

A SURVEY INTO PROCESS AND WORKER'S CHARACTERISTICS IN THE WOOD FURNITURE INDUSTRY IN SONGKHLA PROVINCE, SOUTHERN REGION OF THAILAND

P Tuntiseranee¹, and V Chongsuvivatwong²

¹Department of Community Medicine, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90112; ²Epidemiology Unit, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla, 90112, Thailand

Abstract. A cross-sectional survey of the wood furniture industry was conducted in southern Thailand in February 1993. The aim was to examine the manufacturing process, occupational hazards at the workplace, workers' demographic characteristics, period of employment, incidence rate of work related injury and some reproductive history of workers. Altogether 69 managers and 1,000 workers participated in the study. There are 2 main types of wood industry, rubberwood and hardwood. The rubberwood industry is semi-automated with advanced technology, has a female-dominated workforce of 200-300 workers per factory and overseas-market orientation. The hardwood industry is based in small-scale workplaces ranging from 20 to 60 workers, domestic-market orientation and has a male-dominated workforce. Most of the workers were young, single, of low education and were high turnover rate laborforce, with arduous work and long working hours per week. Solvent was the most frequent chemical exposure. The person-year incidence of chemical exposure in female workers was higher than in male workers for every group of chemicals. The incidence of accidents was twice as high as the official rate. The standardized fertility ratio of female wood workers was only 51.6% of that of the Thai female population. There was a high abortion rate among women who became pregnant inside the wood industry compared to that among pregnancies outside the wood factory. Wood industry workers were exposed to occupational hazards and accident-prone work conditions.

INTRODUCTION

Southeast Asia is well known for rubber plantation for several decades. Southern Thailand is a part of Southeast Asia where rubber plantations occupy approximately 15% of land. Rubberwood furniture industry was introduced in the late 1980s in addition to hardwood furniture industry which has existed for a long time (Academic Center of Economical Industry, Southern Thailand, 1992). The wood furniture industry is rapidly expanding since the demand for furniture both inside and outside Thailand is growing rapidly with the increasing living standard. This industry has also introduced new occupational health problems to the wood furniture workers. From previous literature, respiratory symptoms (Dykewicz *et al*, 1988; Shamssain, 1992), neurological symptoms (Baker *et al*, 1985), reproductive health effects (Lipscomb *et al*, 1991; Cordier *et al*, 1992) and possibly carcinogenic effects (Nylander *et al*, 1993) are expected to be important problems.

Songkhla province is the most industrialized province in Southern Thailand and is surrounded by

rubber plantations. As a result, it is the main location of the rubberwood and hardwood furniture industry including other down-stream businesses. There was also no base-line information on health problems among the workers in the wood furniture industry in southern Thailand. Therefore, our study was performed to explore occupational health problems from the wood furniture industry in this province. The objective of the study was to obtain data on the manufacturing process, physical and chemical hazards in the workplace, demographic characteristics of the workers, injury and reproductive health problems. The last problem was of particular significance as the worker population were mostly young and in the reproductive age group so that they, as well as the coming generation, might be vulnerable to reproductive hazards in the workplace.

MATERIALS AND METHODS

One hundred and twenty-nine wood factories from a computerized registry at Provincial Industrial Works of Songkhla Province were identified.

Inclusion criteria for selection into the study were 1) factories located in Hat Yai district and 2) factories outside Hat Yai district which were engaged in wood impregnation and furniture production. Seventy-three factories were eligible according to these criteria. Ten were out of business, 6 could not be found and 1 refused to participate. Another thirteen factories, which were not registered but identified in the field trip were included. Altogether 69 factories were included in the study. The managers were interviewed using a questionnaire to obtain information on manufacturing procedures, factory age, membership of social security scheme and worker compensation fund, number and sex of workers. Worksites were observed using walk-through survey technic (Harrington *et al*, 1992).

Subsequently, the factories were stratified by the number of workers into 5 strata (<20 workers, 20-49 workers, 50-99 workers, 100-400 workers and \geq 400 workers). The sample of 1,000 out of 4,545 workers was selected proportional to size of each strata. Face-to-face interview was conducted to obtain data on demographic characteristics, work history, chemical exposure at work, work-related injury and reproductive history. Eligible injury was defined as an accident leading to at least one day of sick leave. History of chemical exposure was obtained by asking subjects about exposure to specific agents in daily work (as suggested by walk through survey). Questions on reproductive health problems were confined to female workers.

Data were computerized using the CRS program and SPSS was used for statistical analysis.

RESULTS

There are 2 main categories of wood industry in the study area - rubberwood and hardwood. From interviewing the managers and the walk-through survey, the median age of the factory was 5 years (range 1 to 34 years). The factories were then grouped into type and potential occupational hazards as shown in Table 1.

In rubberwood industry, the production chain starts from the rubberwood *sawmill* which is a small-scale worksite of about 20-30 workers using 48-inch naked saw to cut logs into planks. Afterwards, female workers dip the planks into borax and pentachlorophenol solution barehanded to pre-

serve rubberwood before sending it to the impregnation factories. The *wood impregnation factory* is semi-automated industry where the planks were put in a vacuum tank to impregnate with borax and pentachlorophenol for 3-6 hours. The *furniture production factories* then buy the impregnated planks, cut them into small pieces, and bind them using heated pressure and special glues. These are then shaped up into furniture part, polished both with machine and scrupulously by hands, painted and varnished with lacquer. Most rubberwood factories are semi-automated, have 200-300 workers, a female-dominated workforce, are overseas market-oriented and have daily wage workers except sawmill, wood bead factory and wood box factory. By contrast, *wood bead process* is small with about 35 workers and low-invested equipment. Chemical exposures and work participation are similar to those in the impregnation and furniture factory. *Wood box producing factory* is a very small domestic industry of around 5 workers using hammer and nail to make up boxes. No hazardous chemical is used in this process.

The raw material used in hardwood industry is mainly inferior wood and assorted lumber imported from Malaysia. The typical characteristics of hardwood factories are small scale ranging from 20 to 60 workers, have domestic-market orientation and have male dominated workforce as professional carpenters. The chemical exposures in *furniture production* are pentachlorophenol, formaldehyde from plywood, solvent and paint compounds whereas no chemicals are used in *window and door frame process*. In *wholesale and retail trade*, the main job is to transport the wood parts to the client's place.

In conclusion, chemical exposures in wood and furniture industry are as follows: fungicides and insecticides, eg borax, pentachlorophenol; solvents, eg methyl alcohol, aromatic hydrocarbons, eg toluene, xylene and ketone, kerosene, turpentine, aliphatic hydrocarbons including mixtures of solvent-urea adhesives; painting compounds, eg industrial paint, polyethylene paint and amino-paint. Workers were also exposed to physical hazards such as wood dust; heat from putting firewood into boiler; loud noise from sawing, cutting or automatic polishing machines; whole-body vibration among workers who drive forklift trucks, local vibration among workers using manual polishing tool and sawing machine including ergonomic prob-

Table 1

Raw material, physical and chemical hazards in wood furniture industry according to the process, Songkhla Province, Thailand.

Process (no. of factory)	Raw material		Chemical hazard			Physical hazard				
	Rubber wood	Hard wood	Borax	Pesti- cide	Solvent	Noise	Heat	Dust	Ergo - nomic	Acci- dent
1. Sawmill (7)	7	-	5	-	-	+	-	+	+	+
2. Wood impregnation (9)	9	-	9	2	-	+	+	+	+	+
3. wood impregnation furniture (2)	2	-	2	2	2	+	+	+	+	+
4. Furniture production (22)	14	8	-	4	22	+	+	+	+	+
5. Wholesale and retail (14)	-	14	-	-	-	-	-	-	+	+
6. Window and door frame (13)	-	13	-	-	-	+	-	+	+	+
7. Wood bead (1)	1	-	1	1	1	+	+	+	+	+
8. Wood box (1)	1	-	-	-	-	-	-	-	+	+

lem and accident-prone working conditions, eg, sawing, drilling and cutting machines without an enclosing guard. In addition, the painting and enameling process was usually neither separated from the other processes nor established with adequate ventilation systems. There was also a lack of managerial policy and availability of personal protective devices. Only 42% of the factories were enrolled in social security or worker compensation program.

Out of 4,545 workers, 1,000 workers were randomly chosen and interviewed. Furniture production accounted for more than 70% of all workers. Females were more common than males in all types of factories except sawmill, wholesale and retail and window and door frame. Most workers were Buddhists, had completed primary or secondary school and, except in sawmill and wholesale and retail process, were single. Wood workers had a mean age of 24.8 years (range 15 to 60 years) with standard deviation of 6.8 years. Workers in sawmill and wholesale and retail trade were older than those in other processes (Table 2).

Table 3 shows that turnover rate of the workers in every process was high. Median period of em-

ployment ranged between 0.4 year to 1.2 years among female workers and 0.4 year to 2 years among male workers. Ninety-nine per cent of the workers worked 6 days per week and 61% had overtime jobs.

Quantitative estimates of chemical exposure (Table 4) showed that workers in furniture production process were exposed to large amounts of all chemicals while workers in wholesale and retail trade and window and door frame were seldom exposed to any chemicals. Female workers were exposed to chemicals more than male workers in every group of chemicals except paint.

The incidence rate of accidents in this study was 108 per 1,000 which is twice as high as that reported by Compensation Fund Registry in the same period in Southern Thailand (46 per 1,000).

Among 545 female workers, 194 were married or cohabiting. Contraceptive prevalence rate was 68% and oral pill was the most commonly employed method. Fifty-one cohabiting women did not use any kind of contraceptive since 39 of them wanted a baby and 12 had been pregnant. The average number of children of married female work-

WOOD WORKER HEALTH RISKS

Table 2

Demographic characteristics of the workers in wood industry by each process, Songkhla Province, Thailand (n= 1,000).

Demographic characteristics	Sawmill	Wood impregnation	Wood impregnation and furniture production	Wholesale and retail	Furniture production	Window and door frame	Total
Sex							
male	25	39	29	47	304	11	455
female	5	36	69	1	434	-	545
Age (year)							
15-20	3	19	47	4	240	2	315
21-25	5	24	29	9	239	6	312
26-30	8	16	16	16	147	1	204
31+	14	16	6	19	112	2	169
Education							
no school	-	2	-	-	6	-	8
primary school	24	55	71	39	468	7	664
secondary school	5	12	8	6	106	3	247
vocation school	-	1	3	1	47	1	53
university	-	-	-	-	1	-	1
other	1	-	2	1	13	-	17
Religion							
Buddhist	25	71	87	45	619	11	858
Moslem	5	7	11	3	116	-	139
Christian	-	-	-	-	3	-	3
Marital status							
single	8	41	61	22	442	11	585
married/ cohabiting	20	32	32	25	271	-	380
widowed	2	2	4	-	23	-	31
divorced/ separated	-	-	1	1	2	-	4

Table 3

Period of employment (year) among workers in wood furniture industry, Songkhla Province, Thailand.

Process	Male				Female			
	Min	Max	Mean	Median	Min	Max	Mean	Median
1. Sawmill (7)	0.1	6	1.1	0.8	0.1	6	1.9	1.1
2. Wood impregnation (9)	0.1	4	1	1	0.1	4	0.8	1
3. Wood impregnation and furniture production (10)	0.1	15	1.2	0.4	0.1	5	1.1	0.4
4. Furniture producing (32)	0.1	15	1.7	1.2	0.1	15.3	2.1	1.2
5. Wholesale and retail trade (14)	0.1	32	3.4	0.9	0.2	0.2	0.2	0.2
6. Window and door frame (13)	0.1	7	2.5	2	-	-	-	-

Table 4

Average person years exposure to industrial chemicals per 100 person years among workers in wood furniture industry, Songkhla Province, Thailand.

Process	Sex*	Penta-chlorlo-phenol	Bo-rax	Alco-hol	Thin-ner	Sea-ler	Polyure-than paint	Amino paint	Indus-trial paint
Sawmill	m	-	-	-	-	-	-	-	-
	f	-	21.4	-	-	-	-	-	-
Wood impregnation	m	-	25.2	-	-	-	-	-	-
	f	14	58.7	-	-	-	-	-	-
Wood impregnation and furniture production	m	8.5	8.5	-	5.7	2.8	-	-	-
	f	37.9	37.9	-	6.6	16.5	-	-	-
Whole sale and retail trade	m	-	-	-	0.6	-	-	-	-
	f	-	-	-	-	-	-	-	-
Furniture production	m	0.4	0.6	6.0	14.4	3.1	5.7	1.5	3.3
	f	-	0.6	3.9	34.5	22.3	-	3.3	3.5
Window and door frame	m	-	-	-	-	-	-	-	-
	f	-	-	-	-	-	-	-	-

*m = male workers; f=female workers

Table 5

Indirect standardization of general fertility rate of married female workers in wood furniture industry, Songkhla Province, Thailand.

Age group	No. of female workers in the industry	National general fertility rate 1990 (per 1,000)	expected livebirths	observed livebirths
15-19	145	42.2	6.1	5
20-24	190	110.5	21	8
25-29	106	102.7	10.9	4
30-34	61	64.2	3.9	4
35-39	18	31.3	0.6	0
40-44	7	14.2	0.1	1
Total	527		42.6	22

Standardized fertility ratio = $22/42.6 = 51.6\%$

ers was 1.4. Table 5 shows that standardized fertility ratio among female workers was 51.6% of the national fertility rate. Abortion rate was 19% when female workers became pregnant in the present wood factory but the rate was 5% when the same mother became pregnant before working in the present factory (data not shown).

DISCUSSION

This study shows that wood industry workers were young, Buddhist, of low educational level and were rapid turnover of the labor force. The male to female ratio was 1:1. They were exposed to high levels of both physical and chemical hazards. The common chemicals used in wood industry were borax and pentachlorophenol for wood preservative, solvent and paints. Female workers were exposed to chemicals more than male workers. The injury rate was higher than that reported by the government. Female workers had relatively low fertility rate. Abortion rate was higher when workers got pregnant in the present wood factory than when they got pregnant before working in the present factory.

This study is likely to have encountered the healthy worker effect. Such poor working conditions were likely to lead to health problems and injury which directly or indirectly forced the worker out of the industry. The injury rate and the reproductive health problems found in this study thus underestimate the real situation.

In this study, 13 factories which were found in the field trip were small-scale wood industries in the wholesale and retail trade and hard wood furniture shops. This may suggest some underreporting of small-scale factories in the registry we used. However, it was less likely that a medium and large-scaled factories were not registered in the database we used.

Although we employed the walk-through survey technic which included visiting chemical storage room, not all chemicals could be identified since there was no material safety data sheet providing generic names and properties of each substance. The generic name was sometimes classified by the factory as an industrial secret; or there was no response to the letter asking for the ingredients from any manufacturing factories. We were unable

to analyze these compounds due to their wide variety and the limitation of laboratory resources. Exposure to chemicals was thus broadly specified. The quantitative chemical exposure in person-years depended on direct contact with chemicals while we observed that most hazardous procedures were not performed in a closed system; the workplaces were not equipped with adequate ventilation; and no personal protective device was available. As a result, most workers were unavoidably exposed to toxic substances, so chemical exposure might be higher than that shown in the study.

In this study, the accident incidence rate was twice as high as the regional official rate. This could be explained by the failure to enroll in the social welfare scheme by small-scale factories.

In our study, we found the standardized fertility ratio of female workers was half that of the general population. This could be a function of behavioral characteristics of young working couples to prolong time-to-pregnancy, it could be due to low fecundity among female workers or the fact that infertile women were more likely to stay in employment. It was not the aim of this survey, however, to determine the reason for low fertility in the wood workers.

Organic solvents are volatile liquids with lipid solubility, it is likely that most organic solvents easily cross the lipid barrier of the placenta and to a lesser degree, the testis. Previous epidemiological studies on the effect of solvent to spontaneous abortion have been reported both associations (Heidam, 1984a; Taskinen *et al*, 1986) and no associations (Axelsson *et al*, 1984; Heidam, 1984b). Differences in selection of study population and occupation, specific type of solvents used, low statistical power for separate solvent study, variation of solvent intensity and the fact that actual time of solvent exposure should be the first trimester may explain the inconsistent results. Two case-control studies nested in a cohort from Finland (Linholm *et al*, 1990; Taskinen *et al*, 1989) monitored biologically for exposure to six organic solvents (styrene, toluene, xylene, tetrachloroethylene, trichloroethylene and 1,1,1-trichloroethane) reported a positive association between spontaneous abortion and maternal exposure to organic solvents during pregnancy, especially to aliphatic hydrocarbons (OR 3.9, 95% CI 1.1- 14.2) and paternal exposure to organic solvents in general (OR 2.3, 95% CI 1.1-5.0), high and frequent exposure to

toluene (OR 2.3, 95% CI 1.1-4.7) and miscellaneous organic solvents including thinners (OR 2.1, 95%CI 1.1-3.9). The high abortion rate in our study seemed to be consistent with previous findings, however, it should be noted that many strong confounders such as maternal age, parity or maternal physical workload etc, were not taken into consideration.

In conclusion, the wood furniture industry in Southern Thailand are likely to cause occupational health and safety problems. Employers should be encouraged to provide safe work environment and adequate protective equipment and workers should be regularly trained and monitored to perform safe work practice. The establishment of an action-oriented health and safety committee with employers and workers involvement is recommended as a first step.

ACKNOWLEDGEMENTS

The authors would like to thank Dr Alan Geater and Prof Than Winn or their helpful recommendations and comments on manuscript preparation. Funding for this project was provided by the Danish International Development Assistance (DANIDA) under the Ministry of Foreign Affairs, Denmark and Thailand Research fund (TRF).

REFERENCES

Academic Center of Economical Industry, Southern Thailand. Economical Industry Division. Report on economical industry in 1992 and trend in 1993. Center Office Bureau, Ministry of Industry, 1992.

- Axelsson G, Rylander R. Outcome of pregnancy in women engaged in laboratory work at a petrochemical plant. *Am J Ind Med* 1989; 16: 539-45.
- Baker ELJ, Smith TJ, Landrigan PJ. The neurotoxicity of industrial solvents: A review of the literature. *Am J Ind Med* 1985; 8: 207.
- Cordier S, Ha MC, Ayme S, *et al*. Maternal occupational exposure and congenital malformations. *Scand J Work Environ Health* 1992; 18: 11-17.
- Dykewicz MS, Laufer P, Patterson R, *et al*. Woodman's disease: Hypersensitivity pneumonitis from cutting live trees. *J Allergy Clin Immunol* 1988; 81: 455-60.
- Harrington JM, Gill FS. Occupational Health (pocket consultant), 3rd ed, Oxford: Blackwell Scientific Publications, 1992.
- Heidam LZ. Spontaneous abortions among dental assistants, factory workers, painters, and gardening workers: a follow-up study. *J Epidemiol Community Health* 1984a; 38: 149-55.
- Heidam LZ. Spontaneous abortions among laboratory workers: A follow-up study. *J Epidemiol Commun Health* 1984b; 38: 36-41.
- Lindbohm ML, Taskinen H, Sallmen M, *et al*. Spontaneous abortions among women exposed to organic solvents. *Am J Ind Med* 1990; 17: 449-63.
- Lipscomb JA, Fenster L, Wrench M, *et al*. Pregnancy outcomes in women potentially exposed to occupational solvents and women working in the electronics industry. *J Occ Med* 1991; 20: 241-59.
- Nylander LA, Dement JM. Carcinogenic effects of wood dust: Review and discussion. *Am J Ind Med* 1993; 24: 619-47.
- Shanmssain MH. Pulmonary function and symptoms in workers exposed to wood dusts. *Thorax* 1992; 47: 84-7.
- Taskinen H, Anttila A, Lindbohm ML, *et al*. Spontaneous abortions and congenital malformations among the wives of men occupationally exposed to organic solvent. *Scand J Work Environ Health* 1989; 15: 345-52.