized cases - 65 were lost-time injuries and medical only cases and 15 were lost work-day injuries. There were

16 injured workers who never come to work again after the date of injury. All were lost-time injuries but were considered censored for lost work-day injuries.

Among the total of 162 lost work-day injuries, 10 went to hospital. Only one who broke his leg was admitted as an inpatient. His leg was broken because the reinforced steel fell from the truck while downloading. The remaining 9 injured workers were treated as out patients attending hospital for a few hours. These included 5 head injuries, 1 hand cut by an axe, 2 eye injuries from steel pieces while cutting using a gas welder, and 1 lost a finger caused by a steel bender. Fig. 4.1 summarised details.

Fig 4.1 Categories of injuries by their nature of time lost and medical care (all proportions provided using 815 total injuries as the denominator).



4.3 Distribution of injuries by the time of onset

Since the number of workers varies by day, the daily pattern of injuries was presented using the incidence rate rather than number of injuries. Distribution of total injuries by the time of onset is presented in 4 ways - daily, day of the month, day of the week, and time of the days, as follows:

4.3.1 Incidence of injuries by date of onset

The daily incidence of injury varied widely throughout the study period (Fig. 4.2). Ignoring the days where the construction sites were closed, the minimum incidence was 0.19% (95%CI.; -0.18 to 0.57) on October 7, 1996, when there were only 1 injury among 520 workers on the day. The maximum incidence was 5.78 per 100 worker-days (95%CI.; 3.32 to 8.24) on October 24, 1996, where there were 20 injuries among 346 workers followed by on 10 February, 1997, where the incidence was 5.71per 100 worker-days (95%CI.; 2.81 to 8.62).

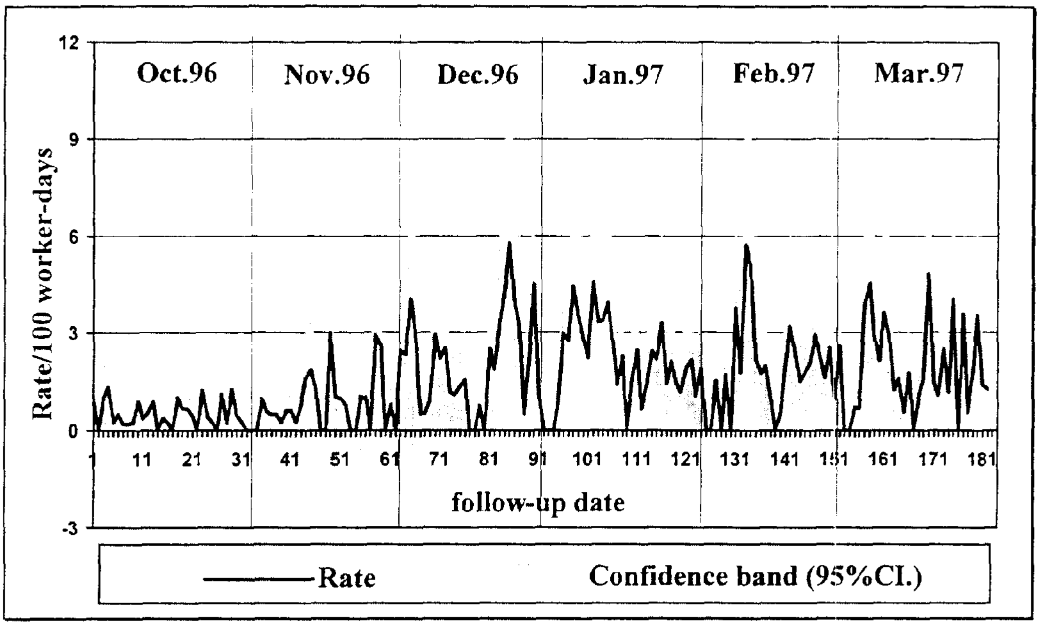
There was increasing trend in injuries from October to the end of December, 1996. Then the pattern stabilised although there was a slight decrease near the end of March, 1997.

The highest risk period was during the second half of December, 1996, and the first half of January, 1997. This was found closely related to the situation at Site B where the construction had been delay before that period due to lack of workers resulting from the rice harvesting period. There was evidence of forcing the workers to work more intensively in order to meet the deadline of a periodic checkup by the owner of the site. It was the most probable explanation of such a high risk period.

The second peak during the first half of February also found only at Site B where the workers disassembled the concrete frame. This type of work was found to be a major cause of injury (data shown in the next chapter).

Rain was rare during the study period and it was found to have no association with the risk of injuries (data not shown).

Fig. 4.2 Incidence of injury per 100 worker-days by date of follow-up

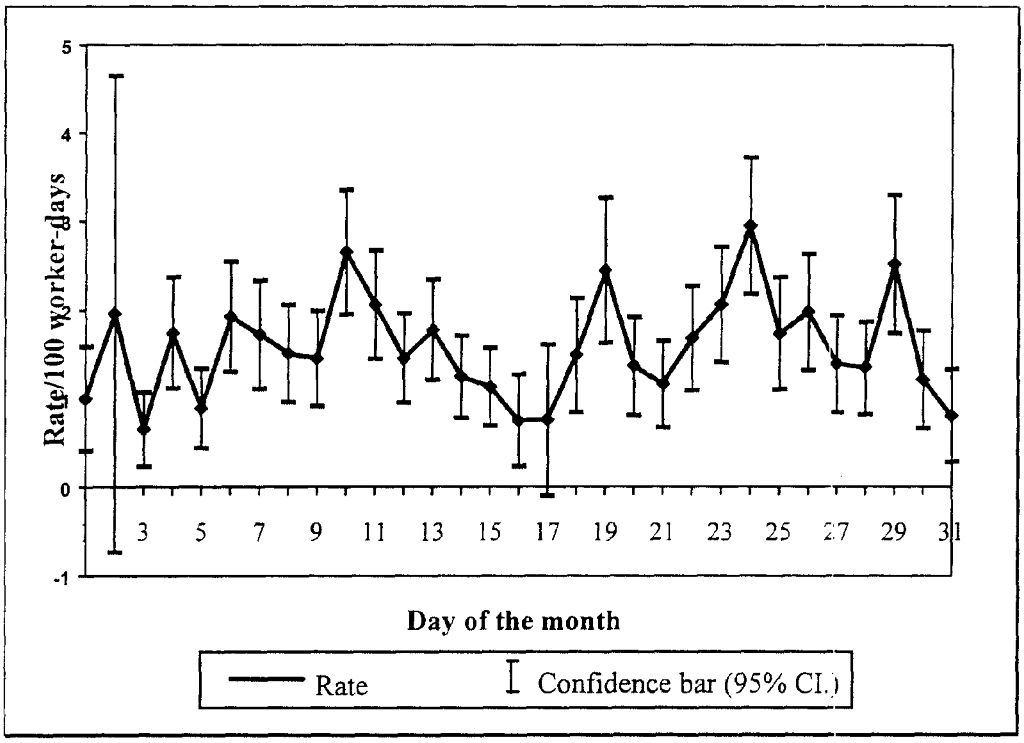


4.3.2 Incidence of injuries by day of the month

There are two periods based on wages payment dates and the closing date of the construction sites - the 1st and the 2nd half of the month. There was some evidence of higher risk at the middle of each half; the incidence increased from the first day of work to the 7th or 8th day of each period then decreased (Fig. 4.3). Causes of this pattern were examined simultaneously with other effects in Chapter 11.

The confidence intervals of the incidence on the 2nd of the month was quite wide (1.96%, 95%CI.; -0.73 to 4.65) since there were only 2 injuries out of 102 worker-days. This was the usual date for closing the sites - the day after payment date. Thus we can see the same pattern for the 17th of the month which was also the date for closing the site after payment date.

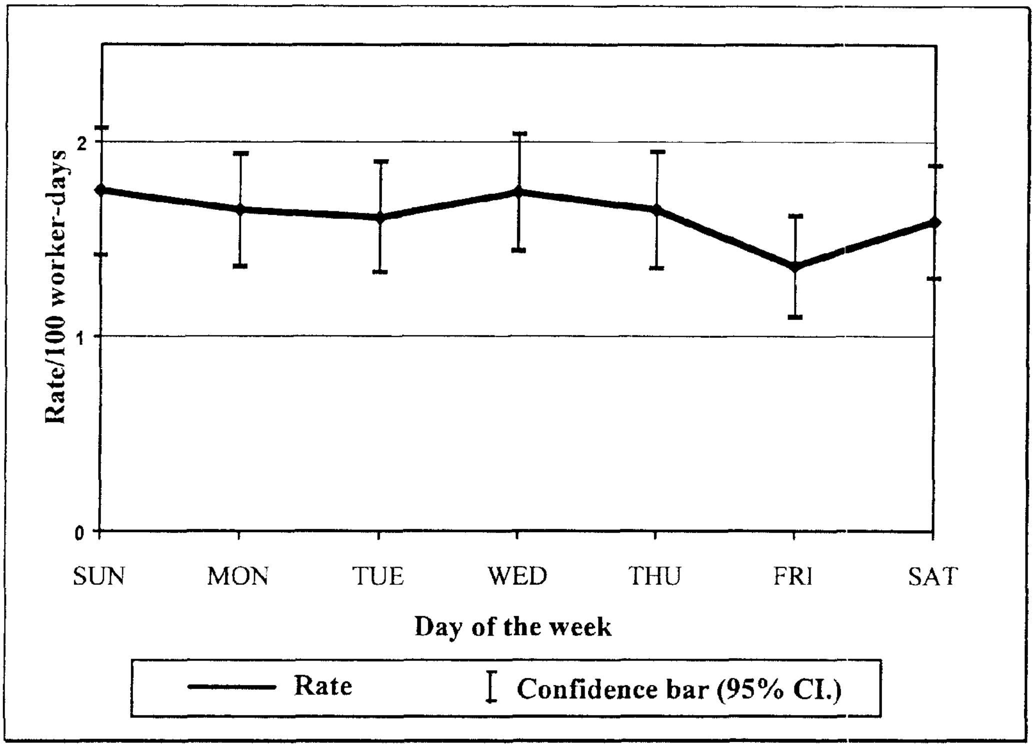
Fig. 4.3 Incidence of injury per 100 worker-days by day of the month



4.3.3 Incidence of injuries by day of the week

The incidence of injuries varied little through out the week suggesting the day of the week played no role in the risk of injuries (Fig. 4.4).

Fig. 4.4 Incidence of injury per 100 worker-days by day of the week



4.3.4 Number of injuries by time of onset during the day

Since there were the same number of workers within the same day, we used the number of injuries to illustrate pattern of injury by time of the day rather than the rate (Fig 4.5). Construction work starts at 7.00 am. there is a break for lunch during 12.00 to 13.00 pm. and work stops at 17.00 pm. every day. Although there were some workers worked overtime for some days but there was only 10 injuries reported. This was excluded here and there were 805 injuries included in this analysis

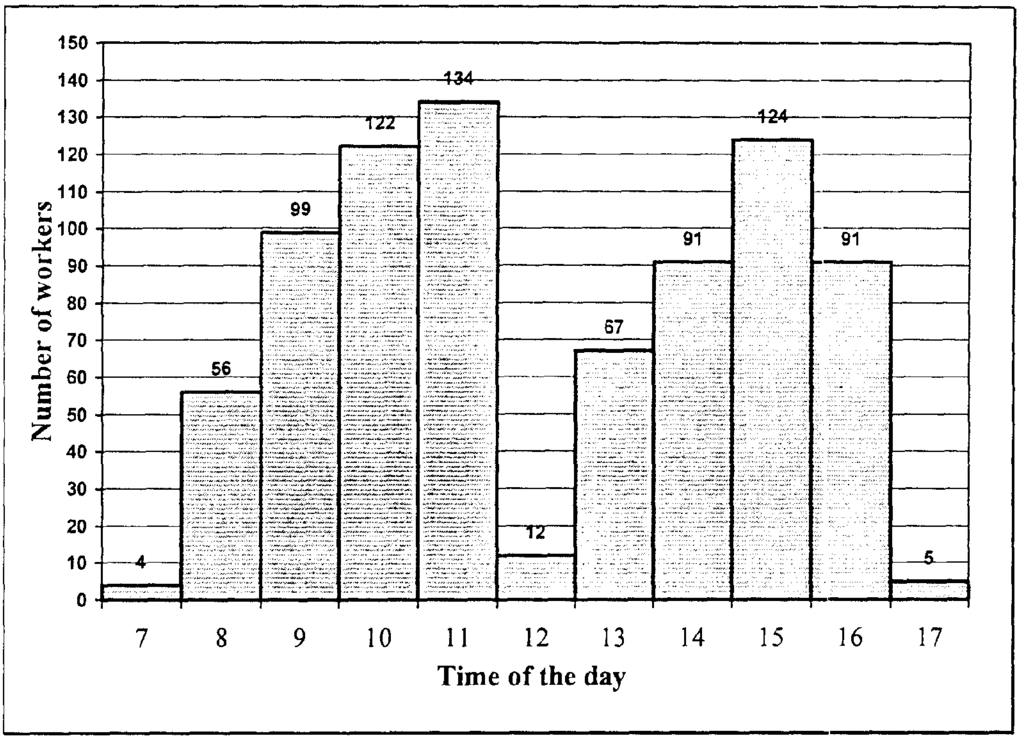
Number of injuries increased from early of the working day to a maximum before noon when there were 134 injuries. There are two main reasons for this pattern. Firstly most of the heavy work, such as cement flattening, were assigned during the first half of the day. This work is closely supervised by the foremen. The workers are forced to work hard without resting. This is a cause of exhaustion which the workers said was their physical state when they were injured (71%, data shown later in this Chapter). Secondly they were hungry for lunch. This was found to be reasons for most cases of injuries before lunch (data not shown). Thus this is a second source of stress and also could also be a consequence of the first.

There was a few injuries (12) during lunch time. Most of them occurred while walking down the building sites for lunch.

For the second half of the day, there was also an increase from 1pm. to the maximum of 124 injuries at 3pm. Then the trend was decrease to the end of the day. Overall there were more injuries during the first half of the day (415) than the second half of the day (378) excluding injuries at noon (12). This can be explained by the fact that little or no intensive work is assigned in the afternoon. The workers are also allowed to rest.

Two points of time during the day where there were a few injuries - 7am. and 5pm. This was because in early morning most of the workers are just preparing things ready for the work. They were also still fresh. Late in the day, they are allowed to rest and most of them stop working to prepare to go back home. The last round of walking around the sites by the foremen was usually at 4pm. This caused fewer injuries at the end of the day.

Fig. 4.5 Number of injury by time of the day



4.4 Type of injuries

Among a total of 815 injuries, almost half of them, 374 (46%), were due to being struck against objects followed by being struck by objects (22%) and steps on sharp objects (15%) (Table 4.3). There was less than one quarter of all injuries, 100 (12.3%), caused by falling objects. Among these, 14 were head injuries alone which was aimed to protected by using helmets. It accounted for only 1.7% of a total of 815 injuries.

Table 4.3 Type of injuries by body region

Type of incident	Total		Body region		
	Number	Percent	Head & Neck	Trunk	Limbs
Struck against objects	374	45.9	34	8	332
Being struck by objects	180	22.1	15	4	161
Steps on sharp objects	123	15.1	0	0	123
Falling objects	100	12.3	14	5	81
Falls from same level	22	2.7	1	2	19
Falls from elevations	6	0.7	0	0	6
Contact with temperature extremes	4	0.5	1	0	3
Caught in/under/between	2	0.3	0	0	2
Others (transport injuries and unclassifiable)	4	0.5	0	0	4
Total	**815**	**100.0**	**65**	**19**	**731**

4.5 Outcomes of the injuries

The majority of injuries were laceration (42%), followed by abrasions (21%) and cuts or puncture wounds (20%, Table 4.4). Contusion, abrasion and laceration were common among all body region whereas cut or puncture wound was found mostly injury of the limbs.

There were 506 (62%) injuries which resulted in blood loss - laceration and cut or puncture wound combined. Two workers, classifying among those with abrasions, received eye injuries. One worker lost his finger (classified as cut or puncture wound). There was a worker who broke his leg. No one die.

Table 4.4 Outcomes of the injuries by body region

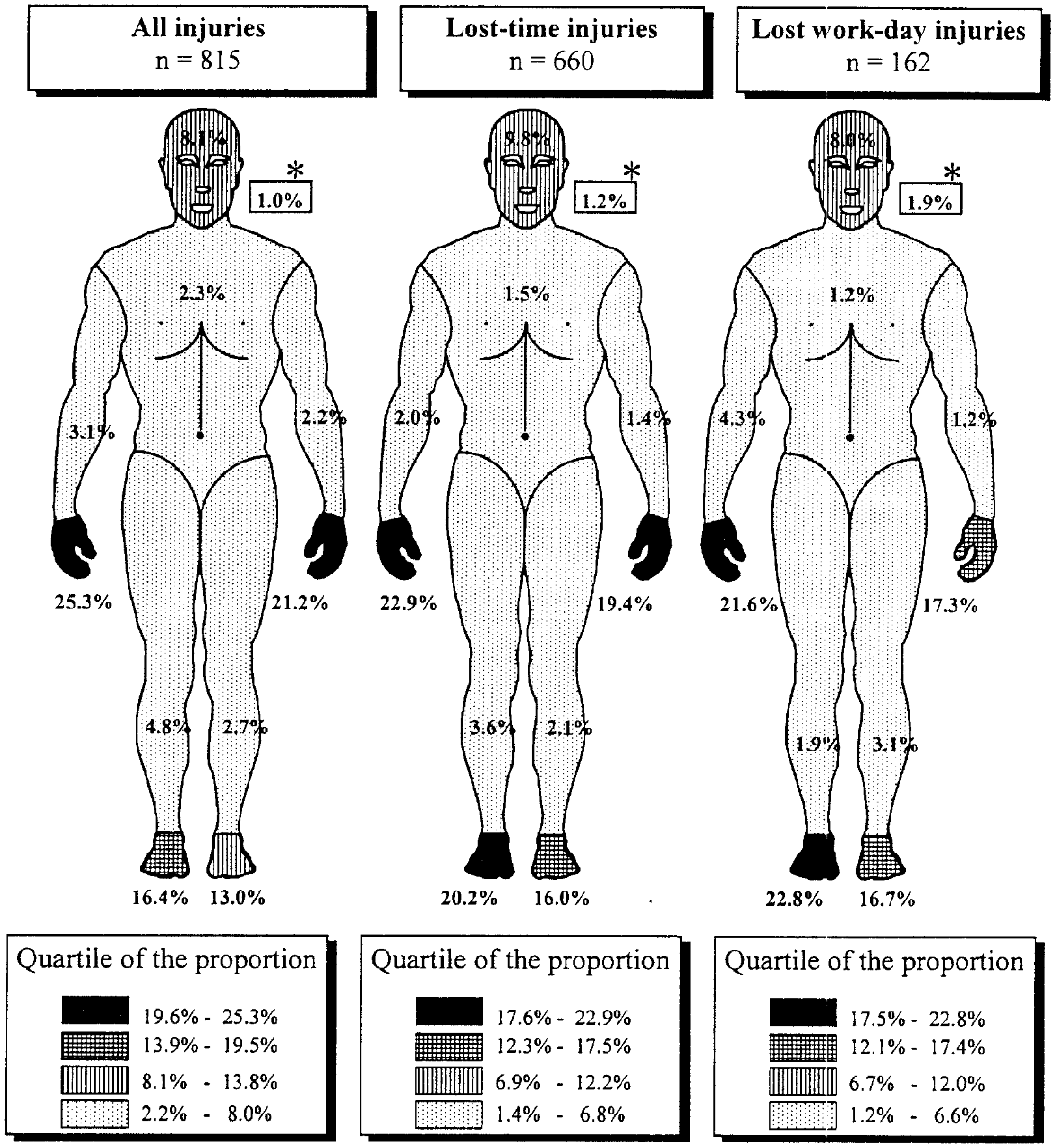
Results from the injuries	**Total**		**Body region**		
	Number	**Percent**	**Head & Neck**	**Trunk**	**Limbs**
Contusion	127	15.6	28	5	94
Abrasion	171	21.0	7	9	155
Laceration	345	42.3	24	4	317
Cut/puncture wound	161	19.8	5	1	155
Burn	6	0.7	1	0	5
Dermatitis	4	0.5	0	0	4
Others (broken leg)	1	0.1	0	0	1
Total	**815**	**100.0**	**65**	**19**	**731**

4.6 Distribution of injuries by body region

4.6.1 Injuries of the body

Almost all injuries involved just one part of the body. The most common injuries were to the hands and the right feet for all type of injuries where the proportion was at the highest quartile (Fig. 4.6).

Fig. 4.6 Proportions by body region of total injuries (n = 815), lost-time injuries (n = 660), and lost work-day injuries (n = 162).



Note: * = *Injuries at multiple sites of body region*

All the head injuries resulted in lost-time and 20% resulted in lost work-day (Table 4.5). Almost all of the feet injuries (99.2%) resulted in lost-time and resulted the highest proportion of lost work-day (26.7%), regardless multiple sites injuries.

Table 4.5 Proportion of lost-times injuries and lost work-day injuries using total injuries as the baseline

Body region	Total injury	Lost-time injury		Lost work-day injury	
		Number	% of all injuries	Number	% of all injuries
Hands	379	279	73.6	63	16.6
Feet	240	238	99.2	64	**26.7**
Head	65	65	100.0	13	20.0
Legs	61	38	62.3	8	13.1
Arms	43	22	51.2	9	20.9
Trunk	19	10	52.6	2	10.5
Multiple sites	8	8	100.0	3	37.5
Total	**815**	**660**	**81.0**	**162**	**19.9**

4.6.2 Injuries of the hands

About half of all the injuries 379 out of 815, 46.5%, involved hands. Half of the hand injury were to the thumb or forefinger (Table 4.6).

Table 4.6 Distribution of hand injuries

Hand injuries	Number	Percent
Thumb	92	24.3
Forefinger	95	25.1
Middle finger	43	11.3
Ring finger	28	7.4
Little finger	21	5.5
Palm of the hand	36	9.5
Back of the hand	41	10.8
Ulna side of hand	1	0.3
Multiple part of body including hand	22	5.8
Total	**379**	**100.0**

4.6.3 Injuries of the feet

The distribution of foot injuries is shown in Table 4.7. Since most injuries were to the sole of the foot, stepping on sharp objects is important. Injury to all toes combined was 35.1%, always due to kicking objects.

Foot injuries cannot be prevented by wearing slippers, which most workers wear. Slippers are similarly of little help. Special designed foot wear is needed (Fig. 4.7)

Table 4.7 Distribution of foot injuries

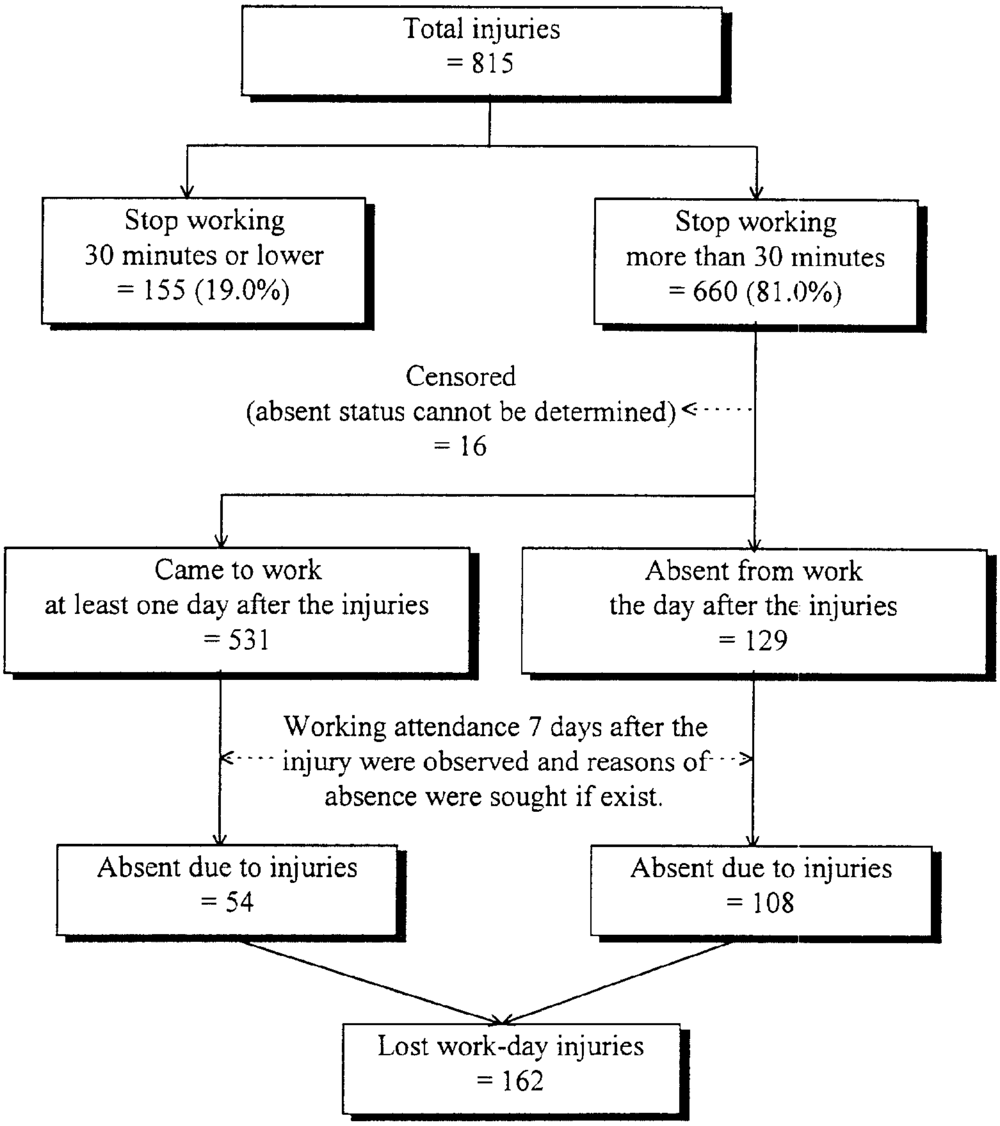
Foot injuries	Number	Percent
First toe	44	18.4
Second toe	13	5.4
Third toe	4	1.8
Fourth toe	8	3.3
Little toe	15	6.3
Sole of the foot	87	36.4
Top (instep) of the foot	27	11.3
Heel	29	12.1
Side/Ball of the foot	6	2.5
Multiple part of body including foot	6	2.5
Total	**239**	**100.0**

4.7 Injuries causing absence from work

For 129 of the 815 injuries (15.8%) the workers were absent the day after the date of injury (Fig. 4.7). Of these 108 (83.7%) the absence was due to the injury. For another 11 injured workers the reason could not be obtained as they did not return to work again. The remaining 10 injured workers were absent due to other reasons. The incidence was 1.98 (10/50387) per 10,000 work-days (95%CI.; 0.95 to 3.65). This could considered as a magnitude of error in estimating of lost work-day injuries if assuming all absentees were due to injuries.

Additionally, there were 54 episodes (6.6% of total injuries) were the worker came to work at least one day after the injury before being absent due to injury. This information was sought within 1 week of each injury. The incidence was 10.72 (54/50387) per 10,000 work-days (95%CI.; 8.05 to 13.98). This could also considered as the magnitude of error one could made if one did not ascertain lost work-day where the workers were absent after coming to work at least one day after injuries.

Fig 4.7 Number of injuries in relation to time lost



Approximately one fourth of all injuries got injured at the first working day after the last absent (Table 4.8). On average, the workers had working for 5 days before getting an injury.

Those who stop working due to injuries can be determined in 162 injuries who stop working at least 1 days and as long as 60 days. The median day for stop working due to injuries was 1 day.

Table 4.8 Duration before or after the injuries

Characteristics	Number	Percent
1. Number of consecutive working days after the last absence and before the date of injury		
0 (get injured on the first day of work)	105	12.9
1 - 10	478	58.7
11 - 30	179	22.0
31 - 60	45	5.5
more than 60	8	1.0
Total	**815**	**100.0**
Median (Minimum : Maximum)		5(0:80)
2. Number of hours stop working at the date of injuries		
30 minutes or less	155	19.0
More than 30 minutes to 1 hour	637	78.2
More than 1 hour	23	2.8
Total	**815**	**100.0**
3. Number of days absent from work due to injuries		
0	637	78.2
1	97	11.9
2	24	2.9
3 or more	41	5.0
Censored	16	2.0
Total	**815**	**100.0**
Median (Minimum : Maximum)		0(0:60)

4.8 Construction jobs related to injuries

Almost half the 815 injuries, 347 (42.6%), were related to assembling or removing wooden frame for concrete formation (Table 4.9). Transporting of mixed concrete from the mixer to the working location ranked the second which involved 12% of all injuries. However there were about half (44.2%) of injuries which related directly to the activities being performed at the time of the injury. The remaining were indirect to the job being performed which mostly caused by other surrounding environments (52.2%) and the act of other workers (3.6%). This imply that skill of the workers is as important as working conditions.

Table 4.9 Construction jobs related to injuries

Characteristics	Number	Percent
1. Type of job being performed at the time of the injury		
Assembling the concrete frame	239	29.3
Removing the concrete frame after the work has finished	108	13.3
Transporting mixed concrete	97	11.9
Running/Walking without job being assigned	46	5.6
Plastering	45	5.5
Transporting wood	44	5.4
Assembling/ Disassembling the scaffolding	38	4.7
Transporting steel	29	3.7
Laying bricks	28	3.4
Transporting bricks	25	3.1
Bending/Assembling the reinforcing steel	18	2.2
Removing unwanted concrete	17	2.1
Flattening out the concrete	15	1.8
Cutting/Welding	15	1.8
Shoveling of gravel/sand/water/cement	14	1.7
Cleaning	14	1.7
Mixing of concrete	7	0.9
Do nothing (just sit or stand)	6	0.7
Assembling tiles for the roof	5	0.6
Assembling tiles for the floor	4	0.5
Transporting tiles	1	0.1
Total	**815**	**100.0**
2. Do the injuries relate directly to the activities being performed at the time of the injury?		
Yes	360	44.2
No	455	55.8
Total	**815**	**100.0**
3. Injuries resulting from their own activities or of other workers		
Their own activities	786	96.4
Other workers' activities	29	3.6
Total	**815**	**100.0**

4.9 Immediate causes of injuries

Epidemiological investigation of each injury provided details about its immediate cause. There were three main causes reported - tools, nails, and steel left out of concrete (Table 4.10). Workers reported that they were accidentally hit by the hammer they using or were collided with steel left out of the column concrete while working or stepped on a nail while walking, for example. Hammers and lifting bars are essential tools for carpenters and mostly used for assembling and disassembling the concrete frame which was the job most commonly associated with injuries.

Table 4.10 Immediate causes of injuries

Characteristics	Number	Percent
1. Tools used at the time of the injuries		
Did not use any tools	584	71.7
Hammer	102	12.5
Lifting bar	57	7.0
Rope-pulling hoist	20	2.5
Steel cutter	10	1.2
Concrete mixer	9	1.1
Saw	8	1.0
Spade/Hoe	8	1.0
Gas welder	6	0.7
Trowel	4	0.5
Axe	2	0.3
Wheelbarrow/Hand cart	2	0.3
Builder's hoist	1	0.1
Crane	1	0.1
Electrical smoothing plane	1	0.1
Total	**815**	**100.0**
2. Tools as the direct cause of the injuries		
Did not use any tools	584	71.7
Tools used but not the direct cause	129	15.8
Hammer	61	7.5
Lifting bar	18	2.2
Rope-pulling hoist	9	1.1
Saw	5	0.6
Steel cutter	3	0.4
Gas welder	2	0.3
Concrete mixer	2	0.3
Ax	1	0.1
Trowel	1	0.1
Total	**815**	**100.0**
3. Getting injured directly from the nail?		
Yes	287	35.2
No	528	64.8
Total	**815**	**100.0**
4. Getting injured directly from the reinforcing steel left out of the concrete?		
Yes	58	7.1
No	757	92.9
Total	**815**	**100.0**

4.10 Workers' states and opinions related to their injuries

For 71% of the 815 injuries the workers reported they were exhausted at the time of the injuries (Table 4.11). Approximately one tenth of them said they were drunk.

The main causes of the injuries according to the injured workers themselves were their own carelessness or ignorance (39.1%) followed by unexpected events (19.3%) and events which were unavoidable (14.2%). In their opinions 66.5% of the injuries could be classified as preventable (all except the unexpected and unavoidable events).

On the other hand, the investigation by the researcher (author) identified the main causes of injuries were unsafe acts of the workers, including not using any personal protective equipment (74.2%), unsafe working conditions (19.0%) and lack of skill, including being physically or psychologically unwell (6.8%). Alcohol-related injuries was classified in the last category. All were preventable injuries.

Table 4.11 Workers' states and opinions related to their injuries

Characteristics	Number	Percent
1. Workers' status at the time being injured		
1.1 Exhausted		
Yes	579	71.0
No	236	29.0
1.2 Sleepy		
Yes	23	2.8
No	792	97.2
1.3 Fever but no medicine taken		
Yes	41	5.0
No	774	95.0
1.4 On some medication		
Yes	37	4.5
No	778	95.5
1.5 Drank alcohol		
Yes	76	9.3
No	739	90.7
1.6 Drank caffeine-mixed tonic		
Yes	2	0.3
No	813	99.7
1.7 Anxious		
Yes	2	0.3
No	813	99.7
1.8 Angry		
Yes	2	0.3
No	813	99.7

Characteristics	Number	Percent
1.9 For female : menstruation		
Yes	5	2.3
No	213	97.7
2. The cause of injuries : the worker's opinion		
Carelessness/ignorance	319	39.1
Unexpected event	161	19.3
Unavoidable	116	14.2
Work hurriedly	74	9.1
Usual events for such a dangerous job	45	5.5
Physically or psychologically unwell	31	3.8
Lack of skill in doing the assigned work	28	3.4
Working in a narrow place	20	2.5
Carelessness of other workers	12	1.5
Unsafe working methods	4	0.5
Unsafe tools	3	0.4
Unsafe behavior	1	0.1
Untidyness	1	0.1
Total	**815**	**100.0**
3. The cause of injuries : findings from the investigation by the researcher		
Unsafe acts/No protective equipment used	605	74.2
Unsafe working conditions	155	19.0
Lack of skill/ Physically or psychologically unwell	55	6.8
Total	**815**	**100.0**

4.11 Proportion of injuries by selected factors

Only 5.7% of all injured workers worked overtime, only 1.8% reported that they were not assigned to the right jobs (Table 4.12). Thus these two factors probably played little role in injuries. On the other hand, most injured workers 645 (79.1%) did not use any personal protective devices, including those only footwear was slippers

Table 4.12 Distribution of injuries by selected risk factors

Characteristics	Number	Percent
1. Working overtime between the date of last absent and the date of injury		
0	676	94.4
1	29	3.6
2	17	2.1
Total	815	100.0

Characteristics	Number	Percent
2. Being assigned to the right job?		
Yes	800	98.2
No	15	1.8
Total	815	100.0
3. Personal protective devices worn		
None (including only slippers as footwear)	645	79.1
Boots/Shoes only	134	16.4
Helmets only	8	1.0
Gloves only	15	1.8
Combination (boots + gloves)	13	1.6
Total	815	100.0
4. Person who always warns the injured workers to be careful before getting injured		
Nobody	226	27.7
Colleague	215	26.4
Foremen	374	45.9
Total	815	100.0

CHAPTER 5

FACTORS AFFECTING INJURY

This Chapter describes factors affecting injuries. It provided the significant predictors as well as their magnitude of association using Relative Risk. Details for methods of data analysis were given in Chapter 2. All findings for this Chapter are summarised in tables shown in Appendix 2.

5.1 Factors affecting total injuries

5.1.1 Association between selected factors and total injury : a univariate analysis

Factors statistically significantly increased risk of injuries include being carpenters, male, young, and marital status single or separated. Less experienced was also significantly increase the risk such as lower number of years working as construction workers and lower number of companies worked with. Other significant factors include place of living other than camp site, working at Site B, being forced to work, and workers who perceived that working as currently did will caused no injuries (Table A2.1).

5.1.2 Association between selected factors and total injury : a multivariable analysis

Findings from the univariate analysis were used to form an initial model of the multivariable analysis. Variables whose p-value of 0.25 or lower were considered to put into the initial model. Several model fitting procedures were tried. The final model suggested significant predictors as shown in Table A2.2.

Risk of injury was twice as high as at Site B compared to at Site A where the work was less intense (p-value < 0.001). Carpenters were the highest risk group - 2.9 times more likely to get injured than masons (p-value < 0.001). Male workers were 1.7 times greater risk than females (p-value < 0.001). The risk decreased as the age increased - workers aged of less than 20 years were 1.4 times those who were 30-39 years old in getting injuries (p-value = 0.001). The more the experience, the lower the risk of getting injuries - either those who had experience less than 1 year or who ever worked 5 years or lower were 1.7 and 1.9 times, respectively, more likely to get injured than those who worked 6 years or more (p-value < 0.001). Those who felt being forced to work were 1.5 times as high risk of injuries as those who felt neutral (p-value = 0.006). Those who lived with relatives house were 2.7 times more likely to get injured than those who live at the camp sites (p-value = 0.005). Those who perceived that working as currently did will cause no injuries were 1.3 time more likely to get injured than those who disagree on that (p-value = 0.002). No interaction effect was detected.

5.2 Factors affecting lost-time injuries

5.2.1 Association between selected factors and injury : a univariate analysis

Factors statistically significantly increased risk of lost-time injuries include working at Site B, carpenter, male workers, younger workers, single or separate marital status, less experiences as to number of years working as construction workers, being forced to work, and workers who perceived that working as currently did will caused no injuries (Table A2.3).

5.2.2 Association between selected factors and injury : a multivariable analysis

The same model fitting procedure as mention in (10.1.2) was also performed at this stage. The final model suggested significant predictors which included working at Site B, being carpenters, male workers, young workers, a few experience years of work, who felt being forced to work, and who perceived that working as currently did will cause no injuries (Table A2.4.). Again there was no interaction effect detected.

5.3 Factors affecting lost workday injuries

5.3.1 Association between selected factors and injury : a univariate analysis

Factors statistically significantly increased risk of injuries included being carpenter, male workers, less experiences as to number of years working as construction workers, being forced to work, and workers who perceived themselves unskilled and that working as currently did will caused no injuries (Table A2.5).

5.3.2 Association between selected factors and injury : a multivariable analysis

The same model fitting procedure as mention in (10.1.2) was also performed at this stage. The final model suggested significant predictors which included being carpenters, young workers, and a few experience years of work (Table A2.6.). Again there was no interaction effect detected.

5.4 Summary

All significant predictors of lost workday injuries were also the predictors of lost-time injuries. Likewise all significant predictors of lost-time injuries were also the predictors of all injuries. Conversely, all but the place of living which were the significant predictors of all injuries were the predictors of lost-time injuries and there were three factors statistically significantly associated with the lost work-days injuries, that is, type of work, age and working experience (Table A2.7). This suggested a strong effect of the three factors on injuries.

Education attainment of the workers and being trained for the current job before working were found not statistically significant associated with injuries. The risk of injuries was not significantly increased whether or not the workers perceived that accident is a chance event, that occupational injuries can be prevented, that minor injuries is not of important, that accident prevention is the workers' responsibility, that the worker who using personal protective devices reflect his being cowardly, that nothing changed although one did not wear hard hat, that construction work has high risk to get injured, that being a construction workers need to challenge any dangerous circumstances, or that being a construction workers need to challenge any dangerous circumstances.

Carelessness or ignorant which was the most important cause of injuries as the workers' opinion was not the significant predictor of injuries, and so was changing the jobs during the study period.

CHAPTER 6

DISCUSSION AND CONCLUSIONS

Baseline characteristics

Generally characteristics of the cohort were more or less the same as the workers in the cross-sectional survey mentioned above. More than three quarters of them were considered lacking experience. Surprisingly, more than one quarter said they were forced to work by others. Almost all of them perceived that construction workers have a high risk of being injured and that injuries can be prevented. Most of them said that the most important cause of injuries was carelessness or ignorance of the workers themselves, that accident prevention is their own responsibility, and that even the minor injuries still be important. However, about 61% of them thought that accidents were due to chance. Most of them perceived that working as currently did could lead to injuries and they needed to be brave to challenge dangerous circumstances. Few workers perceived that using PPDs showed they were cowardly. However, two fifth of them agreed that the risk is not change even if one does wear helmets. When asking causes of injuries, nobody mentioned that failed to use PPDs could cause injuries, which could be why they did not use them.

Epidemiology

Along the six months period of study, the highest risk period was found closely related to that the workers were forcing to work more intensively in order to meet the deadline of a periodic checkup by the owner of the site and when the workers disassembled the concrete frame. Considering day within a month, the incidence increased from the first day of work to the 7th or 8th day of each period then decreased. Evidence to explain this pattern was not clear. Regarding day of the week, the incidence of injuries varied little through out the week suggesting the day of the week played no role in the risk of injuries. Finally, pattern of injuries concerning the time of the day suggested that overall there were more injuries during the first half of the day than the second half of the day.

Most of injuries were due to struck against objects followed by being struck by objects and steps on sharp objects. The majority of injuries were laceration followed by abrasions and cuts or puncture wounds. Majority of injuries were to hands and feet. Foot injuries were the major cause of lost work-day injuries. The distribution of foot injuries showed that most injuries were to the sole of the foot, stepping on sharp objects is important. This fraction of injuries can be prevented by safety shoes. The proposing appropriate shoes was provided at the end of this section. Only 2% of all episodes would be prevented by helmets.

Almost half of all episodes of injuries were related to assembling or removing wooden frame for concrete formation. However there were about half of injuries which related directly to the activities being performed at the time of the injury whereas the other half were indirect to the job being performed which mostly caused by other surrounding environments and the act of other workers. This imply that skill of the workers is as important as working conditions. The immediate cause of injuries were non-power hand tools, nails, and steel left out of concrete.

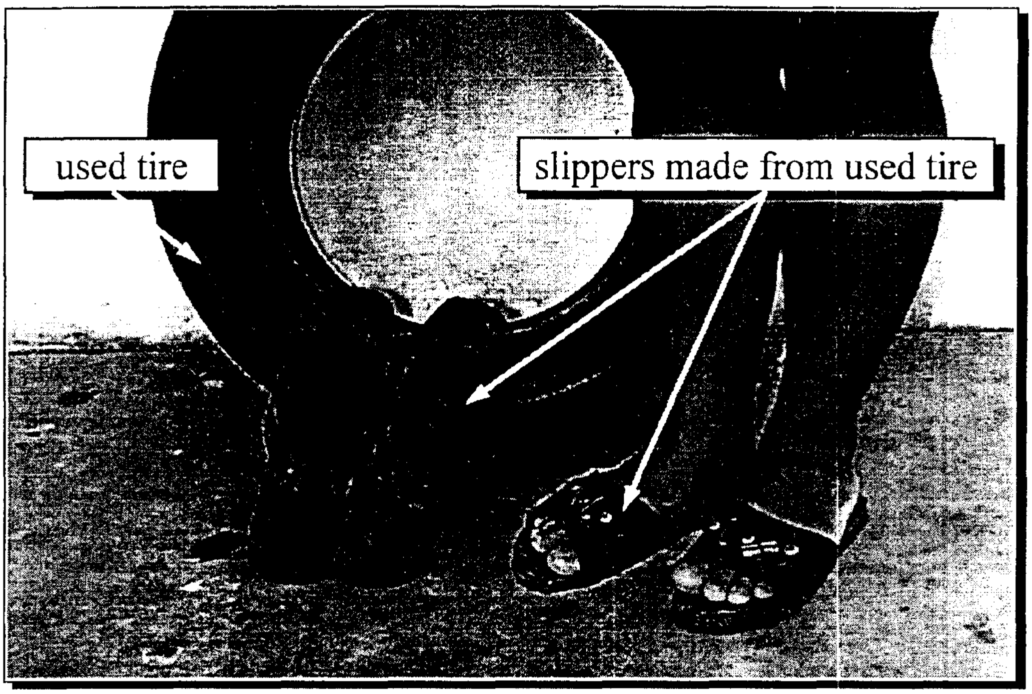
For 71% of injuries the workers reported they were exhausted at the time of the injuries. In their opinions, two thirds of injuries could be prevented. On the other hand, the author found there was evidence that three quarters of all injuries occurred while workers did not using any personal protective equipment. The remaining were due to unsafe working conditions and lack of skill. Thus it can be concluded that all injuries can be prevented. Similar to this study, Ringen et al (1995) also found in their recent study in the United States that nearly all of the injuries and deaths among construction workers are preventable.

Absences from work were studied and can be concluded that: 1) since most injuries were mild, they did not cause immediate absence, 2) information on absences needs to be ascertained for at least 4 days after the injuries to detect delayed absence (data not shown), 3) the temporary in nature of the work - based on no work no pay - caused the workers to still come to work even if they were injured; they only stop working when they are physically unable to work. 4) the work schedule is not so tight, which allows the injured workers to rest while at work, however this will the production.

Considering injury to the feet, it shared a large proportion of total injuries (40%). Moreover it resulted in the highest chance (27% of all feet injuries) to stop working as compared to injury of other body regions. All these injuries can be prevented by safety shoes. They cannot be prevented by wearing slippers, which most workers wear (Fig.6.1). Unsurprisingly there was no worker wore the safety shoes since they were far too expensive and not locally available. The market price was more than 400 to more than 1,000 Bahts a pair (20 Baht = 1 AU$ at the time of the study). Whilst the slippers costs of less than 50 Bahts. Thus the slippers made from used tire could be an alternative for promoting use of shoes to protect feet injuries (Fig. 6.2). This type of shoes were found to be used by some workers. They costs less than 100 Bahts a pair. They are durable, locally available, and can effectively prevent injuries from stepping on sharp objects.

Fig 6.1 Slippers - the most common footwear for construction workers

Fig. 6.2 Slippers made from used tire



Considering injury to the hands, it shared about half of all the injuries (45%). Three quarters of all hand injuries had to stop working for at least half an hour while 17% of all hand injuries had to stop working at least one whole day. From detailed analysis (data not shown) it was found that most of hand injuries involved carpenters during they perform task related to assembling or removing the wooden concrete frame. These task need to use non-power hand tools such as hammer and lifting bar. It cannot proved in this study whether the injuries caused by skill of the workers, worked in narrow space, left or right handed, or so on. What is clear here is that there was no any protection against injuries to the hand from using those tools. It is thus recommended that appropriate design of lifting bar with hand protection and nail holders while hitting the nail with the hammer should be the first priority of effective preventive measure.

Factors affecting injuries

Factors found to increase risk of all injuries included working at the construction site where the work was intense, being carpenters, male workers, young workers, less working year of experience, being forced to work, lived with relatives house, and perceived that working as currently did will cause no injuries. These factors were also significantly related to lost-time injuries except place of living. There were three factors statistically significantly associated with the lost work-days injuries, that is, type of worker, age and working experience, which were also the significant predictors of the previous two type of injuries. This suggested a strong effect of the three factors on injuries. For carpenters, a study by Robinson et al. (1996) evaluated the mortality of 27,362 members of the U.S. Carpenters' Union who died in 1987-1990. These data show that construction carpenters have moderately elevated mortality for the diseases caused by asbestos (lung cancer and malignant mesothelioma) and from traumatic injuries. The finding of elevated mortality for stomach, bone, and breast cancer was unexpected and requires further evaluation of possible occupational factors. This study confirms that construction carpentry is an extremely hazardous trade. The data suggest that additional preventive action guarding against asbestos exposure and occupational injury is urgently needed in this occupation. For young worker, it was also found by Dedobbeleer and German (1987) that it was a strong predictor of safety practice. Dedobbeleer (1990) again pointed out that they were the highest risk group.

Issues about magnitude of injuries

Regarding the magnitude of injuries, on average there were 1.5 injuries per 100 worker-days which was approximately 5 times as much as that from a cross-sectional survey at an Eastern province of Thailand in 1994 where there was 0.32 per 100 worker-days (Aekplakorn et al., 1995). Lost work-day injuries was 0.32 per 100 worker-days, more than 10 times as compared to 0.03 per 100 worker-days that found in a previous cross-sectional survey conducted at the same study area which only lost work-day injuries was studied. Unfortunately there was no such figure reported at national level for the comparison. These differences need to take into account when one considers the magnitude found from sources of information aside from longitudinal workplace-based study. The healthy worker effect does caused the underestimation of the magnitude of injuries in cross-sectional study. This longitudinal study is believed to be able to detect all occurrences of injuries since more than one methods were used for the injuries ascertaining at the camp sites on daily basis. However, evidences observed during the study suggested that the magnitude of injuries among construction workers could also be under estimated, by this type of study, for several reasons. Selected unique issues found in this target population include: i) The workers afraid to loose their jobs if they bring out their health and safety concern on their own. They still keep working and, although being asked orally, said they are fine even if they get severe injured; ii) Following the previous reason, some injured workers did not seek help from the first aid unit within the site. Aside from that, minor or mild injuries may not caused the workers who were working at height, several stories from the ground where the first-aids is available, seek for the first aids. This suggested also that even the on-site record of first aid is underestimate of magnitude of injuries. Self-reporting is even far from the truth; iii) Payment for workers who stop working, no matter what reason including injuries, is extremely rare in construction industries. As wages based on number of days they work, they will stop working only when necessary. For example, a broken arm worker still came to work as long as he can walked. He worked while he used cast - a hard stiff protective covering for holding a broken arms in place while it gets better. This also suggested that lost-time injuries may not reflect all moderate or severe ones; and iv) Generally and traditional the workers perceived the term "injury" as only the severe one. Mild injuries would not be notified by the workers.

Issues about tips of the iceberg

The study demonstrated that there expected to be 80 injuries for every 1 hospitalized cases - 65 were lost-time injuries and medical only cases, and 15 were lost work-day injuries. It Implied that: i) The hospital record is questionable if it was used as the source of information. One need to take the above figure into account when interpretation of the findings is made, ii) Non hospitalized injuries are also important as the lost work-day injuries shared a large proportion among them, and iii) The typical injury requiring treatment is minor with respect to threat to their life. Hospitalised cases - as the tips of the iceberg - provide an inadequate picture of the costs and effects of injuries.

Issues about absence from work

Absence from work is likely to be caused by several factors and any single cause is unlikely to have a strong effect on rate of absent (Briner, 1996). In this study, all injured workers were sought for the reason of absence within 7 days after the injuries. Not all absences related with injuries. Some of the injury-related absentees, injury was not a single cause. Only those who absent due mainly to the injuries were they classified as lost work-day injuries. Thus the lost-time injuries found in this study is believed to be the minimum magnitude. Although it is difficult to obtain objective evidence about the cause of absences, interviewing with the workers is reliable since there was no benefit paid for absentee due to work-related injuries or other sickness. In addition, workers who were absent for more than 3 days will not be allowed to work. This punishment is the purpose of the employers in keeping the workers worked on the day that heavy work is expected. Another possible reason of such punishment could be related to the Labour Law of Thailand. That is, the employers have to pay for compensation for the injuries that need to stop working for 3 or more days. Therefore the lost work-day injuries also minimized by these reasons.

Issues about characteristic of injuries

Findings regarding characteristic of injuries of the present study are consistent with that found from a cross-sectional survey conducted in Thailand by Aekplakorn et al. (1995). That is, higher proportion of injuries was found at lower limbs of the body - especially at the feet, injured by being hit by objects and puncture by nails resulting mostly in cut and puncture wound. No workers worn safety shoes for protection against sharp objects. This confirmed the homogeneity of workers in terms of using of PPDs. The findings regarding characteristic of injuries in Thailand were differ across countries, especially with the developed ones. They were more or less the same as those found at developing country such as in East African countries where there was 40% of injuries caused by "stepping on or being struck by objects", for example (Levy and Wegman, 1995) whereas there were 37% found in the present study. The workers were similar among developing countries - temporary and non-unionized and rarely used of PPDs.

Issues about factors affecting injuries

The two significant risk factors found in a hospital-base case-control study in Hong Kong by Wong (1994), no formal education and no safety training, were not found so in the present study. This difference could be due to the difference of baseline characteristics of the workers, especially used of PPDs where there were common in Hong Kong while very rare in Thailand.

Another comparable study in Thailand, a cross-sectional study by Aekplakorn et al., (1995) suggested the high proportion of injuries among males and young workers which also found in the present study. However, the cross-sectional survey found labourer the highest risk group whereas it was the carpenter in the present study. This inconsistency findings confounded by gender. Further analysis shown that the carpenters is the highest risk group among male workers.

Issues about the effect of injuries investigation

The effect of injuries investigation on magnitude of injuries was carefully minimized. The process of investigation of each injury involved providing on-site first aids followed by interviewing and discussion about its cause with the injured workers as well as their colleagues. The injured workers were informed about what need to be done in order to prevent future injuries including correction of dangerous work environment as appropriate. Failed to do so was considered unethical. This unavoidable activity could have some effect in decreasing the rate of injuries. However the effect is believed to be minimal since most of the cause of injuries were carelessness or ignorant of the workers. They still behave the usual way as well as did not wear PPDs. The slightly increasing trend of injuries over period of the study may also justify such minimal effect.

Issues about preventive measures relating to injury investigation

Following the previous issues relating to the effect of injury investigation, it was found that there were useful information obtained during this process that could be used for prevention. Welch and Roto (1995) advocated workplace investigations, followed by exposure reduction as the effective preventive measure. Simultaneously, these could provide an opportunity for health education of the worker and an education about work-related health problems for the health care providers. In this study, these has been shown not to work if only the injured workers were discussed about the causes of the present injuries and informed about the appropriate measures to prevent future injuries.

Effectively utilizing information obtained from the investigation for prevention is of interest.

Issues about preventive measures relating to roles of the foremen and clerks of the sites

It had been mentioned in the previous study by the author that the workers were influence in may ways by their foremen. The foremen appeared to be a key person for injury prevention in this study too. Their main responsibilities were to deliver commands from the engineers to the workers and monitor the work progress. Thus they worked most closely with the workers. There were evidences that the workers were afraid of and obey the foremen's commands. The main reason was that the foremen can affect on the workers' employment status including their promotion such as increasing wages. Possessing regulatory roles and monitoring, the foremen were an important key person in injury prevention.

The clerks of the construction sites were another key person. Their main responsibility involved important information in the sites such as daily workers' attendant to be used for calculating wages, list of equipment and construction materials in the storeroom including other supplies such as first aid equipment. They also the one who provide first aid for any minor injuries and arrange for referring the injured workers to the hospitals. At least once a day the clerks have to walk through the sites wherever the workers is working for checking of actual work attendant. These roles are very important for injury prevention. They could be the best entry point for establishing health-related information system of the sites. They could also be as the health volunteer for both preventive and curative roles.

Issues about preventive measures relating to roles of information system

Since conventional regulatory strategies have less feasibility in the case of construction industry in Thailand. Effective prevention measures of injuries need to be complemented with effective information strategies. Ringen et al. (1995) also emphasize the need of health information to monitor these problems. The existing injury surveillance network in Thailand was not yet well established, non for the construction industry. Longitudinal study is an ideal methods for studying epidemiology of injuries among construction workers since it is less bias, in particular, healthy workers bias which threaten quality of findings obtained from cross-sectional survey. Also information from retrospective study is known to be limited. However the longitudinal study is expensive and very difficult to conduct in such a constantly changing of job and workers as situation commonly found in construction industry. Periodic survey repeated with comparable methods enabling the analysis of trends would be an alternative. Such methods need to be kept in mind its underestimation of the magnitude of injuries at a certain point in time and rather emphasize in the magnitude over time - the trend. Collaboration and participation of study subjects, particularly workers, foremen, contractors and sub-contractors, and the owners, should be considered at the earliest stage of planning the survey activities. Findings from the study should always be communicated in an easily understandable form to all involved, in particular the contractors, the foremen, and the workers themselves. Regional, national or even international collaborations focusing injury and fatality prevention efforts on the common leading causes and high risk groups, and sharing successful prevention experiences between countries could save the lives of many construction workers world wide. This was also highly recommended from a study by Ore and Stout (1996).

Limitations

The six month follow-up period is too short to provide knowledge on pattern of injuries on time trend including seasonal variation as there may hide some potential causes of injuries. The period of study covered only the middle of winter to the early summer of Thai season. One evidence observed is that there were gradually increasing number of workers who came to the first aids unit asking for analgesic-antipyretic drug (known by the workers as "paracetamol") in the hot day.

Studying at two work sites can not reflect the effect of constantly changing work site of the workers on their health problems. This also brings issue of generalizeability. However, previous study conducted by the author suggested that the construction workers were homogeneous in terms of demographic and socioeconomic background, no matter where, large or small sites, they worked. Thus the findings should be able to applied to the population of construction workers in Northeastern Thailand. However the two study sites were considered the large ones for the northeastern Thailand. Large sites were better than small sites in terms of work environment and safety conditions as found in previous study by the author. Thus one can viewed the findings from this study as the good possible.

Severe injuries was minimal here in this study. Fatal injuries was also not found during the six month period of the study. These reflect the size of the work sites which were not as large as those were found at the big city such as Bangkok and, consequently, the nature of work which were not complicated or involved dangerous tools. Although the two study sites were considered a good representative of most construction sites in the northern Thailand, the findings did not provide enough information about the severe or fatal injuries. To be able to cover these type of injuries, lager study with longer follow-up time were required.

Absence from work is very difficult to obtain the valid and objective underlying cause. It also multi-factorial caused phenomenon. This effect the validity of classifying injuries as the lost work-days type. While only absence of the injured workers were sought for the reasons in this study, the absence of other workers who did not report they got injured may also be important since the magnitude if high (data not shown). This is important in economic perspective. A well plan study studying pattern and causes of the absences could disclose this issue.

Accident liability was observed in this study as shown that more than half of the injured workers got injure more than once up to as high as 13. Unfortunately the author only validated the event. The underlying causes were not clear. Knowing the causes is believed to effectively reduce the occurrence of injuries.

Since each construction worker moves about a site as well as being assigned to different jobs within a day, the worker's status in relation to exposure sources of risk to injuries may change constantly. The foremen may asked the carpenters to remove the lumber which was the job for the labourers, for example. This lead to difficulty of measuring them. Proper measuring exposure method is needed as the fundamental component of risk assessment for health problems in this target population. Ringen et al. (1995) also mentioned the same problems in their study.

Some issues commonly observed while conducted the longitudinal study were not covered particularly skin disease including dermatitis due to cement (dichromate dermatitis). Occurrence of early retirement due to disability or of mortality, hearing loss, abnormal findings at lung auscultation, reduced forced expiratory volume, increased diastolic blood pressure, abnormalities in the electrocardiogram, increased body mass index, hypercholesterolaemia, increased liver enzymes, abnormal findings in an examination of the musculoskeletal system, and abnormalities of the skin should also be focused as necessary. These issues had been successfully done elsewhere such as in Germany by Arndt et al. (1996).

Recommendations

i) Preventive measures

Firstly at national level, it is necessary to upgrade the legislation related to occupational health and safety, in particular establishing notification of work-related events and increasing punishment of fine for penalties. This need to be complemented with establishing inspection services to ensure its enforcement.

The existing system for epidemiological surveillance need to be expanded to cover occupational injuries by revising the notification form. Its utilization of such hospital-based surveillance system need to keep in mind its limitation of underestimation of the detected magnitude and that lost time injury cannot be detected accurately by this system. These limitations can be minimized by establishing workplace-based surveillance which were shown to be feasible via the clerk of the construction sites. This could also potentially expand to surveillance of the working environment and working practices, and of the workers' health aside from injury.

Secondly at the workplace level, it is the employers responsibility to ensure that the construction sites, processes of construction, equipment and the working environment are safe and without risk to health. Based on health provider perspective, it is recommended that good workplace-level organization of safety and health activities, involving both employer and workers, need to be first established, i.e., assign responsibility for safety and health at different management levels. Key persons to be started with are the foremen and the clerks of the sites. Training these group of workers, can be viewed as train-the-trainer programs, should be put at the highest priority. They are at the best position to request for supporting from the employers in various matters such as protective equipment, warning sign, guard netting, first-aid arrangements, etc. They are also the one who implement safety activities such as house keeping for safety workplace, simultaneous instructing, practical guidance, and warning the workers while working at some dangerous work, and provide first-aid including measures to deal with emergencies and accidents.

Thirdly for the workers, ideally they should be informed that they have duty to cooperate and the right to be trained and participate in safety and health activities. They need to take care of their own safety and that of others who may be affected by their acts or omission at work, to comply with instructions given for their own and others' safety and health procedures, use safety devices and protective equipment correctly, to report to the foremen any situation which they believe could present a hazards and which they themselves cannot correct, and to report accidents or injury to health at work. Based on health service providers perspective, it is recommended that, at least, training for new workers should be routinely provided. In practice, however, this is difficult and even less efficient in situation where most of the workers were temporary and non-skill. Thus it is recommended that action-oriented safety and health training is required. Based on the findings, more specific group of workers needed special attention were young workers, carpenters, and those who were lack of experience in construction work. Appropriate approach for the accident-liable workers should also be considered as one way to reduce the occurrence of injuries.

The findings suggest promoting used of safety shoes would effectively reduce occurrence of injuries as most of the injured workers worn ordinary unprotected slippers and feet injuries were the highest proportion of injuries. Taken into account the local situation and start from intervention that can be undertaken by extending the knowledge and experience of local people, slippers made from used tires were suggested. This need to be complemented with an appropriate designed for hot climate workplace and locally available. Appropriate design of non-power hand tools such as lifting bar with hand protection and nail holders should be made available too since hand injuries were also the second most frequent injuries. Modified helmets for hot climate workplace as suggested previously were also recommended in order to enhance rate of their use.

ii) Areas for further studies

A number of important factors related to injuries were not cover in this study. These include climate such as temperature and rain fall, the effect of other health problems on injuries, accident proneness workers, near miss accident, ergonomics, shift of work in particular the night shift, behavioural risks such as alcoholic drinking, and other hazard from construction materials. A larger study involving variety of building sites and stages of construction with longer follow-up period is needed to evaluate their effect on injuries. This study need also to disclose time trend and seasonal variation of injuries. Note that the issues of measuring exposures need to be intensively considered prior to the study since the workers always move around the sites.

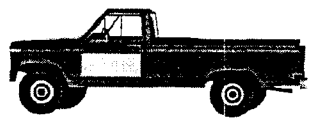
Feasibility of the workplace-based health surveillance system need to be studied. One possible way to do so, taken into account of what they already done, is using of the logbooks recorded by the clerks of the sites. The existing information include name of the workers, daily attendant of the workers, and their wages. This present study also found that it is possible to add another logbook for recording information of first-aid utilization. This could be used as a mean for such surveillance for minor injuries although this present study found that some minor injured workers did not seek for the first-aid. A careful design feasibility study is needed.

Absent from work among temporary construction workers is complicated. This is one potential area of study. The study should suggests appropriate way for determining absent from work, quantify the absences based on their causes, duration, effect in term of economics, and how those absent from work due to work-related injuries will be paid for compensation and treatment cost.

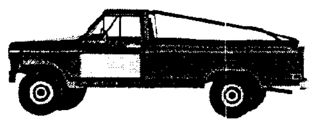
Injuries while traveling from home to the workplace is one main problem that need to be studied. Firstly it is necessary to quantify workers by various type of vehicles, how the vehicles designed as far as safety of the passengers was concerned, and information regarding accidents such as frequency of the occurrences and their causes, type and number of injured workers for each accident, and lost of money, time and life. Figure 6.3 show type of vehicles commonly found in most construction sites. Most of them were own by the workers. Secondly, then, appropriate design to modify their existing form of these vehicles to meet safety criteria could be formulated. Thirdly another field trial for assessing the effectiveness of implementation phase of modified vehicles should be conducted.

Fig. 6.3 The 4 common type of vehicles the workers used for traveling from home to construction sites

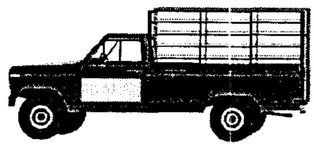
1. Truck without any protection



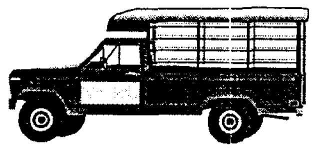
2. Truck with steel bar at the middle



3. Truck with cage



4. Truck with cage and roof



Other health problems commonly found among construction workers in the northeastern Thailand while conducting the present study were dermatitis due to cement (dichromate dermatitis). Another one is food poisoning outbreak which were found at least four occasions during the six-month follow-up. This is urgently need to be solved using known strategies. An epidemiological study may need to be carried out to obtain information for formulating appropriate preventive measures. A well design study, then, need to be conducted to assess efficacy of the intervention being implemented.

A qualitative study of health seeking behaviour among construction workers regarding injuries is needed. Evidence from the present study found this is complicated. One example is how the workers cure their puncture wound. Surprisingly, most of them use the hot ash of the matches. That is, they light the matches until they burned for half an inch then push into the hole of the wound. For nail puncture wound, that process will be followed by hitting strongly 3 times on the wound. They believe that the nail is defeated by the hammer and three times of hitting came from a holy phrase related to their region- Buddhism.

The proposing slippers made from used tires, hand protected lifting bars, nail holders, and modified helmets for hot climate should be designed to meet both safety criteria, low cost, and the workers' need. Thus a qualitative study regarding appropriate style suited the workers' need for these PPDs is needed. These information need to be considered in safety engineering before designing them. It is very important to get acceptance from the workers. Therefore some field trails, then, should be conducted to evaluate their safety and the worker's compliance with such protective devices.

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APPENDIX 1

TABLES SUMMARISED FINDINGS

PRESENTED IN CHAPTER 3:

BASELINE CHARACTERISTICS

OF THE COHORT

Table A1.1 Proportion of selected demographic characteristics of the workers at the entry of the study

Characteristics	Total (n=966)
1. Gender	
Male	59.7%
Female	40.3%
Total	100.0%
2. Age (years)	
Less than 20	26.5%
20 - 29	27.3%
30 - 39	26.6%
40 or more	19.6%
Total	100.0%
Median (Minimum:Maximum)	28(13:64)
3. Marital status	
Single	30.2%
Married and living together	66.4%
Separatedd	3.4%
Total	100.0%
4. Educational attainment	
No formal education	0.6%
Primary school	82.6%
Secondary school or higher	16.8%
Total	100.0%
5. Occupation prior to the current construction work	
No occupation	8.9%
Farmer	52.2%
Construction workers only	16.6%
Others (Labour/Trader/Driver/Fishermen etc.)	22.4%
Total	100.0%
6. The main source of income	
Construction work	69.2%
Others	30.8%
Total	100.0%
7. Place of living	
Original home	53.5%
Camp site	45.5%
Live with relatives	1.0%
Total	100.0%

Table A1.2 Proportions of selected occupation-related characteristics of the workers at the beginning of the study

Characteristics	Total (n=966)
1. Type of workers at the entry to the study	
Labourer	37.6%
Carpenter	30.0%
Mason	14.5%
Iron worker	17.9%
Total	100.0%
2. Number of years of experiencing as a construction worker before working at the current site	
Less than 1	59.6%
1 - 5	29.6%
6 or more	10.8%
Total	100.0%
Median (Minimum: Maximum)	0(0:12)
3. Number of companies worked with before working at the current site	
0 (The current site is the first one)	49.4%
1 - 5	42.0%
6 or more	8.6%
Total	100.0%
Median (Minimum: Maximum)	1(0:30)
4. Construction job before working at the current site	
Never worked as construction workers before	49.4%
Doing different work from the previous job	26.8%
Doing the same as the previous job	23.8%
Total	100.0%
5. Trained for the current job before working (either formally or informally)	
Yes, have been trained	63.7%
No, never been trained	36.3%
Total	100.0%
6. The workers' perception on their skillfulness in the current job	
Skillful	85.6%
Unskillful	14.4%
Total	100.0%
7. Feeling about working as a construction workers	
Against/Being forced to work by others	15.9%
Neutral	21.6%
Favour	62.6%
Total	100.0%

Table A1.3 Perceptions of the workers at the beginning of the study

Characteristics	Total (n=966)
1. Perceptions of accidents from construction work	
1.1 Accidents are due to chance	
Agree	60.9%
Disagree	39.1%
1.2 Occupational injuries can be prevented	
Agree	95.5%
Disagree	4.6%
1.3 Minor injuries are not important	
Agree	40.6%
Disagree	59.4%
1.4 Accident prevention is the workers' responsibility	
Agree	76.4%
Disagree	23.6%
1.5 The worker who used PPDs shows he is cowardly	
Agree	6.6%
Disagree	93.4%
1.6 The risk is not changed even if one does wear a hard hat (helmet).	
Agree	39.1%
Disagree	60.9%
1.7 In construction work there is a high risk of getting injured	
Agree	96.1%
Disagree	3.9%
1.8 Construction workers need to challenge any dangerous circumstances.	
Agree	86.8%
Disagree	13.2%
1.9 If they work as they currently do they will not get injuries	
Agree	22.4%
Disagree	77.4%
2. Workers' opinions on the most important cause of injuries	
Carelessness/ignorance	80.3%
Lack of skill in doing the assigned work	0.6%
Unexpected event	1.9%
Fortune	0.6%
Usual events for such a dangerous job	8.1%
Physically or psychologically unwell	1.7%
Working at a narrow place	0.6%
Carelessness of other workers	1.0%
Work hurriedly	2.6%
Unavoidable	2.7%
Total	100.0%

Characteristics	Total (n=966)
3. Persons who always warn the workers to work carefully	
Nobody	21.0%
Colleagues	25.4%
Foremen	46.8%
Others	6.8%
Total	100.0%

APPENDIX 2

TABLES SUMMARISED FINDINGS PRESENTED IN CHAPTER 4:

FACTORS AFFECTING INJURIES

Table A2.1 Association between selected factors and total injuries

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
1. Sites					
Site A	26056	1.1	-	-	<0.01
Site B	24722	2.1	1.9	1.5-2.4	
2. Type of workers					
Labourer	20682	1.1	1.1	0.8-1.6	<0.01
Carpenter	13978	2.9	2.8	2.0-3.9	
Mason	9225	0.9	-	-	
Steel worker	6893	1.0	0.9	0.6-1.4	
3. Gender					
Male	28534	2.0	2.2	1.8-2.8	<0.01
Female	22244	0.9	-	-	
4. Age (years)					
Less than 20	14196	2.2	1.8	1.3-2.4	<0.01
20 - 29	14034	1.4	1.1	0.8-1.6	
30 - 39	12285	1.2	-	-	
40 or more	10263	1.2	1.0	0.7-1.5	
5. Marital status					
Single	15755	2.1	1.7	1.3-2.1	<0.01
Married and living together	33532	1.3	-	-	
Separated	1491	2.0	1.6	0.9-2.7	
6. Educational attainment					
Primary school or lower	42807	1.5	-	-	0.26
Secondary school or higher	7971	1.8	1.2	0.9-1.7	
7. Number of years experience as a construction worker before working at the current site					
Less than 1 year	30300	1.7	2.5	1.5-4.2	<0.01
1 - 5 years	14843	1.6	2.4	1.4-4.1	
6 or more years	5635	0.7	-	-	
8. Number of companies worked with					
0 companies	25875	1.7	2.2	1.3-3.7	0.02
1 - 5 companies	20571	1.5	1.9	1.1-3.3	
6 or more companies	4332	0.8	-	-	
9. Occupation prior to the current construction work					
None	4687	1.7	1.2	0.8-1.8	0.11
Farmer	26383	1.4	-	-	
Construction workers as only an occupation	8556	2.0	1.4	1.1-1.9	
Others (Labourer/ Trader/ Driver/ Fishermen etc.)	11152	1.5	1.1	0.8-1.4	

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
10. The main source of income					
Construction work	35083	1.5	-	-	0.20
Others	15619	1.7	1.2	0.9-1.5	
11. Feeling about working as a construction workers					
Being forced to work by others	9003	2.3	1.9	1.3-2.6	<0.01
Neutral	10724	1.2	-	-	
Favor	30975	1.4	1.2	0.9-1.6	
12. Place of living					
Original place of living	26093	1.5	1.0	0.8-1.3	0.03
Camp sites	24247	1.4	-	-	
Live at relatives house	438	3.8	2.5	1.3-5.0	
13. Construction job before working at the current site					
Never work as construction workers before	25785	1.7	1.3	0.9-1.7	0.18
Do the different work from the previous one	14868	1.4	1.0	0.7-1.4	
Do the same as previous job	10035	1.4	-	-	
14. The workers' perception on their skillfulness in the current job					
Skillful	43649	1.5	-	-	0.08
Unskillful	7129	1.9	1.3	1.0-1.7	
15. Being trained for the current job before working					
Yes, have been trained	32998	1.5	-	-	0.72
No, never been trained	17780	1.6	1.0	0.8-1.3	
16. Persons who always warn the workers to work carefully					
Nobody	10487	1.4	-	-	0.73
Colleagues	11490	1.6	1.1	0.8-1.5	
Foremen	25345	1.6	1.2	0.9-1.5	
Others (wife/parents)	3456	1.7	1.2	0.8-2.0	
17. Perception at accidents from construction work					
17.1 Accident is a chance event					
Agree	31409	1.2	-	-	0.54
Disagree	19369	1.3	1.1	0.9-1.3	

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
17.2 Occupational injuries can be prevented					
Agree	48156	1.5	1.0	0.6-1.6	0.88
Disagree	2622	1.5	-	-	
17.3 Minor injuries are not important					
Agree	20224	1.7	1.3	1.0-1.4	0.06
Disagree	30554	1.4	-	-	
17.4 Accident prevention is the workers' responsibility					
Agree	38993	1.5	-	-	0.94
Disagree	11785	1.5	1.0	0.8-1.3	
17.5 Workers who use personal protective devices are cowardly					
Agree	3017	1.3	-	-	0.50
Disagree	47761	1.6	1.2	0.7-1.9	
17.6 Nothing changed although one did not wear hard hat					
Agree	20665	1.4	-	-	0.16
Disagree	3011	1.6	1.2	0.9-1.5	
17.7 Construction work has high risk to get injured					
Agree	48285	1.5	1.0	0.6-1.8	0.93
Disagree	2493	1.5	-	-	
17.8 Being a construction workers need to challenge any dangerous circumstances					
Agree	43788	1.6	1.3	0.9-1.8	0.18
Disagree	6990	1.2	-	-	
17.9 Working as currently do will cause no injuries					
Agree	11041	2.0	1.4	1.1-1.8	<0.01
Disagree	39737	1.4	-	-	
18. Workers' opinion on the most important cause of injuries					
Carelessness/ignorance	40618	1.6	1.3	1.0-1.8	0.06
All other *(Lack of skill/ Unexpected event/ Fortune/ Usual events/ Unwell/ Working at a narrow place etc.)*	10160	1.2	-	-	

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
19. Job changed during the study period					
Never change job	46217	1.8	1.1	0.8-1.6	0.61
Change at least once	4561	1.6	-	-	

Table A2.2 Significant predictors of total injuries

Factors	Crude		Adjusted		p-value
	RR	95%CI	RR	95%CI	
1. Sites					
Site A	-	-	-	-	<0.001
Site B	1.9	1.5-2.3	2.0	1.6-2.4	
2. Type of workers					
Labourer	1.1	0.8-1.6	1.5	1.0-2.2	<0.001
Carpenter	2.8	2.0-3.9	2.9	2.1-3.9	
Mason	-	-	-	-	
Steel worker	0.9	0.6-1.4	1.2	0.8-1.9	
3. Gender					
Male	2.2	1.8-2.8	1.6	1.2-2.2	<0.001
Female	-	-	-	-	
4. Age (years)					
Less than 20	1.8	1.3-2.4	1.3	1.0-1.8	0.003
20 - 29	1.1	0.8-1.6	1.2	0.9-1.6	
30 - 39	-	-	-	-	
40 or more	1.0	0.7-1.5	0.9	0.6-1.2	
5. Number of years experience as a construction worker before working at the current site					
Less than 1 year	2.5	1.5-4.2	1.7	1.2-2.5	<0.001
1 - 5 years	2.4	1.4-4.1	1.9	1.3-2.9	
6 or more years	-	-	-	-	
6. Feeling about working as a construction workers					
Being forced to work by others	1.9	1.3-2.6	1.5	1.1-2.0	0.005
Neutral	-	-	-	-	
Favor	1.2	0.9-1.6	1.1	0.9-1.5	
7. Place of living					
Original place of living	1.0	0.8-1.3	1.0	0.8-1.2	0.004
Camp sites	-	-	-	-	
Live at relatives house	2.5	1.3-5.0	2.6	0.9-7.9	

Factors	Crude		Adjusted		p-value
	RR	95%CI	RR	95%CI	
8. Perceived that working as currently do will cause no injuries					
Agree	1.4	1.1-1.8	1.3	1.1-1.6	<0.001
Disagree	-	-	-	-	

Table A2.3 Association between selected factors and lost-time injuries

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
1. Sites					
Site A	26056	1.0	-	-	<0.001
Site B	24722	1.6	1.7	1.3-2.2	
2. Type of workers					
Labourer	20682	0.9	1.1	0.7-1.5	<0.001
Carpenter	13978	2.4	2.9	2.1-4.1	
Mason	9225	0.8	-	-	
Steel worker	6893	0.9	1.1	0.7-1.8	
3. Gender					
Male	28534	1.7	2.4	1.9-3.0	<0.001
Female	22244	0.7	-	-	
4. Age (years)					
Less than 20	14196	1.8	1.7	1.2-2.4	<0.001
20 - 29	14034	1.2	1.1	0.8-1.6	
30 - 39	12285	1.0	-	-	
40 or more	10263	1.1	1.0	0.7-1.5	
5. Marital status					
Single	15755	1.7	1.6	1.3-2.0	<0.001
Married and living together	33532	1.1	-	-	
Separated	1491	1.7	1.6	0.7-4.0	
6. Educational attainment					
Primary school or lower	42807	1.3	-	-	0.74
Secondary school or higher	7971	1.4	1.1	0.8-1.5	
7. Number of years experience as a construction worker before working at the current site					
Less than 1year	30300	1.4	2.3	1.5-3.4	<0.001
1 - 5 years	14843	1.3	2.1	1.3-3.3	
6 or more years	5635	0.6	-	-	

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
8. Number of companies worked with (not including the current site)					
0 companies	25875	1.4	1.9	1.1-3.4	0.09
1 - 5 companies	20571	1.3	1.7	1.0-3.1	
6 or more companies	4332	0.7	-	-	
9. Occupation prior to the current construction work					
None	4687	1.4	1.2	0.8-1.9	0.252
Farmer	26383	1.2	1.1	0.8-1.4	
Construction workers as only an occupation	8556	1.6	1.4	1.0-2.1	
Others (Labourer/Trader/ Driver/Fishermen etc.)	11152	1.1	-	-	
10. The main source of income					
Construction work	35083	1.2	-	-	0.309
Others	15619	1.4	1.1	0.9-1.5	
11. Feeling about working as a construction workers					
Being forced to work by others	9003	1.9	1.8	1.3-2.7	<0.001
Neutral	10724	1.0	-	-	
Favor	30975	1.2	1.2	0.9-1.7	
12. Place of living					
Original place of living	26093	1.3	1.0	0.8-1.3	0.269
Camp sites	24247	1.2	-	-	
Live at relatives house	438	3.4	2.8	0.8-9.8	
13. Construction job before working at the current site					
Never work as construction workers before	25785	1.4	1.2	0.9-1.6	0.366
Do the different work from the previous one	14868	1.2	1.0	0.7-1.4	
Do the same as previous job	10035	1.2	-	-	
14. The workers' perception on their skillfulness in the current job					
Skillful	43649	1.2	-	-	0.185
Unskillful	7129	1.6	1.3	0.9-1.8	
15. Being trained for the current job before working					
Yes, have been trained	32998	1.3	1.0	0.8-1.3	0.930
No, never been trained	17780	1.3	-	-	

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
16. Persons who always warn the workers to work carefully					
Nobody	10487	1.1	-	-	0.734
Colleagues	11490	1.4	1.2	0.8-1.7	
Foremen	25345	1.3	1.2	0.9-1.5	
Others (wife/parents)	3456	1.3	1.2	0.7-2.0	
17. Perception at accidents from construction work					
17.1 Accident is a chance event					0.284
Agree	31409	1.2	-	-	
Disagree	19369	1.4	1.1	0.9-1.4	
17.2 Occupational injuries can be prevented					
Agree	48156	1.3	1.1	0.7-1.6	0.809
Disagree	2622	1.2	-	-	
17.3 Minor injuries are not important					
Agree	20224	1.7	-	-	0.070
Disagree	30554	1.5	1.2	1.0-1.6	
17.4 Accident prevention is the workers' responsibility					
Agree	38993	1.3	1.0	0.8-1.3	0.947
Disagree	11785	1.3	-	-	
17.5 Workers who use personal protective devices are cowardly					
Agree	3017	1.2	-	-	0.713
Disagree	47761	1.3	1.1	0.6-1.9	
17.6 Nothing changed although one did not wear hard hat.					
Agree	20665	1.2	-	-	0.150
Disagree	3011	1.4	1.2	0.9-1.5	
17.7 Construction work has high risk to get injured					
Agree	48285	1.3	1.1	0.5-2.2	0.811
Disagree	2493	1.2	-	-	
17.8 Being a construction workers need to challenge any dangerous circumstances.					0.174
Agree	43788	1.3	1.3	0.9-1.9	
Disagree	6990	1.0	-	-	

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
17.9 Working as currently do will cause no injuries					
Agree	11041	1.6	1.3	1.0-1.7	0.042
Disagree	39737	1.2	-	-	
18. Workers' opinion on the most important cause of injuries					
Carelessness/ignorance	40618	1.3	1.2	0.9-1.8	0.222
All other *(Lack of skill in doing the assigned work/ Unexpected event/ Fortune/ Usual events for such a dangerous job/ Physically or psychologically unwell/ Working at a narrow place etc.)*	10160	1.1	-	-	
19. Job changed during the study period					
Never change job	46217	1.5	1.2	0.8-1.7	0.321
Change at least once	4561	1.3	-	-	

Table A2.4 Significant predictors of lost-time injuries

Factors	Crude		Adjusted		p-value
	RR	95%CI	RR	95%CI	
1. Sites					
Site A	-	-	-	-	<0.001
Site B	1.7	1.3-2.2	1.8	1.4-2.2	
2. Type of workers					
Labourer	1.1	0.7-1.5	1.3	0.9-2.0	<0.001
Carpenter	2.9	2.1-4.1	2.7	2.0-3.8	
Mason	-	-	-	-	
Steel worker	1.1	0.7-1.8	1.2	0.8-1.9	
3. Gender					
Male	2.4	1.9-3.0	1.7	1.2-2.4	<0.001
Female	-	-	-	-	
4. Age (years)					
Less than 20	1.7	1.2-2.4	1.4	1.0-1.9	0.009
20 - 29	1.1	0.8-1.6	1.2	0.9-1.7	
30 - 39	-	-	-	-	
40 or more	1.0	0.7-1.5	0.9	0.6-1.3	

Factors	Crude		Adjusted		p-value
	RR	95%CI	RR	95%CI	
5. Number of years experience as a construction worker before working at the current site					
Less than 1 year	2.3	1.5-3.4	1.8	1.2-2.7	<0.001
1 - 5 years	2.1	1.3-3.3	1.8	1.2-2.8	
6 or more years	-	-	-	-	
6. Feeling about working as a construction workers					
Being forced to work by others	1.8	1.3-2.7	1.4	1.0-2.0	0.014
Neutral	-	-	-	-	
Favor	1.2	0.9-1.7	1.1	0.8-1.5	
7. Perceived that working as currently do will cause no injuries					
Agree	1.3	1.0-1.7	1.3	1.0-1.6	0.012
Disagree	-	-	-	-	

Table A2.5 Association between selected factors and lost work-days injuries

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
1. Sites					
Site A	26056	0.4	1.2	0.9-1.8	0.252
Site B	24722	0.3	-	-	
2. Type of workers					
Labourer	20682	0.1	-	-	<0.001
Carpenter	13978	0.7	5.4	3.4-8.4	
Mason	9225	0.2	1.4	0.7-2.6	
Steel worker	6893	0.3	2.5	1.4-4.5	
3. Gender					
Male	28534	0.5	3.3	2.1-5.0	<0.001
Female	22244	0.1	-	-	
4. Age (years)					
Less than 20	14196	0.5	2.0	1.2-3.3	0.062
20 - 29	14034	0.3	1.2	0.7-2.1	
30 - 39	12285	0.3	1.3	0.7-2.4	
40 or more	10263	0.2	-	-	
5. Marital status					
Single	15755	0.4	1.3	0.9-1.9	0.210
Married and living together	33532	0.3	-	-	
Separated	1491	0.6	2.1	0.8-5.7	

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
6. Educational attainment					
Primary school or lower	42807	0.3	-	-	0.434
Secondary school or higher	7971	0.4	1.2	0.8-1.9	
7. Number of years experience as a construction worker before working at the current site					
Less than 1year	30300	0.4	2.8	1.3-5.9	0.025
1 - 5 years	14843	0.3	2.7	1.2-6.0	
6 or more years	5635	0.1	-	-	
8. Number of companies worked with (not including the current site)					
0 companies	25875	0.4	1.6	0.7-3.8	0.078
1 - 5 companies	20571	0.3	1.0	0.4-2.5	
6 or more companies	4332	0.2	-	-	
9. Occupation prior to the current construction work					
None	4687	0.3	1.1	0.6-2.1	0.608
Farmer	26383	0.3	1.2	0.7-1.9	
Construction workers as only an occupation	8556	0.4	1.5	0.8-2.9	
Others (Labourer/Trader/ Driver/ Fishermen etc.)	11152	0.3	-	-	
10. The main source of income					
Construction work	35083	0.3	1.0	0.6-1.5	0.860
Others	15619	0.3	-	-	
11. Feeling about working as a construction workers					
Being forced to work by others	9003	0.5	2.0	1.1-3.6	0.034
Neutral	10724	0.3	-	-	
Favor	30975	0.3	1.2	0.7-2.0	
12. Place of living					
Original place of living	26093	0.3	1.0	0.7-1.5	0.057
Camp sites	24247	0.3	-	-	
Live at relatives house	438	1.4	4.3	1.3-14.2	

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
13. Construction job before working at the current site					
Never work as construction workers before	25785	0.4	1.8	1.1-3.0	0.053
Do the different work from the previous one	14868	0.2	-	-	
Do the same as previous job	10035	0.3	1.4	0.8-2.5	
14. The workers' perception on their skillfulness in the current job					
Skillful	43649	0.3	-	-	0.026
Unskillful	7129	0.5	1.7	1.1-2.7	
15. Being trained for the current job before working					
Yes, have been trained	32998	0.3	-	-	0.515
No, never been trained	17780	0.4	1.1	0.8-1.7	
16. Persons who always warn the workers to work carefully					
Nobody	10487	0.3	-	-	0.868
Colleagues	11490	0.4	1.1	0.7-1.9	
Foremen	25345	0.3	1.0	0.6-1.5	
Others (wife/parents)	3456	0.4	1.1	0.4-3.1	
17. Perception at accidents from construction work					
17.1 Accident is a chance event					
Agree	31409	0.3	-	-	0.260
Disagree	19369	0.4	1.2	0.9-1.8	
17.2 Occupational injuries can be prevented					
Agree	48156	0.3	1.3	0.6-2.9	0.489
Disagree	2622	0.3	-	-	
17.3 Minor injuries are not important					
Agree	20224	0.3	1.0	0.7-1.5	0.837
Disagree	30554	0.3	-	-	
17.4 Accident prevention is the workers' responsibility					
Agree	38993	0.3	1.2	0.8-1.9	0.394
Disagree	11785	0.3	-	-	

Factors	Worker-days	IR./100 worker-days	RR.	95%CI.	p-value*
17.5 Workers who use personal protective devices are cowardly					
Agree	3017	0.3	-	-	0.816
Disagree	47761	0.3	1.1	0.6-2.0	
17.6 Nothing changed although one did not wear hard hat.					
Agree	20665	0.3	-	-	0.192
Disagree	3011	0.4	1.3	0.9-1.9	
17.7 Construction work has high risk to get injured					
Agree	48285	0.3	1.8	0.7-4.9	0.224
Disagree	2493	0.2	-	-	
17.8 Being a construction workers need to challenge any dangerous circumstances.					
Agree	43788	0.3	1.3	0.8-2.1	0.264
Disagree	6990	0.3	-	-	
17.9 Working as currently do will cause no injuries					
Agree	11041	0.4	1.1	0.7-1.7	0.739
Disagree	39737	0.3	-	-	
18. Workers' opinion on the most important cause of injuries					
Carelessness/ignorance	40618	0.4	1.5	0.9-2.6	0.152
All other *(Lack of skill in doing the assigned work/ Unexpected event/ Fortune/ Usual events for such a dangerous job/ Physically or psychologically unwell/ Working at a narrow place etc.)*	10160	0.2	-	-	
19. Job changed during the study period					
Never change job	46217	0.4	1.3	0.7-2.3	0.348
Change at least once	4561	0.3	-	-	

Table A2.6 Significant predictors of lost work-days injuries

Factors	Crude		Adjusted		p-value
	RR	95%CI	RR	95%CI	
1. Type of workers					
Labourer	-	-	-	-	<0.001
Carpenter	5.4	3.4-8.4	5.7	3.6-9.0	
Mason	1.4	0.7-2.6	1.5	0.8-2.8	
Steel worker	2.5	1.4-4.5	2.5	1.4-4.4	
2. Age (years)					
Less than 20	2.0	1.2-3.3	2.2	1.3-3.6	0.012
20 - 29	1.2	0.7-2.1	1.7	1.0-2.9	
30 - 39	1.3	0.7-2.4	1.5	0.9-2.7	
40 or more	-	-	-	-	
3. Number of years experience as a construction worker before working at the current site					
Less than 1 year	2.8	1.3-5.9	2.6	1.2-5.5	0.017
1 - 5 years	2.7	1.2-6.0	2.6	1.2-5.8	
6 or more years	-	-	-	-	

Table A2.7 Relative risk (95% confidence intervals) of significant predictors of total injuries, lost-time injuries, and lost workday injury

Factors	Total injuries	Lost-time injuries	Lost workday injuries
1. Sites			
Site A	-	-	NS
Site B	2.0 (1.6-2.4)	1.8 (1.4-2.2)	
2. Type of workers			
Labourer	1.5 (1.0-2.2)	1.3 (0.9-2.0)	0.7 (0.4-1.3)
Carpenter	2.9 (2.1-3.9)	2.7 (2.0-3.8)	3.9 (2.2-7.1)
Steel worker	1.2 (0.8-1.9)	1.2 (0.8-1.9)	1.7 (0.9-3.4)
Mason	-	-	-
3. Gender			
Male	1.6 (1.2-2.2)	1.7 (1.2-2.4)	NS
Female	-	-	
4. Age (years)			
Less than 20	1.3 (1.0-1.8)	1.4 (1.0-1.9)	1.4 (0.9-2.4)
20 - 29	1.2 (0.9-1.6)	1.2 (0.9-1.7)	1.1 (0.7-1.9)
30 - 39	-	-	-
40 or more	0.9 (0.6-1.2)	0.9 (0.6-1.3)	0.7 (0.4-1.2)

Factors	Total injuries	Lost-time injuries	Lost workday injuries
5. Number of years experience as a construction worker before working at the current site			
Less than 1 year	1.7 (1.2-2.5)	1.8 (1.2-2.7)	2.6 (1.2-5.5)
1 - 5 years	1.9 (1.3-2.9)	1.8 (1.2-2.8)	2.6 (1.2-5.8)
6 or more years	-	-	-
6. Feeling about working as a construction workers			
Being forced to work by others	1.5 (1.1-2.0)	1.4 (1.0-2.0)	NS
Favor	1.1 (0.9-1.2)	1.1 (0.8-1.5)	
Neutral	-	-	
7. Place of living			
Camp sites	-	NS	NS
Original place of living	1.0 (0.8-1.2)		
Live at relatives house	2.6 (0.9-7.9)		
8. Perceived that working as currently do will cause no injuries			
Agree	1.3 (1.1-1.6)	1.3 (1.0-1.6)	NS
Disagree	-	-	

Note *NS = Non significant*

APPENDIX 3

DATA COLLECTION FORMS

Form 1

Worksite No : ……

ID [ ][ ][ ]

Baseline information of workers at the entry of the study

Questions	Code
1. Name………………………………………… **What type of employment?** 1.Labour 2.Carpenter 3.Mason 4.Steel worker	V1[ ]
2. The first day the worker start working at the site dd/mm/yy: ………/……./………	V2[ ][ ]/ [ ][ ]/[ ][ ]
3. Sex 1. Male 2. Female	V3[ ]
4. Age………………years	V4[ ][ ]
5. Marital status 1.Single 2. Married and living together now 3.Married but not living together now 4.Widowed/Divorced	V5[ ]
6. Educational attainment 1. No education 2. Primary school 3. Secondary school 4. High school 5. Certificate 6.Bachelor's degree 7. Other……………………………	V6[ ]
7. When did you start working as a construction worker? Month : …………………Year : ………	V7[ ][ ]/ [ ][ ]
8. How many construction companies have you been worked with? There were ……………. companies	V8[ ][ ]
9. What was your occupation before you came to work as a construction worker? 1.None 2.Farmer 3.Other, specify…………………………………………………………………	V9[ ]
10. The main reasons for working as a construction worker ……………………………………………………………………………………	V10[ ]
11. Where is your current place of living? 1. Own residence 2. Camp site 3. Rent a house 4. House of relatives 5. Others, specify…………………………………………………………………	V11[ ]

Questions	Code
12. Please tell us your history concerning working as a construction worker:- 12.1 Firstly working as .... 12.2 Then (specify type of construction job in order).......................... .... 12.5 Job being assigned before working at this site..............................	V12_1[ ] V12_2[ ] V12_3[ ]
13. Do you think you are skillful for this job? 1. Yes 2. No	V13[ ]
14. Have you ever been trained for the current job? 1. No 2. Yes, by...	V14[ ]
15. Have you had experience working with the current job? 1. No 2. Yes, for how long? : .... months	V15[ ]
16. Is there anybody warn you to work carefully while working? 1. Nobody 2. Colleague 3. Foremen 4. Others, specify :	V16[ ]
17. Please express you opinion on the following issues:	
17.1 Accident is the role of fortune 1.Agree 2.Disagree	V17_1[ ]
17.2 Occupational injuries can be prevented 1.Agree 2.Disagree	V17_2[ ]
17.3 Minor injuries is not of important 1.Agree 2.Disagree	V17_3[ ]
17.4 Accident prevention is the workers' responsibility 1.Agree 2.Disagree	V17_4[ ]
17.5 The worker who used personal protective devices reflect his being cowardly 1.Agree 2.Disagree	V17_5[ ]
17.6 Nothing changed although one did not wear hard hat (helmet). 1.Agree 2.Disagree	V17_6[ ]
17.7 Construction work has high risk to get injured 1.Agree 2.Disagree	V17_7[ ]
17.8 Being a construction workers need to challenge any dangerous circumstances. 1.Agree 2.Disagree	V17_8[ ]
17.9 Working as currently did will get no injuries 1.Agree 2.Disagree	V17_9[ ]
18. What is your opinion on the most important cause of injuries ? 18.1 First rank .... 18.2 Second rank .... 18.3 Third rank	V18_1[ ] V18_2[ ] V18_3[ ]

Form 2

Worker type : …..

Worksite No : …….

Daily record of work attendance and injuries

(This is an example of the form)

No	Name	Date of month ………………………				
		1	2	3	…	31

Note:

☐ Absent

⍓ Present without any injuries

☒ Present and got injured

Form 3

First aid attendance by the workers

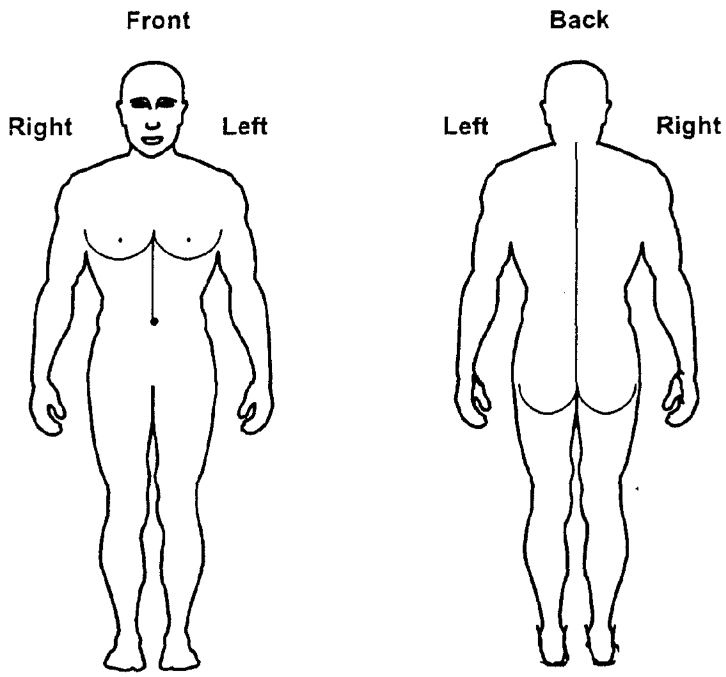
No	Name	Type of work	Date	Time	Complaint	First aid provided

Form 4

Worker type : .....

Worksite No : ....

Injury investigation form

Questions		Code
1.	**Date of investigation** Date...........Month..........................Year.........................	V1[ ][ ]/[ ][ ]/[ ][ ]
2.	**Date of onset:** Date......Month...............Year......... **Time of onset:** Time...	V2[ ][ ]/[ ][ ]/[ ][ ] V2T[ ][ ] : [ ][ ]
3.	**Name of the worker**... **Sex** 1.Male 2.Female	V3[ ]
4.	**What type of employment?** 1.Labour 2.Carpenter 3.Mason 4.Steel worker	V4[ ]
5.	**Provide detail at the specific injured body region?** 	V5[ ]

Questions	Code
6. Place of occurrence (provide detail : map/photos as necessary)	V6[ ]
7. Type of incident 1. Falls from elevations 2. Falls from same level 3. Falling objects 4. Struck by an objects 5. Struck against objects 6. Steps on sharp objects, specify .... 7. Electrocution 10. Others, specify	V7[ ]
8. Results of the incidence 1. Contusion 2. Abrasion 3. Laceration 4. Cut/puncture 5 Burn 6. Dermatitis, specify .... 7. Others, specify	V8[ ]
9. Lost time injuries 9.1) Did you stop working at the day of injury? 0. No 1. Yes, stop for .... hours	V9_1[ ]
9.2) How many days have the worker worked before getting injured? *(obtained from the daily record log-book)* .... days	V9_2[ ]
9.3) Did the worker come to work the day after date of injury? *(obtained from the daily record log-book)* 1.No 2.Yes	V9_3[ ]
9.4) Number of absent days according to Q9.3 *(obtained from the daily record log-book)* .... days	V9_4[ ][ ][ ]
9.5) Number of absent days due to injury *(ask directly from the injured workers)* .... days	V9_5[ ][ ][ ]
9.6) Number of overtime working during the last absent to the date of injuries ? *(obtained from the daily record log-book)* 1. No 2.Yes, for .... day-load	V9_6[ ][ ]
10. Was the current injury related to the construction job? 1. No ==> skip to Q 20 2. Yes	V10[ ]

Questions	Code
11. Where were you working while the accident occurred? 1. Outside the building, at...... metres from ground level 2. Inside the building, at .... metres from ground level 3. Scaffolding, at .... metres from ground level 4. Roof of the building, at ...... metres from ground level	V11[ ]
12. Please describe the circumstances at the moment of injury 12.1) What job were you performing?	V12_1[ ]
12.2) Did the injury directly caused by the job you were doing and how?	V12_2[ ]
12.3) Did the injury related to nail and how? 0. No 1. Yes, by.....................	V12_3[ ]
12.4) Did the injury related to reinforcing steel left out of the concrete and how? 1. No 2. Yes, by......................	V12_4[ ]
13. Do you think you have sufficient skill for the job being performed? 1. No 2. Yes	V13[ ]
14. Were there anybody warn you to work carefully at the moment of injury? 1. Nobody 2. Colleague 3. Foremen 4. Others, specify :	V14[ ]
15. Personal protective device worn, give detail	V15[ ]
16. Tools used at the moment of injury? 0. Did not use any tools ==>skip to Q18 1. Tools type	V16[ ]
17. Please describe how the tools related to the injury ?	V17[ ]

Questions			Code
18.	**How did you feel at the day of injury?**		
	18.1 Exhaust	1.Yes 2.No	V18_1[ ]
	18.2 Sleepy	1.Yes 2.No	V18_2[ ]
	18.3 Fever but no medicine taken	1.Yes 2.No	V18_3[ ]
	18.4 On some medication :	1.Yes 2.No	V18_4[ ]
	18.5 Drank alcohol	1.Yes 2.No	V18_5[ ]
	18.6 Drank alcohol :	1.Yes 2.No	V18_6[ ]
	18.7 Drank caffeine-mixed tonic:	1.Yes 2.No	V18_7[ ]
	18.8 Anxiety:	1.Yes 2.No	V18_8[ ]
	18.9 For female : menstruation	1.Yes 2.No	V18_9[ ]
	18.10 Others, specify.........................		V18_10[ ]
19.	**The cause of injuries : the worker's opinion**		V19[ ]
20.	**The cause of injuries : the investigator's opinion**		V20[ ]