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OCCUPATIONAL VIBRATION AND NOISE EXPOSURES IN FORESTRY WORKERS. R. Neitzel, M. Yost, University of Washington, Seattle, WA

Forty-two noise exposure samples and 166 whole-body (W-B) and hand-arm (H-A) vibration exposures were collected from 43 forestry workers in six trades employed by two forestry companies. Samples were collected on 10 monitoring days over an eight-week period during felling, yarding and landing, road construction, and log-handling operations. Up to five volunteer workers were monitored for noise and vibration each sampling day using datalogging noise dosimeters that provided both daily TWAs and 1-minute averages, and a precision sound level meter equipped to measure human vibration, which provided triaxial H-A and W-B event-weighted averages (AEQs) according to ACGIH W-B and H-A TLV® criteria. Workers completed a short questionnaire throughout the workday detailing the timing and number of tasks performed and equipment used.

The mean for 99 W-B summary-weighted AEQs was 5.28 m/s2 (14.21 SD, range 0.03-101.00), while the mean for 67 H-A summary-weighted AEQs was 8.30 m/s2 (16.34 SD, range 0.05-96.40). Comparisons were made between noise exposures measured using the OSHA and NIOSH metrics. The mean OSHA TWA was 86.1 dBA (6.22 SD, range 71.5-101.5), while the mean NIOSH TWA was 90.2 dBA (5.1 SD, range 81-104.7).

Substantial overexposures to both noise and vibration were observed in the population assessed: for example, 60% of OSHA TWAs and 83% of NIOSH TWAs exceeded 85 dBA. The task and tool associated with the highest noise exposure levels were unbelling chokers on landings and chainsaws, while the tasks and tools associated with the highest vibration exposure levels were spreading rock with a vehicle and bulldozers (W-B), and notching stumps and chainsaws (H-A).

Trade, task, tool, and operation type were found to be good predictors of noise and vibration exposure levels. An internal validation substudy indicated excellent agreement between worker-reported and researcher-documented tasks and tools.

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ASSESSMENT OF DUST EXPOSURE DURING SELECTED TASKS ON A COMMERCIAL TURKEY FARM. J. Hutchins, Ohio Bureau of Workers' Compensation, Toledo, OH

As part of an overall health and safety evaluation of a commercial turkey growing and processing operation, the dust exposure to farm workers was measured. The study focused on the crews assigned to barn cleaning [BC] and turkey vaccination and artificial insemination [VAI]. Job duties were documented and job titles were assigned for the BC (denesting and litter cleanup) and VAI (catcher, shooter) crews.

A total of 35 air samples were collected and analyzed for total (n = 24) or respirable (n = 11) dust according to the NIOSH 0500/0600 methods. Results were compared with the OSHA permissible exposure limits (PELs) of 15 mg/m3 for total dust and 5 mg/m3 for respirable dust. Breathing zone (BZ) dust concentrations for the BC crew exceeded the PEL in 87% of the total dust samples (range 7.3-46 mg/m3). Respirable dust samples for the barn-cleaning crew were all below the PEL (range 0.69-1.9 mg/m3). The BZ concentrations of both total (range 4.2-14 mg/m3) and respirable (range 1.4-4.8 mg/m3) dust for the VAI crew were found to be below the PEL.

Based on these data, and the well-documented potential for organic dusts to cause disease, use of filtering-facepiece respirators was discontinued and a comprehensive respiratory protection program was instituted for workers assigned to the barn-cleaning and vaccinating/artificial inseminating crews.

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FARM WORKERS' EXPOSURE TO RESPIRABLE SILICA DUST IN EASTERN NORTH CAROLINA. J. Archer, L. Nylander-French, P. Reist, University of North Carolina, Chapel Hill, Chapel Hill, NC; J. Storm, North Carolina State University, Raleigh, NC; G. Cooper, NIEHS, Research Triangle Park, NC

Crystalline silica is an occupational hazard that has been linked to some forms of cancer, silicosis, and to a variety of autoimmune diseases. Recently, exposure to respirable (aerodynamic equivalent diameter £4.25 mm) silica dust in agricultural activities has been observed, but little information exists on exposure levels.

The focus of this study was to evaluate farm workers' exposure to respirable crystalline silica (quartz) dust throughout three eastern North Carolina counties. Sandy soils in this region have been shown to contain high levels of respirable silica. Personal breathing zone samples were collected from workers at seven farms during various farming activities (including planting and harvesting). Four-hour samples were collected with 37-mm PVC filters and aluminum cyclones using personal sampling pumps, and analyzed according to NIOSH Method 7500. Environmental variables were observed and recorded during sampling (e.g., wind speed/direction, soil moisture, humidity).

Mean respirable dust and respirable silica levels were 1.65±3.17 mg/m3 and 0.77±1.71 mg/m3, respectively. The highest respirable dust and respirable silica concentrations (7.62±3.34 mg/m3 and 3.91±2.07 mg/m3, respectively) were measured during sweet potato planting. However, excluding sweet potato planting, all other samples combined had mean respirable silica concentrations of 0.12±0.16 mg/m3. Considerable variation was also observed in percent silica, ranging from 14% to 81%.

Results indicate that a potential for exposure to high levels of respirable silica dust exists during sweet potato planting, and somewhat lower levels during other farming activities. However, the variability in exposure throughout all farming activities is high.

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RESPIRATORY HEALTH RISKS IN AT-SITE COMPOSTING SWINERIES. J. Kangas, K. Louhelainen, S. Rautiala, M. Reiman, M. Seuri, Finnish Institute of Occupational Health, KUOPIO, Finland

An exposure assessment survey was conducted to estimate the respiratory health risks in composting swineries. In seven swineries, respiratory symptoms and working conditions of 11 farmers were followed. These farms used both the traditional liquid manure system and the brand new at-site composting facilities. Sawdust was used as the composting bed.

During the project, the composting process was observed visually. Total dust, viable and nonviable microorganisms, endotoxins, and gas emissions were measured regularly.

Before starting the compost manure system, the farmers were interviewed by an occupational physician who also trained them to conduct PEF measurements. The farmers monitored their morning temperature, performed PEF measurements, and recorded present respiratory symptoms daily during four follow-up periods of two weeks.

In three of the swineries, the composting process of the manure did not function well and the compost bed was wet in many places, according to visual observations. Reasons for this were either too many pigs or poor heating or ventilation.

The farmers' exposure to total dust did not increase, and the gas concentrations were lower in composting swineries as compared with those in the traditional facilities. In both composting and traditional swineries, the endotoxin levels were high compared with levels measured earlier in cowsheds. The average amount of microorganisms was higher in the composting swineries than in the traditional facilities but lower than levels found in cowsheds.

Several farmers had work-related respiratory system even before starting the compost manure system. There was no increase in respiratory symptoms or changes in the PEF follow-up, which might be attributed to hygienic conditions in composting swineries. In conclusion, we can assume that swineries with a properly functioning manure composting system partly improved air quality, and the exposed farmers' respiratory symptoms did not increase.

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PRE-EMERGENT HERBICIDE EXPOSURES AMONG CUSTOM APPLICATORS. C. Hines, J. Deddens, S. Tucker, NIOSH, Cincinnati, OH; R. Hornung, University of Cincinnati, Cincinnati, OH

Custom applicators intensively apply pre-emergent herbicides to corn and soybean fields each spring. The primary objective of this study was to characterize the exposure distributions of four pre-emergent herbicides - alachlor, atrazine, 2,4-D ethylhexyl ester (2,4-D EH), and metolachlor - among a group of applicators during the spring spray season. A secondary objective was to evaluate determinants of exposure and to estimate within- and between-worker variance components.

Fifteen applicators were sampled using a systematic design that included spray and nonspray days, and multiple measurements (5-7) on each applicator. Air, patch, and handwash samples were collected on 89 applicator-days. Applicator-days were classified into three categories: target herbicide sprayed, nontarget herbicide sprayed, and no herbicide sprayed.

A repeated measures analysis of variance was performed. For all exposure metrics, mean herbicide exposures were significantly higher on days when target herbicides were sprayed as compared with nonspray days; and for most metrics, mean exposures on target herbicide spray days were significantly higher than on nontarget herbicide spray days.

Exposure to the hands was substantially higher than to other body parts. For 2,4-D EH only, mean exposures on nontarget herbicide spray days were significantly higher than on nonspray days.

Wearing gloves significantly reduced hand exposure for all herbicides (four- to twenty-fold) on days the herbicides were sprayed; however, wearing gloves significantly increased atrazine hand exposure (nine-fold) on days that nonatrazine herbicides were sprayed, and similar nonsignificant increases were observed for metolachlor and 2,4-D EH, suggesting that the inside of gloves might have been contaminated with herbicides.

Few of the other covariates tested were significant, and none consistently across all herbicides. For all exposure metrics, the within-worker variability

(GSDW 2.1-5.9) was greater than the between-worker variability (GSDB 1.2-2.7), suggesting that day-to-day factors influence total variability more than individual work practices.

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PESTICIDE USE PATTERNS AND BIOLOGICAL MONITORING. L. Lowry, University of Texas Health Center, Tyler, TX

Worker exposure to pesticides is best assessed using biological monitoring, since the principal route of exposure is through the skin. Air monitoring and dermal deposition sampling do not assess the degree of absorbed dose. Thus, a cost-effective biological monitoring program becomes the prime method for assessing potential health effects from pesticide exposure.

Pesticide use patterns have changed over the years with the phase-out of the persistent chlorinated hydrocarbons in the 1960s and '70s and their replacement with biodegradable organophosphates (OPs) in the 1980s and '90s. Biological monitoring was used for many of the chlorinated hydrocarbons such as DDT, Aldrin, Dieldrin, Lindane, and their metabolites. Biological monitoring methods for OPs include cholinesterase measurements in blood as well as alkyl phosphate metabolites and some specific OP metabolites in urine.

In the late 1990s, the trend was to move away from the more toxic OPs to the less toxic carbamates and the synthetic pyrethroids, and to use genetically engineered crops that are more resistant to pests. There are few biological monitoring methods for these pesticides.

New methods for biological monitoring of the metabolites of carbamates (Carbaryl) and pyrethroids (Permethrin, Cypermethrin, Deltamethrin, and Fenvalerate) will be reviewed along with their applicability for routine use in exposure assessment of pesticide applicators. The availability of laboratories, methods, and quality assurance programs will be reviewed, along with published health-based guidelines for interpretation.

It is important that exposure assessment technology keep pace with the changing trends in pesticide use.

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SURFACE SAMPLING FOR SOIL IMPREGNATED WITH CHLORPYRIFOS FORMULATION. J. Tso, S. QueHee, J. Froines, UCLA Center for Occupational and Environmental Health, UCLA School of Public Health, Los Angeles, CA

Chlorpyrifos, an organophosphorothioate insecticide, has been measured in surface dust and soil in houses, farms, and restaurants. Concentrations up to 1300 mg/kg dust with surface coverage of up to 6.6 mg/m2 have been reported in the literature. The aim of this study was to show if Lorsban 2E formulation containing chlorpyrifos affected the sampling recoveries of impregnated soil using the portable cordless vacuum pump method.

A 10 cm2 Plexiglas® template was used to define the area sampled. Three-piece polystyrene particle sampling cassettes with matched backup filters and 37 mm diameter cellulose acetate filters equipped with a Tygon® sampling probe were used as the collection apparatus. The sampling efficiencies of soil coated with and without 1300 mg/g chlorpyrifos were compared. The surface soil was sampled at 4 L/min. Three sampling passes showed cumulative collection efficiencies (n = 3) of 90±5% for 19 mg, 79±4% for 16.8 mg, 80±13% for 15.3 mg, 56±15% for 11.2 mg, and 59±16% for 9.88±0.46 mg. Sampling efficiencies >75% were possible only at ³15 mg for coated dust.

The proportion of dust in the sampling probe and in the cassette was about 1:1 at 10 mg loading, whereas the cassette always contained >50% for loading beyond 15 mg. The coated soil caused a difference in recovery due to greater stickiness and tackiness relative to no formulation.

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THE FACTORS AFFECTING THE SKIN DEPOSITION OF ORGANOPHOSPHORUS PESTICIDES. H. Chang, J. Tsai, National Cheng Kung University, Tainan, Taiwan Republic of China; L. Wu, Y. Lai, Kaohsiung Medical College, Kaohsiung, Taiwan Republic of China

A considerably large amount of pesticides was used to increase the production of fruit growth in warm and humid Taiwan. Inappropriate use of pesticides will cause detrimental effects, especially, in the neurological system. Dermal exposure was found to be one of the major routes of exposure during application of pesticides for farmers. However, the exposure-dose patterns developed in previous dermal exposure studies were based mostly on the experimental data from pure pesticides solved in organic solvents, prolonged exposure duration, and high exposure levels, which were significantly different from the real exposure conditions of the farmers in real-world situations: pesticides are prepared in a hydrogenous solution containing surfactants, exposure durations are shorter, and exposure levels are much less.

The purpose of this study was to determine the effects of exposure levels, exposed duration, and solvents used on the skin deposition of organophosphorus pesticides. Nude mice aged 6-8 weeks were exposed to chlorpyrifos, phenthoate, and parathion. Various concentrations of pesticides (10~70, 100~700, and 1000~7000 mg/L) were spiked onto the skin of nude mice. Through various exposure durations (2, 4, 8, and 12 hours) by the diffusion cell, mouse skin was taped 5-7 times to determine the deposition in the stratum corneum and residue skin layer, respectively.

We found that the amount of skin deposition, in general, increases with the exposure duration and exposure levels. However, the deposition rates decrease when the exposure levels increase. The significant increase of skin deposition was found after the addition of surfactant into the solutions of parathion and chlorpyrifos. Skin depositions of three tested organophosphates were significantly higher in a hydrogenous solution than in an organic solvent solution. The findings of this study indicate the possibly erroneous estimates of the dermal uptake in previous studies due to the incompatible exposure scenario of the real-world.

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POSTAL DRIVER VEHICLE EXHAUST EXPOSURES. V. Konopinski, U.S. Postal Service, Cary, IL

A labor relations representative transmitted concern of postal drivers at a particular location regarding vehicle exhaust exposures. A sampling protocol was developed. Field measurements for carbon monoxide (CO) and carbon dioxide (CO2) were obtained at various positions in two delivery vehicles while simulating delivery of mail on city route No. 10 in Cary, Illinois. Measurements were taken at various positions in and outside the vehicle.

The carbon dioxide concentrations detected ranged from 289 ppm to 315 ppm for all testing. The carbon monoxide ranged from 0.4 ppm to 4.5 ppm for slow acceleration and stopping. For fast acceleration and stopping, the concentrations of carbon monoxide varied from 0.9 ppm to 22 ppm for the test positions. All measured concentrations were below the OSHA PEL of 50 ppm for carbon monoxide (CO and 5000 ppm for carbon dioxide (CO2).

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VEHICLE EXHAUST EXPOSURES TO TOLL BOOTH COLLECTORS. H. Bennett, Environmental Profiles, Inc., Baltimore, MD

Several interstate highway toll collectors in Baltimore, Maryland, raised concerns about health problems and vehicle exhaust exposures. Exhaust from vehicular traffic contains a very complex mixture of gaseous emissions, including carbon monoxide (CO) and volatile organic hydrocarbons (VOCs).

The toll collectors' exposures to CO and VOCs were evaluated as an indicator of worker exposure. There are no specific occupational exposure standards for vehicle exhausts. The OSHA PEL for carbon monoxide is 35 ppm, based on an 8-hour time-weighted average (TWA) and a ceiling of 200 ppm. Research on low-level VOC exposures has indicated that concentrations below 3 mg/m3 are not likely to induce observable health effects among humans.

Real-time air monitoring data were collected at 105 analysis points in six different tollbooths during morning and afternoon rush hours. A portable Miran 1B2® ambient air analyzer was used to measure CO levels, and a Photovac MicroTip HL 2000® (PID) was used to monitor the hydrocarbons. Ventilation systems serving the tollbooths were inspected for cleanliness and assessed for operability. Meteorological data and traffic volumes were considered.

Results showed the average CO and VOC levels were well below conservative exposure criteria. Average CO levels ranged from 0.9 ppm to 6.3 ppm. The peak excursions of CO ranged from 8 ppm to 53 ppm, with an average of 11.04 ppm. VOC levels did not exceed 1.9 ppm. The peaks were short in duration and occurred with wind turbulence in the toll plaza and as cigarettes were smoked in the tollbooths.

These results support the need for effective environmental controls and a smoking cessation program for tollbooths.

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RESPIRABLE DUST AND SILICA EXPOSURE OF POTTERY WORKERS IN CENTRAL ITALY. A. Marconi, G. Cattani, Istituto Superiore di Sanità, Rome, Italy; F. Cavariani, Azienda Sanitaria Locale Viterbo 5, Civitacastellana, Italy

The IARC recently included crystalline silica, in the form of quartz or cristobalite, among substances considered human carcinogens. The exposure to silica dust of Italian pottery workers has been associated with a high incidence of silicosis and lung cancer.

An investigation has been conducted to develop estimates of workers exposures from 1993 to 1998 in 18 sanitary ware and 11 crockery manufacturing plants located in the surrounding area of Civitacastellana (Viterbo, Italy). Data of respirable

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