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SHORT COMMUNICATION

A Survey of Occupational Exposure to Inhalable Wood Dust Among Workers in Small- and Medium-Scale Wood-Processing Enterprises in Ethiopia

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ABSTRACT

A study of wood dust exposure in 20 small- and medium-scale wood-processing enterprises was performed in Ethiopia. Sampling was conducted daily from January to June, 2013 and a total of 360 samples from 113 workers were collected with Institute of Occupational Medicine (IOM) personal samplers. Eight-hour time-weighted average exposure to wood dust ranged from 0.24 to 23.3 mg m⁻³ with a geometric mean (GM) of 6.82 mg m⁻³ and a geometric standard deviation of 1.82. Although Ethiopia did not have any defined standard of Occupational Exposure Limit for wood dust exposure, 71% of the measurements exceeded the limit of 5 mg m⁻³ set by the European Union (EU). Higher than the EU exposure limit was measured while workers perform sanding and sawing activities with a GM of 9.72 and 7.60 mg m⁻³, respectively. In conclusion, wood workers in the small- and medium-scale enterprises are at a higher risk of developing different respiratory health problems with continuous exposure trends.

KEYWORDS: Ethiopia; occupational exposure; wood dust; wood-processing enterprises

INTRODUCTION

A number of constituents, hazardous to health, occur in the workplace in the form of aerosols of which inhalable wood dust is one. Wood dust exposure is considered to cause severe irritation problems to the nose, eyes, or throat (Holness *et al.*, 1985; Holmström and Wilhelmsson, 1988; Pisaniello *et al.*, 1991; Alwis *et al.*, 1999). Moreover, prolonged exposure leads to respiratory health problems such as nasal cancer (Nylander and

Dement, 1993; Demers *et al.*, 1995; Blot *et al.*, 1997), lung cancer, and asthma (Mohamed *et al.*, 1996; Fernández-Rivas *et al.*, 1997; Hideto *et al.*, 2000; Fransman *et al.*, 2003; Barcenás *et al.*, 2005; Osman and Pala, 2009).

In order to avoid detrimental health effects from excessive exposure to chemicals, several agencies and organizations developed workplace exposure limits and it is defined as Occupational Exposure Limit (OEL). In 1999, the European Union (EU) decided

the permissible limit for the exposure to inhalable wood dust to be 5 mg m^{-3} , based on an 8-h working day (Magagnotti *et al.*, 2013). To the best of our knowledge, so far, there is no published scientific study on the level of workers' exposure to wood dust in Ethiopia. For this cause, we carried out a survey of workers' exposure to inhalable wood dust in small- and medium-scale wood-processing enterprises in Ethiopia. The objectives of the study were (i) to determine the level of exposure among workers and (ii) to assess compliance of exposure levels with the EU OEL.

MATERIALS AND METHODS

Study design

Inhalable wood dust was measured among workers in 20 small- and medium-scale wood-processing enterprises of Arada Sub-city, Addis Ababa/Ethiopia. Samples were collected daily from January to June, 2013. Enterprises were selected based on number of employees and willingness to take part in the study. Sampling campaign lasted 1 week alternatively for every single enterprise and a total of 360 samples from 113 workers were collected. The study was conducted according to the method described in MDHS 14/3 (HSE, 2000).

Types of wood widely used in the enterprises were; Medium-Density Fiberboard, Austrian Pine, Plywood, *Cordia africana*, *Olea europea-cuspidata*, and *Pouteria adolfi-fredericii*.

Flow rate and volume

In this study, The SKC IOM (Institute of Occupational Medicine) samplers developed in Scotland (Mark and Vincent, 1986) were used. Air from workers' breathing zone was drawn at a flow rate of 2 l min^{-1} through a personal sampling pump. The flow rate was recorded both at the beginning and end of sampling to determine the mean volumetric flow rate. The total volume of air sampled was calculated individually for each pump after multiplying the mean volumetric flow rate by the sampling duration.

Filters and weighing

Inhalable wood dust was collected on a 25-mm-diameter Whatman polycarbonate membrane filter with pore size of $0.8 \text{ }\mu\text{m}$. Filters and cassettes were conditioned for 1 week in the weighing room both before and after

sampling (Lidén and Bergman, 2001). Weighing was performed on Scientech SM50 Semi-Micro Balance with capacity of 50 g and readability of 0.01 mg. The balance was calibrated regularly with 10 g standard weight supplied by the manufacturer and static electricity was removed from filters with an SMC (Sintered Metal Corporation) ionizer prior to any weighing. The weighing room was conditioned to an air temperature of $20 \pm 1^\circ\text{C}$ and a relative humidity of $50 \pm 5\%$.

Inhalable wood dust concentration

Full-shift sampling was carried out with a sampling duration of 6–8 h to determine the time-weighted average (TWA) inhalable wood dust concentration (mg m^{-3}). It was determined after dividing the net weight gain by the total volume of air sampled. Therefore, all calculated inhalable wood dust concentrations were interpreted as 8-h measurement for compliance comparison with OEL.

RESULTS

Measurement of wood dust exposure in the sanding department

A total of 137 samples were collected from 42 workers involved in sanding activity. Personal exposure to wood dust among workers varied between 3.48 and 23.3 mg m^{-3} with a geometric mean (GM) of 9.72 mg m^{-3} and a geometric standard deviation (GSD) of 1.64. During the whole sampling period, 88.3% ($n = 125$) of the measurements from sanding activity were above the OEL set by the EU.

Measurement of wood dust exposure in the sawing department

Primarily sawing was done in the small- and medium-scale wood-processing enterprises with machines like band saw, circular saw, and panel saw. In total, 103 samples from 34 workers were collected and level of exposure ranged from 2.42 to 17.01 mg m^{-3} with a GM of 7.60 mg m^{-3} and GSD of 1.52. In this department, 79.6% ($n = 82$) of the measurements were above the EU OEL.

Measurement of wood dust exposure in the finishing department

In the finishing department, jointing and painting were identified as major tasks. This category was

mainly performed outdoors nearby road sides or on a free space adjacent to the main workshop. Exposure levels ranged from 0.24 to 9.2 mg m⁻³. Workers in this field were observed to be more mobile than those involved in sanding and sawing activities. As a consequence, a relatively lower average inhalable wood dust concentration was measured (GM = 4.16 mg m⁻³ and GSD = 1.66). In total, 120 samples from 37 workers were collected and 41.7% ($n = 50$) of the measurements were above the EU OEL.

Summary of wood dust exposure in the small- and medium-scale wood-processing enterprises

From this study, it can be summarized that a total of 360 samples from 113 workers in small- and medium-scale wood-processing enterprises were collected. Generally, 8-h TWA exposure to wood dust varied between 0.24 and 23.3 mg m⁻³ with a GM of 6.82 mg m⁻³ and GSD of 1.82. The overall average exposure of workers was well beyond the standard set by many countries. It was not possible to compare this result with national standards as the country has not yet defined an OEL for wood dust. Nevertheless, 71.4% ($n = 257$) of the measurements exceeded the standard set by the EU (5 mg m⁻³) (Fig. 1).

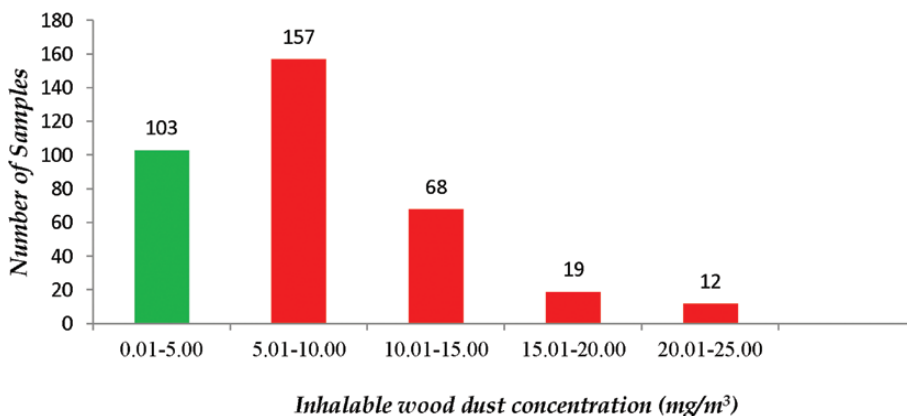
DISCUSSION

In Ethiopia, small- and medium-scale enterprises are currently playing a significant role in youth employment and income generation (Eshetu and Mammo, 2009). The government supports them in various ways such as working premises and product display

center with least price, loan provision, trainings, and market linkage (MoUDC, 2013). However, there is little urgency from any side in providing relevant information about the health risks associated with their working environment.

Small- and medium-scale wood-processing enterprises in Ethiopia are usually working in a limited space within residential areas provided by the government to promote linkage with local markets (Kefale and Chinnan, 2012). This shortage of space has forced enterprises to install machineries within smaller rooms and in the absence of adequate ventilation systems. Working rooms in most enterprises remained the same for different tasks. This situation might have significantly contributed to the presence of higher wood dust concentration levels in the sanding (9.72 mg m⁻³) and sawing (7.6 mg m⁻³) departments that demand working with machineries installed inside smaller rooms.

However, activities of jointing and painting were mainly performed outdoors nearby road sides or on a free space adjacent to the workshops. As a result, 61.7% ($n = 74$) of the measurements in this department produced an exposure level <5 mg m⁻³. Nevertheless, workers in all wood-processing enterprises neither wore respiratory masks nor did the enterprises have local exhaust ventilation systems. Although small- and medium-scale wood-processing enterprises are playing a major role in job creation and employment opportunity for the youth in Ethiopia (Abebe et al., 2009), the health condition of these youth workers is being compromised in almost all the enterprises.



1 Frequency distribution of workers' exposure to wood dust in the small- and medium-scale wood-processing enterprises. Green bar indicates <5 mg/m³ and red bar indicates >5 mg/m³.

CONCLUSION

In the small- and medium-scale wood-processing enterprise of Ethiopia, workers' average wood dust exposure was found to be high (GM = 6.82 mg m⁻³), with 71.4% of the measurements above the current OEL set by the EU (5 mg m⁻³). Workers are not supplied with proper respiratory masks and all the enterprises did not have any local exhaust ventilation systems. Recent studies have reported that in developed countries, workers' exposure to wood dust is decreasing considerably through effective legislative framework, installation of local exhaust ventilation systems as well as enhanced workers' safety protocols (Schlüssen *et al.*, 2008; Galea *et al.*, 2009). Although these enterprises create job opportunity and income to the youth, workers' health condition is poorly managed. Therefore, it is highly important for countries like Ethiopia to set national OEL that protects workers from high level of wood dust exposure and provide a better working environment.

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DISCLAIMER

The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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