

**Occupational exposure to manganese and fine motor skills in elderly men:  
Results from the Heinz Nixdorf Recall Study**

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**Table S1.** Occupations rated as requiring fine motor skills.

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<b>Occupations</b>
Architect
Confectioner (pastry cook)
Conservator or restorer
Craft glazier
Curtain/drapery sewer
Dental technician
Dentist
Draftsman
Engraver
Garment maker
Landscape architect
Laundry tailor
Leather sewer
Ophthalmic optics process mechanic
Oral surgeon
Painter and decorator
Pattern maker
Polisher
Precision mechanic
Shoemaker
Stenotypist
Technical draftsman
Watchmaker

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**Table S2.** Occupation and other potential predictors of fine motor skills of the non-dominant hand in 1,232 men assessed with Poisson regression.

Variable	Value	n	Tapping hits			Line tracing errors			Steadiness errors			Aiming errors		
			Exp( $\beta$ )	95% CI		Exp( $\beta$ )	95% CI		Exp( $\beta$ )	95% CI		Exp( $\beta$ )	95% CI	
Intercept		1232	277	256	300	10.1	8.10	12.6	1.01	0.62	1.63	0.12	0.05	0.27
Occupation	Blue-collar without exposure to Mn (last occupation)	237	1			1			1			1		
	Welders	24	0.99	0.93	1.05	0.95	0.81	1.10	0.69	0.46	1.03	0.86	0.47	1.58
	Occasional welding	195	1.01	0.98	1.03	1.01	0.95	1.09	0.89	0.76	1.04	<b>0.76</b>	<b>0.57</b>	<b>0.99</b>
	Other potential exposure to Mn	103	<b>1.04</b>	<b>1.00</b>	<b>1.07</b>	0.98	0.90	1.06	0.94	0.78	1.13	0.94	0.69	1.28
	Manually skilled	112	1.01	0.97	1.04	0.99	0.92	1.08	0.86	0.71	1.04	0.85	0.62	1.17
	White-collar	561	<b>1.03</b>	<b>1.01</b>	<b>1.05</b>	0.99	0.93	1.04	0.99	0.87	1.12	0.87	0.71	1.07
Age [per 10 years]		1232	<b>0.93</b>	<b>0.92</b>	<b>0.94</b>	<b>1.16</b>	<b>1.13</b>	<b>1.20</b>	<b>1.52</b>	<b>1.43</b>	<b>1.63</b>	<b>1.28</b>	<b>1.14</b>	<b>1.44</b>
Smoking status	Never	367	1			1			1			1		
	Former	687	1.00	0.98	1.02	1.01	0.96	1.05	1.02	0.92	1.14	1.15	0.95	1.39
	Current	178	<b>0.97</b>	<b>0.94</b>	<b>0.99</b>	1.04	0.97	1.11	<b>1.29</b>	<b>1.11</b>	<b>1.49</b>	1.20	0.92	1.57
Test time [sec]		1232				<b>1.01</b>	<b>1.00</b>	<b>1.01</b>				<b>1.05</b>	<b>1.03</b>	<b>1.07</b>

**Table S3.** Odds ratios for at-risk occupation and other factors on substantially impaired fine motor tests of the non-dominant hand in 1,232 men.

Variable	Value	Tapping hits			Line tracing errors			Steadiness errors			Aiming errors		
		n <sup>a</sup>	OR <sup>b</sup>	95% CI	n	OR <sup>b</sup>	95% CI	n	OR <sup>b</sup>	95% CI	n	OR <sup>b</sup>	95% CI
Occupation	Blue-collar jobs without exposure to Mn (last occupation)	28	1		21	1		29	1		38	1	
	Welders	4	1.71	0.53 5.51	1	0.48	0.06 3.81	1	0.35	0.05 2.69	3	0.77	0.22 2.74
	Occasional welding	27	1.32	0.74 2.36	20	1.26	0.64 2.47	23	1.04	0.57 1.88	23	0.72	0.41 1.26
	Other potential exposure to Mn	12	0.88	0.42 1.84	18	1.67	0.81 3.46	14	1.02	0.51 2.07	13	0.73	0.37 1.45
	Manually skilled occupations	11	0.84	0.40 1.79	14	1.44	0.68 3.06	9	0.64	0.29 1.43	14	0.77	0.40 1.49
	White-collar occupations	46	0.74	0.44 1.23	54	1.13	0.65 1.97	51	0.79	0.48 1.30	77	0.90	0.59 1.38
Age [per 10 years]		128	<b>2.61</b>	<b>1.97</b> <b>3.46</b>	128	<b>2.73</b>	<b>2.04</b> <b>3.65</b>	127	<b>2.51</b>	<b>1.90</b> <b>3.31</b>	168	<b>1.45</b>	<b>1.14</b> <b>1.85</b>
Smoking status	Never	35	1		36	1		34	1		47	1	
	Former	71	1.03	0.66 1.60	70	1.02	0.65 1.59	70	1.01	0.65 1.57	95	1.08	0.74 1.58
	Current	22	<b>1.90</b>	<b>1.05</b> <b>3.45</b>	22	<b>2.03</b>	<b>1.10</b> <b>3.73</b>	23	<b>1.96</b>	<b>1.09</b> <b>3.53</b>	26	1.34	0.79 2.27
Test time [sec]				128	<b>1.06</b>	<b>1.04</b> <b>1.07</b>				168	1.04	0.98 1.09	

<sup>a</sup>Participants at risk; <sup>b</sup>Odds ratio with 95% confidence interval (CI) for substantially impaired dexterity (hits <10<sup>th</sup> percentile, errors >90<sup>th</sup> percentile).

**Table S4.** Cumulative exposure to manganese and other predictors of fine motor skills of the non-dominant hand in 1,232 men assessed with Poisson regression.

Variable	Value	n	Tapping hits			Line tracing errors			Steadiness errors			Aiming errors		
			Exp( $\beta$ )	95% CI		Exp( $\beta$ )	95% CI		Exp( $\beta$ )	95% CI		Exp( $\beta$ )	95% CI	
Intercept		1232	287	265	310	9.98	8.05	12.4	0.91	0.57	1.46	0.09	0.04	0.20
Cumulative exposure to Mn [ $\mu\text{g}/\text{m}^3$ years]	0	910	1			1			1			1		
	> 0 – 58.0	161	1.00	0.98	1.03	0.96	0.90	1.02	<b>0.84</b>	<b>0.73</b>	<b>0.98</b>	0.79	0.61	1.03
	> 58.0 – 184.8	81	1.02	0.99	1.05	1.03	0.95	1.12	0.85	0.70	1.03	0.84	0.60	1.18
	> 184.8	80	0.98	0.95	1.01	1.05	0.97	1.14	1.02	0.85	1.22	1.02	0.76	1.38
Occupational qualification	University	350	1			1			1			1		
	Foremen/technician	269	0.98	0.96	1.01	0.99	0.93	1.05	1.06	0.92	1.22	0.94	0.72	1.21
	None/vocational	623	<b>0.97</b>	<b>0.96</b>	<b>0.99</b>	<b>1.05</b>	<b>1.00</b>	<b>1.10</b>	<b>1.16</b>	<b>1.04</b>	<b>1.30</b>	<b>1.43</b>	<b>1.16</b>	<b>1.75</b>
Age [per 10 years]		1232	<b>0.93</b>	<b>0.92</b>	<b>0.94</b>	<b>1.16</b>	<b>1.13</b>	<b>1.20</b>	<b>1.52</b>	<b>1.43</b>	<b>1.62</b>	<b>1.30</b>	<b>1.16</b>	<b>1.46</b>
Smoking status	Never	367	1			1			1			1		
	Former	687	1.00	0.99	1.02	1.00	0.96	1.05	1.02	0.91	1.13	1.12	0.93	1.35
	Current	178	<b>0.97</b>	<b>0.95</b>	<b>1.00</b>	1.03	0.97	1.10	<b>1.27</b>	<b>1.10</b>	<b>1.48</b>	1.15	0.89	1.50
Test time [sec]		1232				<b>1.01</b>	<b>1.00</b>	<b>1.01</b>				<b>1.05</b>	<b>1.02</b>	<b>1.07</b>

**Table S5.** Odds ratios for cumulative Mn exposure, iron status, and other potential predictors of substantially impaired dexterity of the non-dominant hand in 860 men.

Variable	Value	Tapping hits			Line tracing errors			Steadiness errors			Aiming errors		
		n <sup>a</sup>	OR <sup>b</sup>	95% CI	n <sup>a</sup>	OR <sup>b</sup>	95% CI	n <sup>a</sup>	OR <sup>b</sup>	95% CI	n <sup>a</sup>	OR <sup>b</sup>	95% CI
Cumulative exposure to Mn [µg/m <sup>3</sup> years]	0	58	1		58	1		61	1		90	1	
	> 0 – 58.0	13	1.18	0.61 2.28	16	1.46	0.77 2.80	11	0.91	0.45 1.84	9	<b>0.40</b>	<b>0.19</b> <b>0.83</b>
	> 58.0 – 184.8	6	1.14	0.45 2.90	1	0.18	0.02 1.36	7	1.28	0.53 3.09	4	0.41	0.14 1.18
	> 184.8	11	<b>2.24</b>	<b>1.06</b> <b>4.76</b>	11	<b>2.54</b>	<b>1.16</b> <b>5.57</b>	11	2.03	0.95 4.31	12	1.18	0.59 2.38
Iron status	Normal	73	1		69	1		69	1		104	1	
	Hemoglobin < 13 g/dL	9	0.98	0.45 2.11	8	0.92	0.40 2.13	14	1.85	0.94 3.61	9	0.77	0.36 1.63
	Ferritin ≥ 400 µg/L	6	0.74	0.30 1.79	9	1.38	0.63 3.04	7	0.96	0.42 2.23	11	0.95	0.48 1.89
Occupational qualification	University	19	1		22	1		19	1		28	1	
	Foremen/technician	17	1.02	0.50 2.08	14	0.81	0.38 1.71	18	1.11	0.54 2.26	19	0.91	0.48 1.71
	None/vocational	52	1.42	0.78 2.56	50	1.26	0.70 2.29	53	1.53	0.84 2.77	77	<b>1.64</b>	<b>1.00</b> <b>2.68</b>
Age [per 10 years]		88	<b>2.67</b>	<b>1.89</b> <b>3.78</b>	86	<b>3.50</b>	<b>2.40</b> <b>5.10</b>	90	<b>2.87</b>	<b>2.03</b> <b>4.07</b>	124	<b>1.63</b>	<b>1.21</b> <b>2.18</b>
Smoking status	Never	23	1		26	1		25	1		35	1	
	Former	50	1.00	0.58 1.71	47	0.87	0.50 1.51	51	0.89	0.52 1.51	66	0.93	0.59 1.47
	Current	15	1.89	0.90 3.93	13	1.69	0.77 3.70	14	1.65	0.78 3.46	23	1.62	0.88 2.98
Gamma-glutamyl transferase [U/L]	< 74 (90 <sup>th</sup> percentile)	76	1		74	1		79	1		112	1	
	≥ 74	12	1.58	0.80 3.13	12	1.83	0.90 3.73	11	1.33	0.66 2.70	12	1.02	0.53 1.97
Test time [sec]					86	<b>1.05</b>	<b>1.03</b> <b>1.07</b>				124	1.05	0.99 1.11

<sup>a</sup>Participants at risk; <sup>b</sup>Odds ratio (OR) with 95% confidence interval (CI) as estimate of the relative risk for a substantially impaired dexterity (hits <10<sup>th</sup> percentile, errors >90<sup>th</sup> percentile).