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A Multi-Centre Cross-Sectional Survey on Safety at Construction Sites in Thailand, 1994–1995

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Abstract: A Multi-Centre Cross-Sectional Survey on Safety at Construction Sites in Thailand, 1994-1995: Construction Worker Research Group of Thailand— A multi-centre cross-sectional study was conducted under a uniform protocol in rapidly developing municipal areas in eight provinces of Thailand: Bangkok, Chonburi, Chiang Mai, Pisanulok, Khon Kaen, Nong Kai, Hat Yai and Phuket. Altogether information was collected by structured questionnaire interviews and inspection from 184 construction sites, 242 subcontractors, 171 workers' camps and 3614 workers. Males comprised 66% of the workers. 47% of the workers had worked 4 or more years in the industry. The majority (78%) had come from an agricultural background. Standards of education were uniformly low. Companies on small construction sites provided less protection facilities than at large scale construction sites and the injury rate in the former was 1.83 times higher. A nail in the foot was the most common injury (61%) resulting in stopping work. The overall incidence of injuries resulting in stopping work averaged 1.5 per 100 worker-months. Twelve work-related deaths were recorded at the construction sites studied. Causes were fall (4), electrocution (4), machinery (2) falling object (1) vehicle (1). The work-related death rate was 68 per 100,000 worker-years (95%CI 35-118). This rate is 2–5 times higher than those reported in western countries. Construction sites in Thailand have poor safety measures. The injury incidence rate and mortality rate are high.
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Worldwide, construction work in one of the occupations that has very high work-related injuries and deaths. These losses could be prevented by improvement of site management, better training and improvement of work practice[1)]. In developing countries, the situation is worse. Most of the construction workers are immigrants from rural areas, who have only a little training and workplace management is generally poor. Yet there has been very little research documented on such problems in developing countries.

In the past few decades, relatively high and stable economic growth in Thailand has led to a rapid increase in construction and influx of unskilled workers to major cities. The country could therefore serve as a case study of such important occupational problems. Findings of such a study would have implications for planning to prevent these problems in other growing and developing countries as well.

Evidence that construction workers in Thailand are at high risk comes from the rates of work-related accidents. In 1991, the Ministry of Interior reported that among the construction workers, there were 15,628 events or 180 per 1,000 worker-years. Of these, there were 132 deaths (1.5 per 1,000 worker-years), 5 completely disabled and 312 partially disabled. The relative risks of death and being disabled were 13.8 and 3.4 times respectively those of all manufacturing industries[2)].

The Construction-worker Study Group of Thailand was formed to collect data essential for planning health

programmes for these workers. The current report covers the objectives to determine conditions of work safety at work sites, the incidence density of work related injuries, the pattern of injuries and causes of injury-related deaths.

Methods

Study cities

Data collection was carried out during 1994–1995. This was a multi-centre cross-sectional study conducted under the same protocol. The study covered urban areas where the economic growth rates and the number of construction sites were high. The study regions and the districts selected were: Klong Toey and Lad Krabang Districts of Bangkok, Chonburi Municipality in the eastern region, Chiang Mai Muang District and Pisanulok Muang District in the northern region, Khon Kaen Muang District and Nong Kai Muang District in the northeastern region and Hat Yai District and Phuket Island in the southern region.

Sampling technique

In Bangkok, name lists of the construction sites were obtained from the municipality offices where the companies must obtain permission. In other provinces where a large proportion of construction sites were outside the municipality, the research team drove a car along the main streets in the study area and identified the actual construction sites visible.

Each of the identified sites was first visited by the research team to obtain basic data from the announcement board about the site, which included the stage of the construction (digging soil, setting up the foundation, framework, plumbing, etc.), size of the building (height and floor area), and total costs of the project. Further information such as the estimate of the number of workers was obtained by interviewing the foreman at the site.

The construction sites were classified into large sites and small sites. A large site was defined as having a 10,000 square metre or larger floor area. If it was multi-storey then the total area for all floors was calculated.

The protocol called for ten randomly selected large sites and ten randomly selected small sites to be chosen for further study. There were some minor deviations in the classification system at different centres. For the provinces where there were not enough large sites, i.e. Khon Kaen, Nong Kai, Phisanolok, the largest of the small sites were chosen to make up the required sample size (n=10).

The structure of the organisation of the work force and safety measures at construction sites was rather complicated. A large construction site would be run by several (up to 20) subcontractors whereas a small site often was under a single exclusive construction company. For a site with more than one contractor, we randomly chose only one subcontractor and its employees as informants for our data collection.

Variables and measurement

The manager of the site/subcontractor was interviewed to obtain information safety policy, experience of visits by government officers, availability of a safety training programme, provision of safety clothing, and incidence of injuries. The construction site was then inspected with checklists on the general level of safety in the working environment, safety precaution, and the proportion of workers using protective clothing. The workers were then interviewed as to their experience with injury in the past month. Injury in our study was confined to that causing at least one work-day loss.

Statistical analysis

The data from different regions were pooled and analysed. Because we found very little difference between patterns for different cities and regions, we report here only the overall results.

For summary statistics, a weighted percentage was calculated to take into account the relative numbers of workers on small and large sites in the sampling frame for each study area.

Incidence density was computed based on the number of events by period of employment of the individual. We assume that the number of workers working for a given subcontractor at the time of interview is representative of the mean number of workers since the time the construction began. Then we calculated, for each subcontractor, the total number of worker-years. Summing the values for each subcontractor gives the estimated total number of worker-years for all the study sites. Because the number of deaths was very small, sub-group analysis of mortality was omitted.

Results

Characteristics of Work sites

Only three sites out of 189 failed to be included because of refusal to participate in the study. Two other sites were excluded because the same subcontractors were working at two sites.

As a result of our sampling scheme, small sites made up 60%, and large, 40% of the sampled sites. This contrasts with the reference population of construction sites (sampling frame) in which small sites were more numerous and comprised 81% of sites. Large sites, however, have on average many more workers than small sites. Overall the estimated total number of workers in the sampled sites was 21,952. Large sites were taller, more expensive, employed more workers and took longer to complete (Table 1).

Demographic characteristics of workers

Socio-demographic characteristics were uniform in all the study areas. Two thirds (65.9%) of workers were male. Almost all were Buddhist (98.4%). Most workers

Table 1. Comparison of selected characteristics of small and large construction sites

Characteristic	Small Sites	Large Sites
Total floor area	<10000 m^2	>=10000 m^2
Median height of construction (m)	12	20
Median estimated cost of construction (millions Baht)	8.2	90.2
Mean number of workers	67	232
Median estimated total duration of construction (months)	11.5	16.5

Table 2. Proportion of selected socio-economic characteristics by size of constructions and pooled

Characteristic		Small sites (n=2123)	Large sites (n=1478)	Weighted mean
Sex	Male	65.8	68.0	66.5
	Female	34.2	32.0	33.5
Age	10–14	0.8	1.2	0.9
	15–19	12.8	10.5	11.8
	20–29	34.3	35.5	33.7
	30–39	31.4	32.2	33.1
	40–49	15.5	15.6	15.5
	50+	5.2	5.1	5.0
Education	No formal education	5.1	4.9	4.8
	Primary	87.5	84.9	86.6
	Lower Secondary	4.7	6.3	5.4
	Upper Secondary	1.6	2.5	1.9
	Vocational/Other	1.1	1.3	1.2
Years in construction industry				
	<1			
	1–<4	28.5	27.8	28.3
	4+	23.2	26.1	24.3
		48.3	46.0	47.4
Total monthly family income				
	<3000 B	25.8	18.9	23.3
	3000–<5000 B	42.8	38.3	40.6
	5000–<10000 B	27.4	36.6	31.3
	10000 B+	4.0	6.2	4.8
Family debt	Yes	49.1	46.7	48.2
	No	50.9	53.3	51.8
Birthplace (Region)				
	Central	4.8	6.5	5.5
	North-east	53.3	39.3	47.8
	North	33.6	42.6	37.0
	South	8.2	11.6	9.8

were between 20 and 40 years old, but 1% were less than 15 years old (Table 2). Almost half had worked in the construction industry for four or more years. Altogether, 78% had previously worked in agriculture. Most workers had a primary school level of education. Almost two thirds (64%) of workers had a self-declared combined family income of less than 5,000 baht/month. About half were in debt.

Most construction workers came from the north or north-east of Thailand. Analysis by region reveals similarity of birth place distribution except in Hat Yai where 74.5% of workers came from the southern region.

Table 3. Safety measures provided by construction companies

safety equipment/facilities provided	small site (%)	large site (%)	Weighted (%)
helmet	29.4	56.8	39.5
safety glasses	22.0	40.5	28.5
safety shoes	33.9	48.6	40.2
gloves	40.4	52.7	45.6
safety belt for high place working	12.8	31.1	20.2
safety training for workers	25.7	48.6	35.9
safety training for foremen	26.6	60.3	38.5
warning sign at work site	13.6	43.2	23.6
fence around work site	26.4	66.2	37.0
first-aid kit available	60.6	86.5	70.4

Table 4. Causes of injury during construction work

Cause of injury	Number	Percentage
Nail in foot	204	60.9
Cuts	32	9.6
Fall from height	21	6.3
Particle in eye	14	4.2
Struck by falling object	14	4.2
Struck by vehicle	13	3.9
Electrical injury	8	2.4
Struck by toppling object	7	2.1
Hand or foot severed	5	1.5
Struck by bouncing object	4	1.2
Struck by hammer	4	1.2
Other	8	2.7
TOTAL	334	100.0

Table 5. Causes of death on construction sites

Cause of death	Total
Fall from height	4
Electric shock	4
Struck by machinery	2
Struck by falling object	1
Struck by vehicle	1
Total work-related deaths	12
Cause of death unrelated to work	12

The Phuket site also had a substantial number of Mon workers from Myanmar but these were not included in the main part of the survey.

Site inspections

According to the subcontractors, only 65.6% of sites had been visited by at least one representative of any safety regulation agency. One-third (33.7%) of the contractors had been visited by representatives from the Civil Works Department and municipality (who are responsible for engineering safety), 16.9% from the Provincial Health Departments and 18.5% from the Provincial Labour Department.

Safety equipment and facilities provided by the companies are shown in Table 3. For all items, workers at large construction sites were relatively better protected than those at small sites. None of the items reach 75% weighted coverage.

Accidents and deaths in the workplace

There were 334 accidents (all non-fatal) resulting in stopping work registered within one-month prior to our visits. The incidence of injuries resulting in stopping work, as reported by subcontractors, averaged 1.52 per 100 worker-months. By small and large sites, the corresponding numbers of injuries were 152 and 182, the numbers of worker-months were 6,867 and 15,085 and the rates were 2.21 and 1.21 per 100 worker-months, respectively, so that the rate on small sites was 1.83 times that on large sites (95% CI: 1.47, 2.29). The types of injuries are summarised in Table 4.

Altogether 12 people died because of work related accidents during work on the 184 construction sites surveyed since the construction had started. The causes of death are summarised in Table 5. A further 12 people died of causes unrelated to accidents at work.

Total person-time at risk across the study sites was 17,663 worker-years. This gives a rate of 68 work-related deaths per 100,000 worker-years (Poisson 95% CI: 35–118). If we consider all causes of death, the rate is doubled.

Discussion

The overall picture from this study shows a high level of problems among construction workers throughout major cities in Thailand. On work sites where there are young migrants from poor rural areas of the country and without much work experience and poor inspection

coverage from authorities, the working conditions are poor.

Safety measures provided by the companies were scant. As a consequence, the injury rates and death rates were high. The incidence of work-related injuries in the current study is 1.52 per 100 worker-months. This is approximately twice the rate of 7.63 per 100 worker-years or 0.63 per 100 worker-months in rural Iowa reported by Zwerling, *et al.*[3]

The injury rate was also higher among workers on small construction sites. This finding is consistent with that found in Alberta[4]. Oleinick *et al.*[5] argued that the turnover rate among workers on small sites is likely to be higher than that on large sites resulting in more under-registration of workers at risk and under-estimation of the injury rate among this group. Combining these with the finding that all safety measures were more commonly provided by the large companies, priority should be given to controlling problems in the small-scale construction industry.

Although non-fatal injuries such as falls from a height, particles in the eye, being struck by a vehicle, electrical injuries and severed hand or foot were not as common as a nail in the foot, they are potentially more serious. A nail in the foot was very common in our study but almost never mentioned by investigators in most previous studies. This difference may be due to better prevention measures or due to under reporting of such problem in other studies. Most studies in the west were based on claim registrations whereas ours was a field survey. Since this problem is less serious than the others, the probability of under-claiming may be lower.

The pattern of causes of death among workers in Thailand in this study was somewhat similar to that in previous studies elsewhere[1, 6, 8], in which falls and electrocution were among the most common work-related causes of death among construction workers.

The estimated work-related fatality rate from this survey (68 per 100,000 worker-years) was less than half of those previously reported by the Department of Labour (152 per 100,000 worker-years). In the official report, the denominators are from the labour statistics, which refer only to registered companies. The official national estimate of 86,704 workers is certainly a gross underestimate of the true number of workers. We calculated that in the sampled districts in Bangkok alone, the estimated number of construction workers was around 25,000. Although there are also some concurrent underreported work-related deaths, this error is unlikely to be as large, so that the previous official estimated rate is an over-estimation. Our own estimate has some deficiencies as well because of the complexity of organisation of the site-contractor-worker relationship. Nevertheless, our estimated rate is still clearly high.

One may argue that our study was a cross-sectional survey in workplaces where turnover rates were relatively high. There might have been a degree of bias due to the "healthy worker effect". Workers who had been injured were more likely to have left the workplace, leaving those relatively healthy and less injured remaining in the study period. We argue that this is unlikely to be the case because the number of injuries or the numerator of the injury rate was not obtained from the currently sampled workers but obtained either from the record or from the manager. Similarly, the denominator was estimated from the number of workman-days, which is also independent of the injury status of the sampled workers, so that the "healthy worker effect" was not much of a problem in our case.

One limitation of this study is that the injuries were obtained from the manager's records. Minor injuries not leading to work-day loss might not be included. This is, however, less important as the magnitudes of economic and health loss are likely to be not as great as those requiring absenteeism.

The fact that the construction workers are at high risk of work-related death has been reported previously by different investors. In the United States, the work-related fatality rate per 100,000 worker-years was estimated to be 24.0 during 1980–1985 by Bell *et al.*[9], 13.3 and 14.2 in 1992 and 1993 by Pollack *et al.*[10], 14.5 in New Jersey during 1983–1989 by Sorock *et al.*[7], 8.8 in South Carolina during 1989–1990 by Stone[8] and the second highest cause of work-related deaths in Alaska in 1992 by Schnitzer[11]. The rate in Australia was slightly lower than that of the United States during 1988–1991[12]. The rate in Quebec, Canada, declined from 27.8 per 100,000 in 1981 to 15.9 per 100,000 in 1988[13].

Our estimated work-related fatality rate of 68 per 100,000 worker-years is lower than that in Brazil in 1979–1989 (94.3 among carpenters and 63.3 among bricklayers)[14], and is 2–5 times higher than those in the developed countries mentioned above.

Recently, Chang and Wang[15] suggested that the cumulative injury rate should be calculated to enable international comparison. In our study, however, the construction workers are highly mobile and a cross-sectional survey is insufficient to obtain detailed data, so this kind of rate is therefore unfortunately not obtainable in the current study. A longitudinal study on such a worker population is necessary for future work.

Basic protective equipment has the potential to greatly reduce the number of work-related injuries on construction sites. The importance of this is well illustrated by the large numbers of workers wearing open shoes, and the fact that 60% of injuries resulting in stopping work were caused by a nail in the foot. Presumably many of these injuries could have been prevented if the worker had been wearing covered, hard-soled shoes. Similarly, a substantial proportion of work-

related deaths could have been prevented by improvements in the physical work environment and more attention to personal safety. Fall from a high working place caused one third of all deaths, but safety belts for such work were available only in 20 percent of the companies sampled. Electrocution also causes one third of work-related deaths, but none of the sites had an earth line for any electrical equipment.

In conclusion, safety measures for construction workers in Thailand are poor. Work-related morbidity and fatality rates are high. There is a need to improve this situation.

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