Estimation of cumulative exposure to manganese using the exposure database MEGA and occupational histories of male participants of the Heinz Nixdorf Recall Study

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Objective

- In 2015, the German Occupational Exposure Limit (OEL) for inhalable manganese (Mn) was reduced to 200 µg/m³ due to reports of neurotoxic effects in the low-dose range
- Here we took advantage of a large dataset of personal measurements compiled in the exposure database MEGA and estimated average exposure concentrations for at-risk occupations
- These means were used to calculate cumulative exposure to Mn of men investigated within the framework of the Heinz Nixdorf Recall Study (HNRS)

Methods

I 4,635 personal measurements of inhalable Mn measurements collected between 1989 to 2015 (MEGA)
- Measurements below the limit of quantification (LOQ) were multiply imputed according to their distribution above LOQ **(Figure 2**)
- Mixed-effects models were applied to the log-transformed Mn concentrations to calculate the annual geometric means (GMs) of shift exposure in at-risk occupations

II Working as welder or in other at-risk occupations (supplemental questionnaire) of 354 male participants of HNRS

III Linking annual GMs with the occupational histories to calculate cumulative exposure to Mn **(Figure 1)**

$$\sum GM\ [\mu g/m^3] \times Duration\ [years] \times Intensity\ score$$

Intensity score: working as regular welder (1), frequent welding (0.25), occasional welding (0.1)

Results

- Exposure to Mn was strongly influenced by the major technique and the Mn content of the electrode/processed material **(Table 1)**
- GMs > 200 µg/m³ (OEL) were observed in gas welding and gas metal arc welding with consumable materials of Mn content > 5%
- Median cumulative exposure to Mn: 58 [µg/m³ x years] in all men working in at-risk occupations and 1,121 [µg/m³ x years] in 26 welders

Conclusion

Supplemental questionnnaires in addition to the job title are necessary to collect information on major predictors of the exposure level to Mn (e.g. welding technique) in community-based studies like HNRS when estimating neurotoxic effects of occupational exposure to Mn.

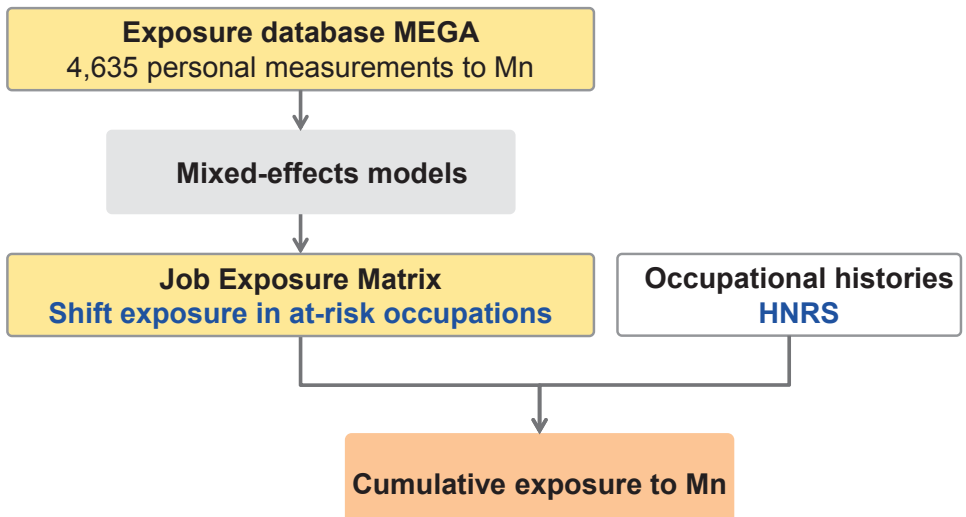

Figure 1 Quantitative exposure assessment in the HNRS study

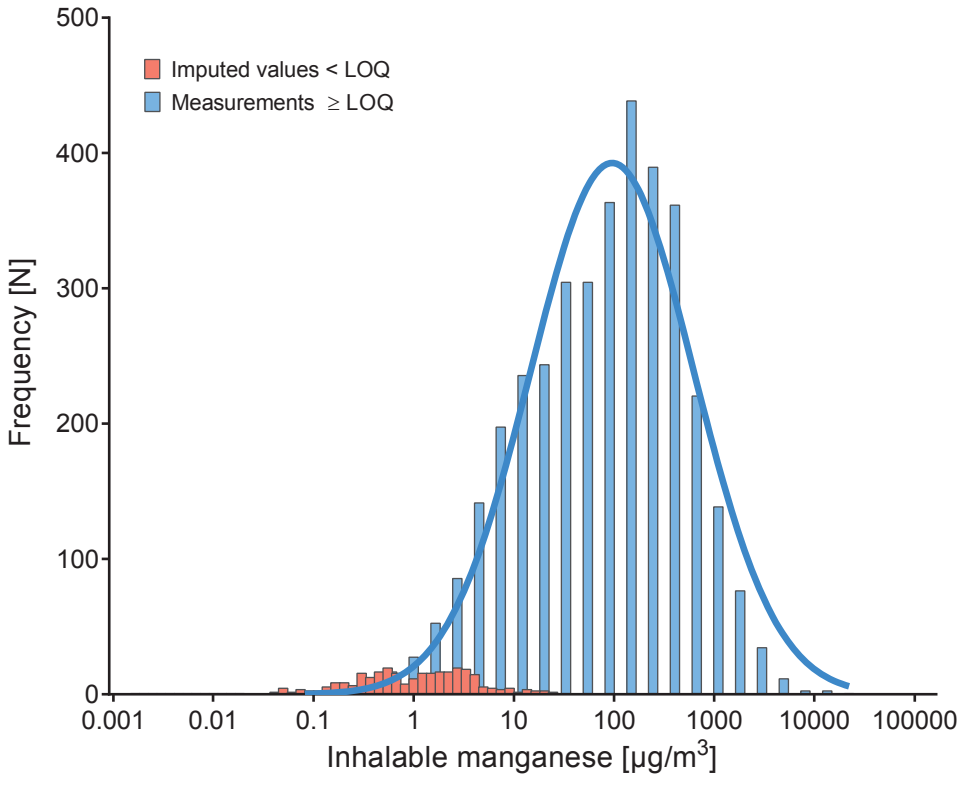

Figure 2 Density function of the concentrations of inhalable manganese among welders

Technique	Material	N	GM [µg/m³]	95% CI [µg/m³]
GMAW	Mild steel	1418	95	87 – 105
	Stainless steel	342	54	47 – 62
	Mn content >5%	47	201	138 – 291
TIG	Mild steel	60	10	8 – 12
	Stainless steel	332	6	5 – 7
	Mn content >5%	10	21	14 – 31
SMAW	Mild steel	85	40	32 – 51
	Stainless steel	84	23	18 – 29
	Mn content >5%	22	84	56 – 127

GMAW: Gas metal arc welding, TIG: Tungsten inert gas welding, SMAW: Shielded metal arc welding

Table 1 Model-based estimates of average shift exposure to inhalable Mn for major welding techniques and material predicted for the year 2009 (MEGA database, 1989-2015)

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