OCCUPATIONAL EXPOSURE IN METAL 3D PRINTING

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Background Metal 3D printing is a growing industry that poses potential exposure risks to metal dust and nanosized particles with known toxic characteristics. Selective Laser Melting (SLM) is an additive manufacturing technique where metal particles similar to welding fumes are released as a result of the laser heating of a metal powder. Particles are also released during powder handling and post-processing. Currently, research on exposure in metal 3D printing remains limited.

Materials and methods This study monitored metal 3D printing operators (n=18) and other workers (n=14) during their work shifts. The occupational exposure assessment included collection of dust samples and dermal wipes. Mass and number concentrations of airborne particles were measured using personal and stationary equipment. Urine samples and exhaled breath condensates (EBC) were collected pre- and post-shift to determine levels of various metals (e.g., Fe, Ni, Cr, Al, Co, Cu, Mn, Pb, Sn and V). Metal levels were compared to an unexposed control group (n=15, matched for age, sex and smoking) and to the established guidance values.

Results High concentrations of nanoparticles were detected during powder handling and post-processing. Operators showed high dermal metal concentrations post-shift. However, metal levels in urine and EBC were generally comparable to those observed in the control group, but the post-shift EBC samples of the 3D-printing operators showed significantly higher levels of copper than controls.

Conclusions Metal 3D printing workers are potentially exposed to nanosized metal dust, especially during powder handling and post-processing work activities if adequate exposure control measures are not implemented.