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Health and Working Conditions in Carpenter's Workshops in Armenia (Colombia)

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Abstract: We conducted a study of the health and working conditions in 10 carpenter's workshops in the municipality of Armenia (Colombia). In these workshops, all the most exposed workers to wood dust were surveyed at the areas of sanding, brushing, immunization and painting (workers with the highest risk to get chronic respiratory disease). They were 177 workers. The use of hard and soft woods for furniture was detected. Besides, some pesticides, volatile organic solvents, synthetic epoxy resins glues and paintings, were used for finishes, which increases the risk of acquiring some neurological diseases and damage to the nervous system. Occurrence of cancer in nostrils mainly due to the use of hardwoods is an additional risk. With regard to the basic lighting conditions, it was found that half of workshops had deficiencies in special carving areas, because they were below the minimum allowable lighting limit level (500 lux). With relation to noise, all the workshops exceeded the permissible maximum limit value (85 dBA). With respect to the occurrence of occupational events, no data were found in the companies, or analysis of employee absenteeism due to the exposure to particulate matter.

Key words: Wood dust, Particulate matter, Noise, Lighting, Health and working conditions

Introduction

One of the aspects covered by the Colombian law on occupational health is to standardize parameters leading to improve working conditions[1, 2]. To do so it is necessary to have resources, methods and/or techniques to identify these working conditions and their adequacy must be assessed in any situation[2].

The total population of Colombia was 44,450,260 inhabitants in 2006, and more than 80.07% of them were considered as potentially economically active, i.e., people of working age[a3, 4]. However, only 14.5% of these people are contributing to the social security system, which manages all what is related to Colombian workers' health, pensions and professional risks[3].

Armenia, a Colombian municipality located in the coffee area, has a population of 321,378 inhabitants; there are 135,690 workers that are contributing to the social security system, of which 6,018 are employees in wood industry[5].

One of the main economic activities in Armenia is the wood industry from growing trees until their transformation into furniture. In 2004 as many as 164 logging companies were recorded with approximately 6,018 workers who were engaged in the manufacture of furniture, sales of finished products and by-products that the vast majority were informal or craft economy[5]. The manufacturing of wood involves processes and operations mainly related to the mechanization, which increases the proba-

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[a]Economically active population includes all the people of working age that are working or looking for job. Age able to work corresponds to the age of 10/12 yr or more in rural/urban areas up to 64 yr and older[3].

Table 1. Description of the 10 companies visited and number of workers surveyed in the areas of sanding, brushing and immunization[36)]

Workshop	Type of production	Total number of workers	Workers surveyed
1	Furniture	136	34
2	Furniture	100	38
3	Carpentry	2	2
4	Carpentry	3	1
5	Carpentry	11	9
6	Furniture	35	24
7	Carpentry	160	20
8	Carpentry	6	3
9	Furniture	12	9
10	Furniture	150	37

bility of occurrence of occupational events (accidents at work and/or occupational diseases). If we consider in addition the hazardous chemicals for finishes, the risk of illness and death of the worker greatly increases, and his/her quality of working life is reduced[6–10)]. These processes involve hygiene risks such as those related to noise levels higher than 85 dBA, particulate matter, spraying of organic solvents and paints, among others[11–14)].

From these sanitary risks, exposure to particulate matter from wood dust of woodworkers is the one which concern us most as a research group for the prevention of occupational risks. From the health point of view, soft woods are irritating, allergenic, and over time they may give rise to occupational asthma and Chronic Obstructive Pulmonary Disease (COPD)[8, 13–15)]. Hard wood dust has been associated with several types of cancer including the ones in nasal cavity, lung, and gastrointestinal tract, and the Hodgkin's disease[6, 17–19)]. Of all these diseases, the cancer of the nasal cavity is the most serious epidemiological evidence. It also may appear eczema and urticaria on the skin[13)].

From the standpoint of knowledge, the study here presented allowed us to diagnose the real characteristics of the health and working conditions of the most exposed workers to wood particulate matter in the Quindío region (Colombia). This information is fundamental to take further steps for the promotion and prevention of occupational health in this coffee region[20)].

Method

The study was conducted by describing through an observational method[21)] the working conditions and health of workers exposed to wood dust in carpenter's workshops in the municipality of Armenia on the first semester of 2006. Following to Brosseau *et al*. (2001) and Lazovich *et al*. (2002) studies, we took a sample of convenience from ten companies previously identified[22–24)]. We also took into account that the tasks of preparing wooden furniture were similar[15, 23)]. These ten companies included 615 workers. All the workers in the areas of sanding, brushing, immunization and painting were surveyed, since they are the most exposed ones to particulate matter[25–27)]. Table 1 identifies the timber companies and the number of workers and employees in related areas of sanding, brushing, immunization and painting that were selected for the survey of working conditions and felt morbidity.

Shop owners were contacted by invitation letter and telephone to ensure them eligibility criteria to the study. If the eligible owner was interested in participating, a meeting was then scheduled to explain him/her the study procedure, obtain his/her written consent, collect information about the shop and schedule dates for sampling. The researchers then met with employees to explain the study, obtain their approval, and describe the sampling procedures. During all of the environmental sampling procedures and the poll to workers, the coordinators of the companies responsible for the Occupational Health and Industrial Safety were present and also in some cases the entrepreneurs interested in the study. The medical researcher specialist in occupational health selected 40 out of 177 surveys about heartfelt morbidity whose responses were positive with regard to respiratory problems (those workers with suspected chronic respiratory disease) to conduct their occupational medical histories.

The environmental sampling instruments used were: pumps for sampling air particulate matter (air sampling pump GilAir 5 Gilian Multi Fol. No. 800519 with calibrator type Sensidyne Filian Gilibrator TM 2 803024B, and bubble generator rang 20 CC-6LPM P7N 800286), filters made of silical (5.0 μm PH-PVC 37 mm), desiccator with silica gel and analytical balance (Precisa 405M-200 calibrated on 01 March 2006), sound level meters

(Simpson 899 TYPE 2 with gauge Simpson 890-2), and lux meters (Foot Candle/Lux Meter Extech), according to the environmental health regulations of the Ministry of Social Protection of Colombia published on 2002[28, 29] and the NIOSH analytical method 0500 for the non-respirable fraction of total dust[28, 30].

Results

Materials and supplies used in the processing of wood

During the visits at the companies, it was detected that they used hardwoods and softwoods. In addition, some immunization agents (pesticides), volatile organic solvents, synthetic resins, epoxy, glue, paints, among other products, were added in the making of the furniture. Table 2 lists the chemicals and other supplies that woodworkers have used in the processing of wood[31].

Working conditions of the workers surveyed

Out of the 615 employees of the 10 companies, all the 177 workers in the areas of sanding, brushing, and immunized and paintings were surveyed (see Table 1). These workers are the most exposed to particulate matter (workers with a higher risk to get suspected chronic respiratory disease).

Workers reported some deficiencies in the facilities and workplaces. As can be seen in Fig. 1, 78% of workers surveyed said they were exposed to particulate matter, 71% were exposed to noise that exceeds 85 dBA, and 50% were exposed to gaseous chemicals (vapours) from paints and solvents. About 29% of workers were exposed to muscular overloads because they must load and unload

Table 2. List of chemicals and supplies used in the companies visited[36]

Materials and supplies	Products used in the companies visited
Woods	Hardwood (cedar and walnut). Softwoods (Laurel arrears, Nazareth, Perillo Antioqueño, Canadian pine, rosemary pine, rosemary smooth, Sajo, Vakera), conglomerate (Tablex, Triples, MDF).
Foams for upholstery	Blocks of foam polyurethane-coated cotton with different densities.
Finishings	Synthetic resins that give colour and appearance to the finished wood. They use some bases of type Caramel sealant, Mocca sealant, Simulated grain, Caramel finished, Mocca finished.
Paintings, inks, lacquers	These paintings are based on synthetic paints with a mixture of volatile organic solvents. Lacquers. Catalysts. Extra lacquer synthetic resins, Semi bright lacquer, Matt lacquer.
Sticking	Boxer (basis of polypropylenes), Uregin 50
Sealants	Pre-sealants (epoxy resins), Sealants, Sealants PL-285, Carpincol (basis of polyvinil acetate), Adhesives, Tar.
Solvents	Thinner (solvent volatile organic, SVO), Barsol (SVO), Gasoline (SVO).
Immunization agents and/or pesticides	Dursban (organophosphate pesticide), Demon pyretroid.

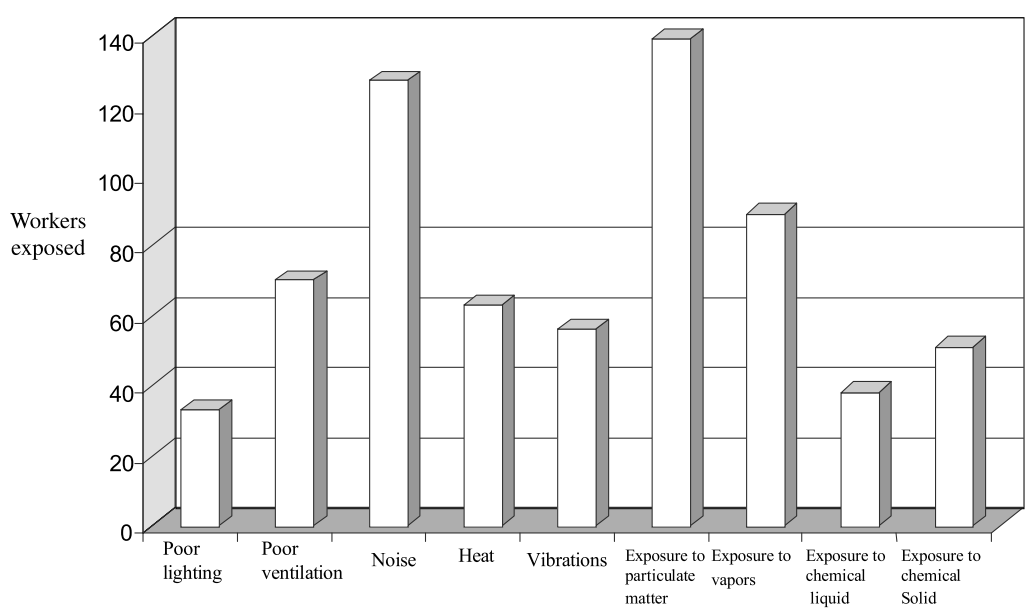

Fig. 1. Working conditions in the areas of sanding, brushing, immunization and painting[5, 36].

Table 3. Economic activities and categories of lighting taken from Lighting Technical Rules of the Ministry of Social Protection of Colombia (2002)[27, 36]

Area/Activities	Lighting range (lux)
Job with wood	
Thick cuts and workplaces	200–500
Classification according to size, planting, thick sanding, medium capacity machines, pasting, plating	200–500
Fine works and machines work, fine sanding and finishing	500–1,000
Assembly	
Simple	200–500
Medium difficulty	500–1,000
Difficulty	100–2,000

Table 4. L_{eq} measured values in the companies visited and L_{eq} recommended values for carpentry jobs[28, 36]

Workshop	L_{eq} measured (dBA)	Degree of risk	Time of exposure allowed (h)	L_{eq} recommended[28] (dBA)
1	93.4	3.2	2.5	85
2	96.62	5	1.6	85
3	97	5.3	1.5	85
4	93.6	3.21	2.4	85
5	91.14	2.35	3.4	85
6	91.3	2.4	3.34	85
7	95.7	4.4	1.8	85
8	89.5	1.87	4.3	85
9	103	6	0.66	85
10	93.75	3.36	2.38	85

sections of wood and furniture manually (exceeding 50 kg).

In 70% of companies some disorder of material without storing or stacking in places designed for that purpose was evident, with uneven floors without repair.

Environmental measurements for occupational hygiene

Lighting: Parameters for the assessment of the lighting and the minimum luminance intensity in workplaces were taken into account as detailed in Table 3.

Noise: To assess the occupational exposure to industrial noise, the continuous equivalent sound pressure level (L_{eq}) was measured as A-weighted decibels (dBA) with slow response of the sound level meter. Measurements obtained for L_{eq} at the companies visited are shown in Table 4[29].

Particulate matter: In Table 5 it can be observed that 50% of companies had the highest Occupational Exposure Average (OEA)[32, 33] surpassing the degree of risk of 1.

Table 5. Occupational Exposure Average (OEA) at the companies visited and degree of risk for exposure to wood dust[26, 36]

Workshop	OEA (mg/m^3)	Degree of risk
1	21.6	2.16
2	14.55	1.46
3	3.36	0.36
4	1.6	0.16
5	34	3.4
6	7.04	0.704
7	57.4	5.74
8	2.61	0.261
9	1.95	0.2
10	61.4	6.14

Health conditions of the workers surveyed

The perception of health conditions in the workers was measured by a tool (self-report) consisting of 59 questions aimed to symptoms dependent on the different organ systems, with particular emphasis on those that can be more compromising from the typical tasks in industry furniture.

Basic characteristics of surveyed workers were as follows:

Age: Out of the total number of workers chosen for the medical records, 45% were women and the remaining 55% were male. Their average age was 31 yr, the youngest 19 and the oldest 51, with a standard deviation of 10.1 yr.

Seniority: 62.5% of workers were in their first year of work. Very few go beyond five years and in all the cases they are trusted employees or work in very specialised tasks, and therefore represent a great value for the company. Posts of workers who underwent clinical history were: sand area (37.5%), operators of machinery (15.0%) and brushing, immunization and painting area (47.5%).

Habits: 20% of those tested smoked and 45% ingested liquor.

Physical exercise: 45.0% of the workers related to practice some sort of sporting activity at least once a week. In addition they expressed that their long working day is the reason for not being able to have a greater commitment to the sport.

Those variables of the self-report representing some unsuitable conditions in the work environment in the process of the manufacture of wooden furniture were grouped as follows (see Fig. 2):

Burning, irritation or redness in the eyes: It was referred by 40.4% of workers, what suggests poor conditions of environmental pollution and/or lack of an appropriate use of visual protection.

Nasal and/or forehead congestion: It was referred by 17.4% of workers, what may be suggests some events that affect the upper airway.

Nasal secretion, smelly nose: It has only been referred by 6.7% of workers, what indicates some kind of infectious complication of the upper airway.

Coughing fit: As indicated by 14.6% of the staff; tears, 10.6%; hoarseness, 14.6%; throat discomfort, 28.6%, which can be related to an extended exposure to dust in the working environment.

Shortness of breath when climbing scales: 21.9%, although most of the factories visited have just one floor and 50% of workers are in the second decade of his/her life. It should not be forgotten this point as for their adaptive physical conditions.

Feeling tightness in the chest: 11.8%, as well as other symptoms related to the effort, should be taken with reservations, since as lonely item does not give enough information about a specific health event.

Shortness of breath at night (in bed): 3.3%, and only two of the employees are older than forty years. Here the subjectivity in the assessment of the symptom plays a very important role.

Occupational disease: 3.9%, but the reports analyzed did not show any notice about this type of occupational event.

Skin allergies: 15.7%, without any discrimination at this point whether the health event has been originated in the company or outside.

Dryness in the skin: 26.4%, can be associated with the type of chemicals that are used in the manufacturing process for wooden furniture.

Fungi somewhere in the body: 9.5%, mainly associated with humid conditions in feet.

Occupational events: With regard to the occurrence of industrial accidents or occupational diseases during their working lives, 27.5% reported to have had an accident recognized as such, and 100% denied to have got any occupational disease.

Occupational clinical histories of workers

Their most relevant results were as follows:

Review of systems: 65% of interrogated workers reported that over the past two months have presented some

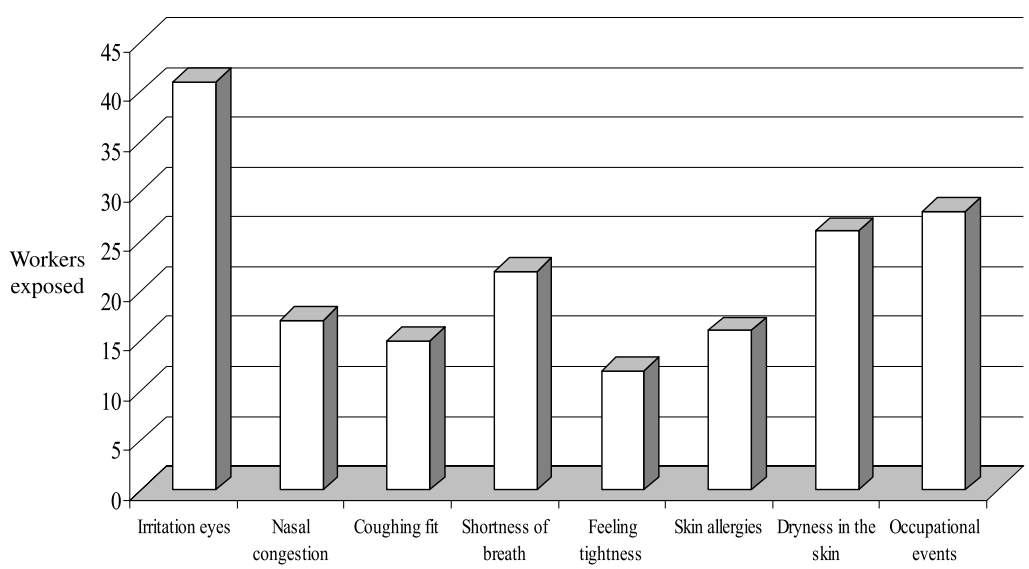

Fig. 2. Health conditions in the areas of sanding, brushing, immunization and painting[5, 36].

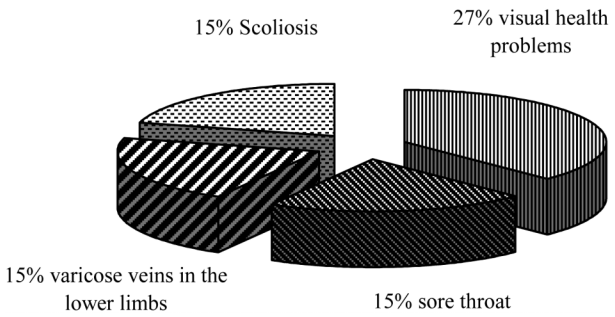

Fig. 3. Results of the physical examination conducted to workers selected for establishing their occupational medical histories[36].

symptoms related to various health events that although they had not been disabling, had led to require consultation or to self-formulate some kind of medication. The detail is found in each of the occupational medical histories.

Weight: The weight of workers examined is interpreted more easily correlating with height, through the Body Mass Index (BMI), also known as the Quetelet Index. The BMI is an index of a person's weight in relation to his/her height. Although it makes no distinction between the fatty and non-fatty components of the total body mass, it is the most practical method for assessing the degree of risk associated with obesity. According to the classification of the World Health Organization (WHO), the BMI normal values for the workers examined were given in 79.5% of workers. Then, overweight and obesity occurred in a low percentage.

As can be seen in Fig. 3, 26.5% of workers had some visual problems which might be linked to the high concentration of wood dust in the atmosphere, 15% of varicose veins in the lower limbs, 15% of scoliosis, and 15% of sore throat.

Absenteeism and disability working in the timber industry workers

There was not found any data about absenteeism nor morbidity and mortality registers.

The coordinators of Occupational Health and Industrial Safety of the enterprises expressed not showing any type of absenteeism regarding exposure to wood dust. However, there are frequent accidents at work related to the handling of tools and machinery. Regarding the occurrence of occupational events, we found that 27.5% of workers surveyed have had an accident and 100% denied to have had any occupational disease.

Discussion

Chemicals used in the wood processing

Chemicals used in the wood processing increase the risk of getting diseases and neurological damages to the central nervous system[6]. From a toxicological point of view, it should be borne in mind that pesticides, besides of the chemical compound that combats plague, contain some substances which dissolves the product, usually organic solvents, whose toxic properties may be higher than the own active principle[17]. Among the pesticides, the so-called organchlorines seem to alter the mielinic structure of the nerve fibres causing upsets of nerve conduction. The organphosphate pesticides act on the central nervous system from cholinesterase inhibition, which is a basic substance in the electrochemical process of transmission of nerve impulses[13]. The alteration of the cholinergic synapses at different levels of the functional status of the nervous system result in neurological and neuropsychiatry tables whose intensity and persistence depend on the magnitude and duration of exposure to these substances[13, 17].

Working conditions

It was noted that the elements of personal protection were not used appropriately and that some elements were inadequate for the protection of workers in some companies[14]. At naked eye, it was detected that mono filter or dual filter respirators were saturated of dust and paint (in painting and immunization areas). The rest of the workers used a mask for sweeping dust, which is not suitable for their protection. Replacement of the mask is done in a period of time that is not recommended for this type of work (once a month). It was observed that they work standing throughout the day (12 h a day). We did not observe any mechanical aids for the transport of the wood sections, or elements for personal protection. It was further reported that they unknown health and safety standards.

Most of the workshops had uneven and broken floors, which may pose risk of falls. There was a high content of wood chips in all areas except from the areas of finishes and cellars. These conditions showed a high risk of uncontrolled fire, as there were an insufficient number of fire extinguishers according to the area and type of fire. Furthermore, the companies have not any emergency brigades[14].

Environmental measurements in the areas of sanding, brushing, and immunized and paintings

Lighting: It was detected that the conditions of the companies visited did not meet the minimum safety standards of order and cleanliness[34], which hinders the proper lighting in the work areas. It was further noted layers of particulate matter covering the lamps. In some cases the light was very high by dispersing the beam on the workplace (above 3 m). Furthermore, it can be seen in Table 6

Table 6. Lighting measurements in the companies visited and recommended average lighting levels (E_p) values for carpentry jobs[27, 36]

Workshop	E_p measured (lux)	E_p recommended (lux)
1	212–267	500–1,000
2	176–307	500–1,000
3	350	500–1,000
4	652–842	500–1,000
5	263	500–1,000
6	107	500–1,000
7	38	500–1,000
8	956–780	500–1,000
9	200–500	500–1,000
10	240–333	500–1,000

that 50% of the companies visited, do not fulfil the lighting levels recommended for woodworking (500–1,000 lux). In some carved places the levels were under 200 lux. In almost all areas natural and artificial lighting coexisted, but it was not enough to meet the minimum lux level required by the Ministry of Social Protection. Poor lighting conditions contribute to worsening the eyesight of workers and increase the number of occupational events[34].

Noise: It can be seen in Table 5 that noise in all the companies visited was above the maximum allowable level of 85 dBA[29], generated by the machines of the premachining and machining areas where it is very common use of circular saws, radials, pendulum, and spin-outs, among others. The workers used hearing protectors of insertion and handset type. However, it is important to conduct a hygiene study to assess the frequencies of octaves and recommend suitable hearing protectors. The areas were not broken down by walls or noise absorbent panels, so that the noise of the machines operating was detected everywhere. During rest time, only the compressor kept running and noise did not surpass 70 dBA.

Particulate matter: Workers were using protective respiratory mask type for sweeping dust and respirators with oversaturated filters. One-hundred percent of workers were unaware of the standards of maintenance and replacement of the elements of respiratory protection. None of the companies carried the agenda of epidemiological surveillance of particulate matter, despite that the staff interviewed complained of suffering from cough, hoarseness, rhinitis and frequent flu.

The work areas with the highest dust concentrations measured were those that used stationary or belt sanding tools, sanding with electric hand tools, sawing, assembly, and dust cleaning by hand or vacuum[35–39]. Levels of wood dust increased when belt sanders were used[36]. The samples were above the allowed TLV of 10 mg/m^3 in accordance with NIOSH analytical method 0500[30]. This corresponds to a highly polluted work environment by particulate matter from wood, which suggests that industrial hygiene controls are poor or non-existent and therefore injurious to health.

Health conditions

One of the most striking results from the self-report about health conditions was the number of bad safety habits that workers usually had. These are the most important ones:

- Smoking and drinking liquors: It is well known that tobacco smoking has a negative impact for health. Meanwhile, the consumption of liquor is entrenched as a social act and its adverse health effect is not as easily understood as the tobacco.
- Use of strange attachments (paper) within the breathing protectors with the false idea of increasing their effectiveness.
- Inadequate frequency of change of the filters of breathing protectors.
- Do not use personal protective equipment throughout the workday.
- Some workers said that their breathing protectors did not have an adequate quality to retain dust.

Analysis of absenteeism and disability working

Professionals whose occupational risk prevention services are provided to the timber companies do not properly carry a programme of epidemiological surveillance of workers in the sector. Neither they monitor absenteeism of workers which could correlate potential problems or respiratory diseases associated by exposure to wood dust. Although they can control industrial accidents, are unable to track occupational diseases. This is a reflection of a social problem which is not unique to developing countries but also to some developed ones, because there are controls of dust in large enterprises but not in SMEs, where poor working conditions are usually detected regarding workers' respiratory protection.

Conclusions

There is a notable lack of healthy lifestyles of workers, as far as some habits persist with serious implications for health conditions and at work, such as the intake of alcohol or consumption of tobacco. All this, combined with the adverse environmental conditions in their areas of work, generate an important risk factor for chronic health events, such as the chronic obstructive pulmonary disease. The low motivation in the group of workers to maintain a minimum safety, although it is a constitutional provision (Art. 49 Colombian Constitution), requires a

significant degree of awareness and sensitization in order to use adequate individual protective elements, maintenance and care. This study of the 10 timber companies in the municipality of Armenia has led to the formulation of future research projects related to the study of particulate matter from wood dust in the region of the Colombian coffee axis, as follows:

- Developing methodological strategies for social projection to educate and sensitize employers and employees, with respect to self-healthy lifestyles (this project was implemented during the first half of 2007).
- A study of the incidence of morbidity and mortality from respiratory diseases at work generated by exposure to particulate matter from wood dust from these companies.
- A study of the characterization of particulate matter from wood dust in order to determine the distribution of particle sizes which can vary slightly depending on the process affecting the upper and lower respiratory tracts.
- Designing remedial interventions of respiratory protection that best fit the socio-economic situation in the region and with less impact on the comfort of employees.
- Implementation of a system of epidemiological surveillance for workers exposed to particulate matter from wood, in order to detect with greater certainty chronic respiratory diseases.

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