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RESPIRATORY SYMPTOMS AND RUBBER-TREE-WOOD DUST EXPOSURE AMONG FURNITURE-FACTORY WORKERS IN THAILAND.

Anamai Thetkathuek[1], Tanongsak Yingratanasuk[1], Phayong Thepaksorn[2], Sastri Saowakhontha[3]

[1]*Department of Industrial Hygiene and Safety, Faculty of Public Health, Burapha University, Chonburi 20131, Thailand.*

[2]*Department of Environmental and Occupational Health Sciences, School of Public Health and Community Medicine University of Washington, Seattle, USA.*

[3]*Faculty of Public Health, Burapha University, Chonburi 20131, Thailand.*

ABSTRACT

This study assessed the respiratory symptoms of dust exposure among 685 rubber-wood workers in eight furniture factories in eastern Thailand. The study data were gathered using questionnaires and by sampling inhalable wood-dust. The correlation coefficients *(r)* of the independent variables and respiratory symptoms were determined by logistic regression analysis.

Of the 685 workers, 369 (53.6%) were female and 316 (45.9%) male; their average age was 32 years (range: 15-60 years). The questionnaire results showed that 131 workers had cough during the day or night (19.0%), 131 had phlegm (19.0%), 299 had chest pain/tightness or breathlessness (43.3%), 169 felt short of breath when walking quickly or running (24.5%), and 103 felt short of breath walking at an ordinary pace on level ground (14.9%). Wood-dust exposure was classified into three levels: < 1 mg/ m^3 (n=0), 1-5 mg/ m^3 (n=43; 74.1%), and > 5 mg/ m^3 (n=15; 25.9%). Logistic regression analysis showed that high exposure to wood dust correlated with cough during the day or night for > 3 months ($p < 0.05$). Longer duration of employment correlated with chest pain/tightness or breathlessness ($p < 0.05$). Using a cotton mask correlated negatively with cough during the day or night ($p < 0.05$).

Keyword: Rubber wood dust, respiratory symptoms, wood workers, occupational dust exposure.

* Corresponding author. E-mail address: anamai@buu.ac.th

INTRODUCTION

Wood workers in the furniture industry are at high risk of exposure to wood dust in different wood-working processes, including raw material preparation, cutting, drilling, planning, sanding, assembling, and finishing. Researchers have been concerned about occupational exposure to wood dust (Cormier et al., 2000; Demers et al., 2000) because continuing wood-dust exposure causes respiratory symptoms (Ordma, 1949), such as reduced lung function, asthma, chronic bronchitis, and nasal irritation (Meo, 2006; Okwari et al., 2005; Venturini et al., 2004; Haman et al.,1995), which depend on wood-dust exposure levels (Liou et al., 1996; Milanowski et al., 2002). In addition, wood-dust exposure can cause cough, wheeze, shortness of breath, and phlegm (Arbak, 2004; Dutkiewicz et al., 2001; Milanowski et al., 2002; 1988; Talini, 1998), and chest pain (Milanowski et al., 1996).

Several studies have revealed an increased risk of bronchitis (Eduard et al., 1993; Hausen, 1989; Mandry et al., 1999; Rosenberg et al., 2002; Schlunssen et al., 2002; Schlunssen et al., 2002; Schlunssen, 2001) and asthma (Chan Yeung et al., 1984). Respiratory symptoms varied with type of wood, e.g., hardwood, softwood, dry wood, green wood, or with species (Maciejewska, 1993). Wood-dust exposure at 1 mg/m^3 can cause sinusitis, chronic obstructive pulmonary disease (COPD), and sinonasal cancer (Borm et al., 2002; Enarson and Chan-Yeung, 1990; IARC, 1995; Nylander, 1993). In addition, allergy symptoms were found among 64% (n=127) of Swedish wood workers, such as eye and nose irritation (Turjanmaa et al, 1996; Ahman et al., 1995; Ahman et al., 1995).

Although occupational exposure to wood dust has been studied in several countries, few have focused on para rubber-tree *(Hevea brasiliensis)* wood-dust exposure. This study aimed to assess respiratory symptoms among para rubber-wood furniture-factory workers in Thailand.

MATERIALS AND METHODS

Study population

Data for this cross-sectional-study were collected at randomly selected factories that used natural rubber-tree wood, in eastern Thailand, between April-October 2007. Since the participation of factory owners was limited, and some factories had closed due to the economic recession, only 8 of the initial 27 randomly selected factories were studied. The types of work involving rubber-tree wood included preparation of raw material, cutting, drilling, planning, assembly, finishing, and clerical work. The sample inclusion criteria were age ranging from 18 to 60 years old who had been working for a minimum of three months in this factory or similar rubber-wood factory. Subjects were excluded if exposed to solvent mixed with paint, or glue. All invited participants were free to decline participation or withdraw at any time without penalty. Written informed consent was provided by those who agreed to participate. The Institutional Review Board of Burapha University approved the study protocol.

Data collection

The wood-worker samples to be studied were recruited and divided into small groups, and were interviewed using a questionnaire that covered all aspects of respiratory symptom assessment. Wood-dust samples were also collected from different wood-working areas. It was assumed that airborne wood dust dispersed homogeneously across all departments. So a full-shift single sample of wood dust was collected at the workstations of selected workers in each department. The sampling equipment comprised low-flow pumps (SKC Model 224-PCXR4), IOM samplers (SKC Model 225-70A), and 25 mm PVC filters (SKC, Inc., 2007). The device was assembled on a stand, 1.6-meters high (breathing-zone height). The flow rate of the pump was 2 L/min. Gravimetric analysis of the sample filters was performed using NIOSH Method No.

0500 (NIOSH, 1994), at the Department of Industrial Hygiene and Safety Laboratory, Burapha University. The wood-dust exposure of each individual worker was computed from the results of the stationary dust sample concentration at each workstation.

Data analysis

Statistical analysis was performed with the computer program SPSS (Version II). Data analysis comprised descriptive data, such as numbers and percentages, used to describe the characteristics of the study participants, i.e., work history, and medical history. The correlation coefficients *(r)* for determinant factors of respiratory symptoms were analyzed by logistic regression. Independent variables comprised, gender, age, dust level, year of employment, and respiratory protection equipment. Dependent variables were respiratory symptoms, such as cough, phlegm, and wheeze.

RESULTS

Of the 685 sample workers, 369 (53.6%) were female and 316 (45.9%) male. Most were from eastern (n=265, 38.5%) and northeastern (n=165, 23.9%) Thailand. Regarding respiratory symptoms, 543 wood workers (78.8%) had no cough in the morning, 591 (85.8%) had no cough when they left for work, 600 (87.1%) had no cough when they had their first cigarette, and 605 (87.8%) had no cough 4-6 times/day for 4 days or more per week. In addition, 131 (19.0%) had cough during the day or night, and 36 (5.2%) had cough during the day or night for > 3 months, as shown in Table 1.

Table 1. Cough symptoms of woodworkers reported by number and percentage.

Cough	Number (Total=685)	Percent
1. Do you usually cough first thing in the morning?		
Yes	137	19
No	543	78.8
Not sure	5	0.7
Total	685	100
2. Do you usually cough on first going out of doors in the morning?		
Yes	92	13.4
No	591	85.8
Not sure	2	0.3
Total	685	100
3. Do you usually cough with first smoking?		
Yes	81	11.8
No	600	87.1
Not sure	4	0.6
Total	685	100
4. If you cough, do you cough like this on most days for as much as four to six times a day, four days or more a week?		
Yes	70	10.2
No	605	87.8
Not sure	10	1.5
Total	685	100

Cough	Number (Total=685)	Percent
5. Do you usually cough during the day or at night?		
Yes	131	19
No	544	79
Not sure	0	0
Total	685	100
6. If yes to either question 4-5, do you cough like this on most days for as much as three months a year?		
Less than 3 months	95	13.8
Equal or more than 3 months	36	5.2
Total	685	100

A few of them (n=131; 19.0%) often had phlegm in the morning, whereas all the rest (n=408; 59.2%) did not. Of these, 130 had phlegm during the day and at night (18.9%), and 48 had phlegm > 3 months (7.0%), as shown in Table 2.

Table 2. Phlegm symptoms of woodworkers reported by number and percentage.

Phlegm	Number (Total=685)	Percent
1. Do you usually bring up any phlegm from your chest first thing in the morning?		
Yes	131	19
No	408	59.2
Not sure	146	21.2
Total	685	100
2. Do you usually bring up any phlegm from your chest during the day or at night?		
Yes	130	18.9
No	466	67.6
Not sure	89	12.9
Total	685	100
3. If yes to question 1-2, do you bring up any phlegm like this on most days for as much as months each year?		
Less than 3 months	81	11.8
Equal or more than 3 months	48	7
Total	130	18.9
4. Have you had bloody phlegm?		
Yes	19	2.8
No	666	96.7
Total	685	100
5. Have you had yellow or brownish phlegm?		
Yes	34	4.9
No	651	94.5
Total	685	100

Two hundred and ninety-nine (299) wood workers had experienced tightness in the chest and breathlessness (43.4%). Of these, 104 had symptoms when they had a cough (15.1%) and 189 did not have any cough (27.4%). One hundred and thirty (130; 18.9%) wood workers experienced continuous chest tightness and breathlessness, 169 (24.5%) had these symptoms while walking quickly or running, 103 (14.9%) had chest tightness and breathlessness moving at an ordinary pace on level ground, and 84 (12.2%) had to stop for breath, as shown in Table3.

Table 3. Chest illnesses or dyspnea of woodworkers reported by number and percentage.

Chest illnesses	Number (Total=685)	Percent
1. Do you have chest pain or tightness or breathlessness?		
Yes	299	43.4
No	383	55.6
Not sure	3	0.4
Total	685	100
If yes, do you have these symptoms just only when you have a fever?		
Yes	104	15.1
No	189	27.4
Not sure	6	0.9
Total	299	43.4
If no, do you have chest pain or tightness or breathlessness when?		
1.1 Exercise		
Yes	79	11.5
No	116	16.8
Total	195	28.3
1.2 Consistently		
Yes	130	18.9
No	65	9.4
Total	195	28.3
2. Are you ever troubled by shortness of breath, when hurrying on walking or running?		
Yes	169	24.5
No	516	74.9
Total	685	100
3. Do you get short of breath walking with other people at an ordinary pace on level ground?		
Yes	103	14.9
No	582	84.5
Total	685	100
4. Do you have to stop for breath when walking at your own pace on level ground?		
Yes	84	12.2
No	601	87.2
Total	685	100

In total, 115 (16.7%) wood workers had experienced wheeze. Fifty-eight (58) (8.4%) wood workers did not experience wheeze when they had fever, and 58 (4.1%) wood workers had this symptom after starting to work at this furniture factory, as shown in Table 4.

Table 4. Wheeze symptoms of woodworkers reported by number and percentage.

Wheeze	Number (Total=685)	Percent
1. Do you have wheeze?		
Yes	115	16.7
No	564	81.9
Cannot remember	6	0.9
Total	685	100
If yes, do you have wheeze occurs just only when you have a cold?		
Yes	54	7.8
No	58	8.4
Not sure	3	0.4
Total	115	16.7
2. When have you had wheeze?		
Before starting to work at this factory	54	3.3
After working at this factory	58	4.1
Not sure	3	1.5
Total	61	8.9

Most wood workers (n=289, or 43.3%) had a stuffy nose or nasal inflammation during cold weather, and only 36 of them (or 5.2%) had a stuffy nose or nasal inflammation almost every day during cold weather, as shown in Table 5.

Table 5. Stuffy nose symptoms of woodworkers reported by number and percentage.

Stuffy nose	Number (Total=685)	Percent
1. Do you have stuffy nose or nasal congestion during cold weather?		
Yes	298	43.3
No	387	56.2
Total	685	100
2. Do you have stuffy nose or nasal congestion during warm weather?		
Yes	48	7
No	637	92.5
Total	685	100
3. Do you stuffy nose or nasal congestion like this on most days for as much as three months a year?		
Yes	36	5.2
No	649	94.2
Total	685	100

Most wood workers used respiratory masks (n=570; 82.7%) and most used them every day (n=397; 57.6%). However, only half of them wore a mask all the time while working (n=326; 47.3%), as shown in Table 6.

Table 6. Uses a respirator protection of woodworkers reported by number and percentage.

Respiratory protection	Number (Total=685)	Percent
1. Do you use a dust respirator?		
Yes	570	82.7
No	115	16.7
Total	685	100
2. What is type of dust respirator?		
Cotton mask	570	82.7
Other	0	0
Total	571	82.7
3. Do you use dust respirator every day?		
Most/ all of the time	397	57.6
Some of the time	174	25.3
Total	571	82.9
4. How often do you use a dust respirator?		
All of the time while working	326	47.3
Less than 2 h a day	60	8.7
2 – 4 h a day	69	10
More than 4 h a day	116	16.8
Total	571	82.9
If no, does your factory providing a dust respirator for you?		
Yes	104	15.1
No	11	1.6
Total	115	16.7
5. If the factory provides the dust respirator for you, do you use it?		
Yes	43	6.2
No	72	10.4
Total	115	16.7
6. Why do you do not use a dust respirator?		
Frustration/ annoyance	63	9.1
Thought to be no health effects	22	3.2
Other	30	4.4
Total	115	16.7

This study grouped the prevalence of wood-dust in an area into three levels. No dust sample contained < 1 mg/ m^3; 43 dust samples had dust levels of 1-5 mg/ m^3 (74.1%), and 15 dust samples had dust levels of > 5 mg/ m^3 (25.9%).

The correlations between determinant factors and independent variables, i.e., predictive factors--age, gender, years employed, dust levels, mask use, and respiratory symptoms including cough, phlegm, chest tightness, and wheeze, were determined by

logistic regression analysis. A significant correlation was found between gender and cough in the morning (p=0.01); male workers were at 2.56 times higher risk of cough in the morning than female workers (OR=2.56; 95%CI=1.12-2.56), as shown in Table 7a.

Table 7a. Correlation coefficient of independent variables (gender, age, years employed, wood dust levels) and respiratory symptoms.

Dependent variable	Independent variable	Logistic variable					95.0 % C.I. for EXP (β)		Cox & Snell R^2	Nagelkerke R^2
		β	S.E.	df	Sig.	Exp (β)	Lower	Upper		
Cough first thing in the morning	1. Gender	.528	.210	1	.012*	1.695	1.123	2.560	.017	.027
	2. Age	.308	.218	1	.157	1.361	.888	2.086		
	3. Years of employment	-.210	.220	1	.340	.811	.527	1.247		
	4. Wood dust levels	.089	.296	1	.764	1.093	.612	1.953		
	5. Respirator use	-.245	.227	1	.280	.782	.501	1.221		
	Constant	-1.540	.254	1	.000	.214				
Cough during the day or at night	1. Gender	.459	.216	1	.034*	1.582	1.035	2.418	.019	.030
	2. Age	.091	.223	1	.685	1.095	.707	1.696		
	3. Years of employment	-.107	.226	1	.634	.898	.577	1.398		
	4. Wood dust levels	-.201	.330	1	.542	.818	.429	1.560		
	5. Respirator use	-.482	.228	1	.035*	.618	.395	.966		
	Constant	-1.329	.251	1	.000	.265				
Cough during the day or at night ≤ or more than 3 months	1. Gender	.335	.466	1	.472	1.398	.561	3.485	.101	.145
	2. Age	1.369	.515	1	.008*	3.931	1.432	10.791		
	3. Years of employment	-.054	.456	1	.906	.948	.388	2.317		
	4. Wood dust levels	1.295	.649	1	.046*	3.652	1.024	13.025		
	5. Respirator use	-.836	.500	1	.095	.433	.162	1.156		
	Constant	-1.634	.563	1	.004	.195				

*Two-sided *P*-value < 0.05

For correlation between independent variables and cough during the day and night (*p*=0.03), male workers were at 1.58 times higher risk of cough during the day and night than female workers (OR=2.56; 95%CI=1.04-2.15). Cotton-mask use correlated negatively with cough during the day and night; by using a mask, workers could more successfully prevent cough than without using a mask (*p*=0.035; OR=0.62; 95%CI=0.39-0.97), as shown in Table 7a).

Correlations between the independent variables and cough during the day and at night > 3 months showed the older group was at 3.91 times higher risk than the younger group (p=0.008; OR=3.93; 95%CI=1.43-10.79). The risk of the group with higher exposure to cough during the day and at night > 3 months was 3.65 times that of the group with lesser exposure (p=0.008; OR=3.65; 95%CI=1.02-13.03). Male workers were at 2.22 times higher risk of having phlegm in the morning than female workers (p < 0.001; OR=2.22; 95%CI=1.45-3.39), as shown in Table 7b. In addition, male workers had a 1.69 times higher risk of phlegm during the day and at night than female workers (p=0.014; OR=1.69; 95%CI=1.12-2.58) (Table 7b).

Table 7b. Correlation coefficient of independent variables (gender, age, years employed, wood dust levels) and respiratory symptoms.

Dependent variable	Independent variable	Logistic variable				95.0 % C.I. for EXP (β)		Cox & Snell R^2	Nagelkerke R^2
		β	S.E.	df	Sig.	Exp (β)	Lower	Upper	
Phlegm in the morning	1. Gender	.797	.216	1	.000*	2.220	1.452	3.392	.025	.039
	2. Age	.097	.220	1	.660	1.102	.715	1.697		
	3. Years of employment	.017	.221	1	.939	1.017	.659	1.570		
	4. Wood dust levels	-.133	.308	1	.666	.875	.478	1.602		
	5. Respirator use	.194	.239	1	.418	1.214	.760	1.940		
	Constant	-1.979	.274	1	.000	.138				
Phlegm during the day or at night	1. Gender	.527	.214	1	.014*	1.694	1.115	2.576	.016	.026
	2. Age	.118	.220	1	.592	1.125	.731	1.733		
	3. Years of employment	-.066	.222	1	.767	.936	.606	1.447		
	4. Wood dust levels	-.526	.337	1	.119	.591	.305	1.144		
	5. Respirator use	.292	.241	1	.226	1.339	.835	2.146		
	Constant	-1.835	.271		.000	.160				
Phlegm during the day or at night less than and equal or more than 3 months	1. Gender	.131	.417	1	.573	1.140	.504	2.581	.043	.059
	2. Age	.106	.422	1	.802	1.112	.486	2.544		
	3. Years of employment	.715	.411	1	.082	2.044	.913	4.576		
	4. Wood dust levels	.735	.643	1	.253	2.086	.591	7.356		
	5. Respirator use	-.205	.476	1	.667	.815	.320	2.073		
	Constant	-1.026	.530		.053	.358				

*Two-sided P-value < 0.05

For the correlation between independent variables and shortness of breath when walking at an ordinary pace on level ground, male workers had a slightly fewer prevalence of symptoms than female workers (p=0.05; OR=0.62; 95%CI=0.38-1.00). In addition, more years employed correlated with the prevalence of chest tightness and breathlessness (p=0.029); wood workers who had worked longer had more of these symptoms (1.71 times) (OR=0.62; 95%CI=1.06-2.77), as shown in Table 7c. Correlations between the independent variables and stopping for breath while walking at your own pace on level ground revealed that male workers had this symptom almost 50% less frequently than female workers (p=0.01; OR=0.48; 95%CI=0.28-0.84). The risk of the group with higher exposure stopping for breath while walking at your own pace on level ground was 2.26 times higher than for the group with less exposure (p=0.015; OR=1.71; 95%CI=1.17-4.37) (Table 7c,d). In addition, male workers had slightly more wheeze than female workers (p=0.05; OR=1.55; 95%CI=0.99-2.40) (Table 7d).

Table 7c. Correlation coefficient of independent variables (gender, age, years employed, wood dust levels) and respiratory symptoms.

Dependent variable	Independent variable	Logistic variable					95.0 % C.I. for EXP (β)		Cox & Snell R^2	Nagelkerke R^2
		β	S.E.	df	Sig.	Exp (β)	Lower	Upper		
Chest pain or tightness or breathlessness	1. Gender	-.056	.170	1	.743	.946	.677	1.320	.006	0.008
	2. Age	.092	.176	1	.600	1.096	.777	1.547		
	3. Years of employment	.212	.177	1	.230	1.236	.874	1.747		
	4. Wood dust levels	-.230	.248	1	.353	.795	.489	1.291		
	5. Respirator use	-.081	.188	1	.665	.922	.638	1.333		
	Constant	-.249	.204		.222	.780				
Short of breath walking compare with other people at an ordinary pace on level ground	1. Gender	-.484	.247	1	.050*	.616	.380	1.000	.029	0.051
	2. Age	.478	.257	1	.063	1.612	.974	2.669		
	3. Years of employment	.537	.245	1	.029*	1.711	1.058	2.768		
	4. Wood dust levels	.437	.325	1	.178	1.548	.819	2.926		
	5. Respirator use	-.375	.262	1	.153	.687	.411	1.150		
	Constant	-1.888	.293		.000	.151				

*Two-sided P-value < 0.05

Table 7d. Correlation coefficient of independent variables (gender, age, years employed, wood dust levels) and respiratory symptoms.

Dependent variable	Independent variable	Logistic variable					95.0 % C.I. for EXP (β)		Cox & Snell R^2	Nagelkerke R^2
		β	S.E.	df	Sig.	Exp (β)	Lower	Upper		
Stop to breath while walking at your own pace on level ground	1. Gender	-.724	.281	1	.010*	.485	.280	.841	.032	.062
	2. Age	.484	.285	1	.090	1.623	.928	2.838		
	3. Years of employment	.359	.272	1	.188	1.432	.840	2.441		
	4. Wood dust levels	.816	.336	1	.015*	2.262	1.172	4.367		
	5. Respirator use	-.472	.291	1	.106	.624	.353	1.105		
	Constant	-2.007	.319		.000	.134				
Wheeze during the day or at night	1. Gender	.437	.223	1	.050*	1.548	.999	2.400	.009	.014
	2. Age	.075	.231	1	.745	1.078	.686	1.694		
	3. Years of employment	.082	.231	1	.722	1.086	.691	1.706		
	4. Wood dust levels	.088	.309	1	.775	1.092	.596	2.001		
	5. Respirator use	.233	.254	1	.358	1.263	.768	2.077		
	Constant	-2.025	.285		.000	.132				

*Two-sided *P*-value < 0.05

DISCUSSION

This study examined the correlation coefficient of determinant factors (gender, age, years employed, wood-dust levels) and respiratory symptoms (such as cough, phlegm, shortness of breath, chest tightness, and wheeze) by using logistic regression analysis. The studies by Douwes et al. (2001) and Eduard et al. (1993) found a correlation between wood-dust exposure and respiratory symptoms among wood-workers in wooden-furniture factories. Like the previous studies, this study found respiratory symptoms among wood-workers exposed to wood dust in wooden-furniture factories. Specifically, male workers had a cough in the morning slightly more frequently (1.67 times) than female workers ($p < 0.05$; OR=1.67; 95%CI=1.12-2.56). In addition to cough in the morning, male workers also coughed slightly more during the day and night than female workers ($p < 0.03$; OR=1.58; 95%CI=1.04-2.42). Like the study by Arbak (2004), this study found that both male and female wood-workers coughed significantly more than the controls (p=0.016, p= 0.034, respectively). This result is similar to a Polish study that found 38 wood-workers (n=48; 79.2%) in wooden-furniture factories had cough associated with wood-dust exposure at work (Milanowski et al., 2002).

In the study by Talini et al. (1998), the prevalence of respiratory symptoms among 296 wood-workers in furniture factories was higher among females (n= 38) than males (n=258). More female workers had chronic symptoms, such as cough, phlegm, and wheeze, than male workers (6.5% among male workers agaianst 12.5% among females; p=0.08). These proportions may be the result of there being fewer female workers.

This study found a significantly negative correlation between using a cotton mask and cough during the day and night (p=0.035). Use of a cotton mask provides 0.62 times more protection against wood-dust exposure and cough prevention during the day and night than non-use (OR=0.62, 95%CI= 0.39-0.97). For the correlation between age and cough during the day and night for > 3 months, older workers were at 3.93 times higher risk than younger workers (p=0.008; OR=3.93, 95%CI=1.43-10.79).

In addition, this study found that higher exposure correlated with 3.65 times higher risk of cough during the day and night for > 3 months (p= 0.046) than lower exposure (OR=1.21, 95%CI=1.02-13.03); wood-dust inhaled into the nasopharyngeal region can cause cough (Liou et al., 1996). Like the study by Mandry et al. (1999), this study found that the prevalence of cough was higher among the wood workers than the control group. The study of by Pisaniello (1992) found that wood workers exposed to wood dust at levels > 5 mg/m^3 had higher rates of respiratory symptoms than those with lower levels of exposure. The study by Fransman et al. (2003) found plywood workers exposed to higher levels of wood dust had 1.3 times more cough than those exposed to lower levels (OR=1.20, 95%CI=0.50-3.90).

This study found gender correlated with having phlegm in the morning (p=0.001). Male workers were at 2.22 times higher risk of phlegm symptoms than female workers (OR=2.22, 95%CI= 1.45-3.39). Male workers also had a 1.69 times higher risk of having phlegm during the day and night than female workers (OR=1.69, 95%CI=1.11-2.58). These results are similar to the studies by Ugheoke et al. (2005) and Mandry et al. (1999).Male gender correlated negatively with walking on level ground (p=0.05), since male workers were at lower risk of shortness of breath than female workers (OR=0.62, 95%CI=0.38-1.00). Longer length of employment correlated with chest and breathlessness (p=0.03). Workers with longer tenure had higher risk (OR=1.71, 95% CI=1.06-2.77). These results were similar to the study by Malo (1996), which found that years employed and duration of wood-dust exposure correlated with respiratory symptoms among cedar-wood workers.

The study by Deeprecha et al. (1994) found a high prevalence of asthma among longer-term wood workers, since longer employment period entailed greater risk of exposure to wood dust. Moreover, Arbak et al. (2004) found that the prevalence of asthma among wood workers exposed to wood dust for 1-2 years was greater than the control group. However, the study by Borm et al. (2002) found no relationship between duration of wood-dust exposure and respiratory symptoms.

A negative correlation was found between gender and stopping to catch breath while walking on ground level (p=0.01); male workers were at 0.48 times less risk of shortness of breath walking on ground level than female workers (OR=0.48, 95%CI=0.28-0.84). In addition, higher level of dust exposure correlated with stopping to catch breath while walking on ground level (p=0.02); workers exposed to higher dust levels were at 2.26 times higher risk of stopping to catch breath while walking on the ground level than the control group (OR=1.55, 95%CI=1.17-4.37).Like the study by Carosso et al. (1987), gender correlated with wheeze in the morning (p=0.05); male workers were at 1.55 times higher risk of wheeze than female workers (OR=1.55, 95%CI=0.99-2.40).

The main limitation of this study was that the number of wood-dust samples was small, at only one sample per sector. Therefore, the correlation between wood-dust concentration and respiratory symptoms may not be reliable. In addition, the

study subjects came from only eight factories, and thus might not validly represent workers in all furniture-factories in eastern Thailand.

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