

Occupational biomechanical risk factors for surgically treated ulnar nerve entrapment in a prospective study of male construction workers ¹

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Abbreviations

GrpForce	Intensity of hand grip force	WristExt	Frequency of full wrist extension
UEload	Intensity of upper extremity load	ElbowExt	Frequency of full elbow extension
fElbowF-E	Frequency of repetitive elbow flexion and extension work	PostureTool	Frequency of using a hand held tool in a fixed position
fWristF-E	Frequency of repetitive wrist flexion and extension work	LeanElb	Frequency of leaning on the elbow
fHandTool	Frequency of hand-held tool use	HAV	Magnitude of hand-arm vibration
fStatic	Frequency of upper extremity static work	HA-fShock	Frequency of impact shocks during HAV

Table S1 – Job-exposure matrix developed to assess ulnar nerve entrapment related biomechanical exposure in the construction worker cohort. All ergonomic factors were coded (1-low, 2-moderate, 3-high) and vibrational factors were coded (1-none, 2-acceptable, 3-high), except, frequency of leaning on the elbows and of shocks during HAV which were graded dichotomously (1-no, 3-yes).

	Grip F	UE load	fElbow FE	fWrist FE	fHand Tool	fStatic	Wrist Ext	Elbow Ext	Posture Tool	Lean Elb	HAV	HA- fShock
Asphalt workers	1	2	2	1	1	1	1	1	1	1	1	1
Brick layers	2	2	3	3	3	1	2	1	1	1	1	1
Concrete workers	3	3	2	1	3	2	1	1	3	1	3	3
Crane operators	1	1	1	3	1	3	2	1	1	1	1	1
Drivers	1	1	1	1	1	3	2	1	1	3	1	1
Electricians	2	2	1	2	3	3	2	2	3	3	2	3
Floor layers	2	2	1	1	2	1	1	1	2	1	2	1
Foremen	1	1	1	1	1	1	1	1	1	1	1	1
Glaziers	3	3	1	1	1	1	1	2	1	1	1	1
Ground prep	2	2	1	1	2	1	1	1	1	1	1	1
Heavy machinery operators	1	1	1	1	1	3	2	1	1	3	1	1
Insulators	2	2	1	1	2	2	1	1	2	1	2	1
Painters	2	2	3	3	3	1	1	3	1	1	1	1
Plumbers	3	2	2	2	3	3	1	1	3	3	1	1
Refrigerator technicians	2	2	1	1	2	2	1	1	2	3	2	3
Repairers	2	2	1	1	2	2	1	1	2	3	3	3
Rock blasters	3	3	1	1	3	3	1	1	3	1	3	3
Roofers	2	2	2	1	3	2	1	1	1	1	1	1
Sheet-metal workers	3	3	1	1	3	2	1	1	3	1	2	3
White collar workers	1	1	1	1	1	2	1	1	1	3	1	1
Wood workers	3	3	3	3	3	2	2	2	3	1	2	1

Table S2 – *Total study cohort*: Association between individual biomechanical factors and UNE risk. Models adjusted for BMI, smoking, age, and number workers; IR – incidence rate per 100,000 person-years; RR – relative risk; CI – confidence interval.

	<i>N</i>	<i>person-years</i>	<i>cases</i>	<i>IR</i>	<i>RR</i>	<i>95% CI</i>
<i>Grip Force</i>						
low	52 605	660 836	100	15.13	1	--
moderate	71 875	908 374	152	16.73	1.15	0.90-1.47
high	105 209	1 327 491	303	22.83	1.54	1.24-1.92
<i>Upper Extremity Load</i>						
low	48 743	612 362	89	14.53	1	--
moderate	92 802	1 171 611	209	17.84	1.27	1.00-1.61
high	88 144	1 112 728	257	23.10	1.63	1.30-2.06
<i>Frequency of repetitive elbow flexion and extension work</i>						
low	112 708	1 421 411	242	17.03	1	--
moderate	41 824	524 231	125	23.84	1.36	1.10-1.68
high	75 157	951 059	188	19.77	1.18	0.97-1.43
<i>Frequency of repetitive wrist flexion and extension work</i>						
low	105 758	1 328 290	273	20.55	1	--
moderate	46 730	592 235	90	15.20	0.77	0.63-0.94
high	77 201	976 176	192	19.67	0.99	0.85-1.15
<i>Frequency of hand-held tool use</i>						
low	54 747	687 873	104	15.12	1	--
moderate	17 282	216 914	52	23.97	1.58	1.13-2.22
high	157 660	1 991 914	399	20.03	1.37	1.09-1.71
<i>Frequency of static work</i>						
low	68 709	865 468	142	16.41	1	--
moderate	96 762	1 220 843	273	22.36	1.36	1.12-1.65
high	64 218	810 390	140	17.28	1.06	0.85-1.32
<i>Frequency of full wrist extension</i>						
low	130 049	1 635 855	324	19.81	1	--
moderate	99 640	1 260 846	231	18.32	0.95	0.822-1.105
high	--	--	--	--	--	--
<i>Frequency of full elbow extension</i>						
Low	128 973	1 619 541	335	20.68	1	--
moderate	83 270	1 056 980	187	17.69	0.90	0.75-1.07
High	17 446	220 180	33	14.99	0.74	0.52-1.05
<i>Frequency of using a hand held tool in a fixed position</i>						
Low	87 400	1 098 429	187	17.02	1	--
moderate	9557	120 346	25	20.77	1.21	0.78-1.86
High	132 732	1 677 926	343	20.44	1.22	0.99-1.50
<i>Frequency of leaning on elbows</i>						
Rare	160 023	2 017 203	411	20.37	1	--
Often	69 666	879 498	144	16.37	0.81	0.69-0.95
<i>Hand-arm vibration</i>						
None	104 465	1 313 192	233	17.74	1	--
Acceptable	98 322	1 247 061	240	19.25	1.13	0.95-1.33
High	26 902	336 448	82	24.37	1.35	1.07-1.71
<i>Frequency of shocks during hand-arm vibration</i>						
Rare	162 350	2 046 663	391	19.10	1	--
Often	67 339	850 038	164	19.29	1.02	0.85-1.22

Table S3 – *Total Study Cohort*: Spearman correlation coefficients assessing the relationship between the 10 ergonomic and 2 vibration biomechanical exposure factors. Individual factors with correlations ≥ 0.7 (marked in bold) were grouped into *exposure scores*.

	Grip F	UE load	fElbow FE	fWrist FE	fHand Tool	fStatic	Wrist Ext	Elbow Ext	fPosture Tool	Leaning Elb	HAV	HA. f Shock
GripF	1											
UEload	0.9	1										
ElbowFE	0.6	0.6	1									
Wrist FE	0.4	0.4	0.8	1								
fHand Tool	0.8	0.7	0.6	0.6	1							
fStatic	0.3	0.1	-0.2	0.1	0.4	1						
Wrist Ext	0.2	0.3	0.3	0.6	0.3	0.4	1					
ElbowExt	0.2	0.3	0.5	0.8	0.5	0.0	0.5	1				
PostureTool	0.8	0.7	0.3	0.3	0.8	0.6	0.4	0.3	1			
Leaning Elb	-0.2	0.4	-0.4	-0.1	0.0	0.7	0.2	-0.1	0.1	1		
HAV	0.6	0.8	0.1	0.1	0.6	0.4	0.3	0.2	0.8	0.1	1	
HA. fShock	0.2	0.3	-0.4	-0.3	0.4	0.5	0.0	0.0	0.5	0.3	0.7	1

New Exposure Scores

1. Grip Score = Intensity of hand grip force + Intensity of upper extremity load + frequency of using a hand tool in a fixed posture + frequency of hand tool use
2. Grip + Vibration Score = Intensity of hand grip force + Intensity of upper extremity load + frequency of using a hand tool in a fixed posture + frequency of hand tool use + HAV
3. Vibration Score = HAV + frequency of impact shocks during HAV
4. Repetitive Flexion/Extension Score = Frequency of repetitive elbow flexion and extension work + Frequency of repetitive wrist flexion and extension work
5. Static work / Leaning = Frequency of upper extremity static work + Frequency of leaning on the elbow

Table S4 – *5-yrExp cohort*: Personal factors and relative risk for UNE from crude models. Significant values shown in bold text. Mean ($\bar{x}$) BMI exposure values given for both groups. N – number workers; IR – incidence rate per 100 000 person-years; RR – relative risk; CI – confidence interval.

	<i>N</i>	<i>person-years</i>	<i>cases</i>	<i>IR</i>	<i>RR</i>	<i>95% CI</i>
<i>BMI</i>						
healthy ($\bar{x}$ =22.2)	62 016	785 578	142	18.08	1	--
overweight ($\bar{x}$ =28.5)	22 759	283 590	60	21.16	1.17	0.87-1.58
<i>Smoking</i>						
Never	38 082	487 310	69	14.16	1	--
Ever	42 544	530 377	118	22.25	1.57	1.17-2.12
Unknown	4 149	51 481	15	29.14	2.06	1.18-3.60
<i>Age</i>						
25-34	11 907	153 524	21	13.68	1	--
35-44	23 636	303 446	54	17.80	1.30	0.79-2.16
45-54	27 197	344 120	86	24.99	1.83	1.13-2.95
55-64	22 035	268 078	41	15.29	1.12	0.66-1.89

Table S5 - *5-yrExp cohort*: Occupational group among Swedish construction workers and relative risk for UNE in final model adjusted for BMI, smoking, age, and surgery date. Significant risk values shown in bold text. N – number workers; IR – incidence rate per 100 000 person-years; RR – relative risk; CI – confidence interval.

Occupational Group	N	person- years	cases	IR	RR	95% CI
Insulators	766	9 572	1	10.45	0.79	0.12-5.17
Repairers	729	9 211	1	10.86	0.81	0.12-5.26
Crane operators	723	8 928	1	11.20	0.85	0.13-5.57
Plumbers	6 322	79 542	9	11.31	0.88	0.41-1.87
Foremen	9 941	125 222	16	12.78	1	--
Painters	6 400	80 771	11	13.62	1.07	0.52-2.20
Electricians	10 946	139 338	19	13.64	1.10	0.59-2.05
Heavy machinery operators	2 822	35 257	7	19.85	1.43	0.63-3.28
Refrigerator technicians	417	5 302	1	18.86	1.45	0.22-9.51
Woodworkers	19 070	241 708	45	18.62	1.48	0.87-2.52
Glaziers	765	9 662	2	20.70	1.59	0.41-6.26
White collar workers	3 567	44 919	10	22.26	1.60	0.75-3.41
Asphalt workers	1 462	18 349	4	21.80	1.68	0.61-4.66
Brick layers	2 271	28 468	6	21.08	1.68	0.70-4.03
Rock workers	1 930	24 226	6	24.77	2.01	0.84-4.84
Concrete workers	7 214	90 231	24	26.60	2.05	1.14-3.70
Drivers	1 017	12 739	4	31.40	2.22	0.80-6.14
Sheet-metal workers	3 529	44 579	13	29.16	2.24	1.13-4.44
Ground preparatory workers	2 815	35 059	11	31.38	2.42	1.18-4.94
Roofers	424	5 274	2	37.92	2.79	0.71-10.96
Floor layers	1 645	20 811	9	43.25	3.37	1.57-7.22

Table S6 – *5-yrExp cohort*: Association between biomechanical exposure scores and relative risk for UNE. Models adjusted for BMI, smoking, age, and time of surgery. N – number workers; IR – incidence rate per 100 000 person-years; RR – relative risk; CI – confidence interval.

Factor	N	person- years	cases	IR	RR	95% CI
<i>Grip Score^a</i>						
Low	18 070	227 065	38	16.74		
High	66 705	842 103	164	19.48	1.16	0.81-1.52
<i>Vibration Score^b</i>						
Unexposed	38 529	484 190	83	17.14		
Exposed	46 246	584 978	119	20.34	1.19	0.91-1.47
<i>Repetitive Flexion & Extension Score^c</i>						
Low	29 943	376 559	81	21.51		
High	54 832	692 609	121	17.47	0.81	0.53-1.09
<i>Static Work & Elbow Leaning Score^d</i>						
Low	25 299	318 342	59	18.53		
High	59 476	750 826	143	19.05	1.03	0.72-1.33

^a. Intensity of hand grip force + Intensity of upper extremity load + frequency of using a hand tool in a fixed posture + frequency of hand tool use

^b. HAV + frequency of impact shocks during HAV

^c. Frequency of repetitive elbow flexion and extension work + Frequency of repetitive wrist flexion and extension work

^d. Frequency of upper extremity static work + Frequency of leaning on the elbow