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## **Risk factors for upper-extremity musculoskeletal disorders in the working population.**

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**Table 1. Potential risk factors for UEMSDs considered in the study and univariate analyses**

		Altogether (n = 3,710)					Men (n = 2,162)			Women (n = 1,548)		
		N <sub>sample</sub>	n <sub>UMSD</sub>	OR	[95%CI]	p <sup>γ</sup>	OR	[95%CI]	p <sup>γ</sup>	OR	[95%CI]	p <sup>γ</sup>
<b>PERSONAL FACTORS</b>												
<b>1. Personal factors and medical history</b>												
Age	< 30 (ref)	875	39	1			1			1		
	30-34;	572	44	1.8	[1.1 - 2.8]		1.8	[1.0 - 3.3]		1.7	[0.9 - 3.4]	
	35-39;	508	61	2.9	[1.9 - 4.4]		2.5	[1.4 - 4.4]		3.6	[1.9 - 6.6]	
	40-44;	561	73	3.2	[2.1 - 4.8]	<b>&lt;0.001</b>	2.9	[1.7 - 5.1]	<b>&lt;0.001</b>	3.5	[1.9 - 6.4]	<b>&lt;0.001</b>
	45-49;	538	109	5.4	[3.7 - 8.0]		4.9	[2.9 - 8.2]		6.4	[3.4 - 10.8]	
	50-54;	451	103	6.3	[4.3 - 9.4]		5.5	[3.2 - 9.2]		7.6	[4.3 - 13.7]	
	55 yrs	198	42	5.8	[3.6 - 9.2]		5.1	[2.7 - 9.6]		6.7	[3.4 - 13.5]	
Gender	<i>Female vs male</i>	1,548	229	1.4	[1.1 - 1.7]	<b>0.001</b>						
Body mass index (Kg/m <sup>2</sup> )	Normal (BMI=18.5-24.9)	2,157	230	1			1			1		
	Underweight (BMI<18.5)	124	8	0.6	[0.3 - 1.2]	<b>&lt;0.001</b>	-	-	<b>&lt;0.001</b>	0.7	[0.3 - 1.4]	<b>0.006</b>
	Overweight (BMI=25-29.9)	1,078	160	1.5	[1.2 - 1.8]		1.6	[1.2 - 2.1]		1.6	[1.1 - 2.2]	
	Obesity (BMI≥30)	300	59	2.1	[1.5 - 2.8]		2.5	[1.7 - 3.9]		1.7	[1.0 - 2.7]	
Prior history of at least one of the UEMSDs	<i>yes vs no</i>	713	226	5.3	[4.3 - 6.5]	<b>&lt;0.001</b>	4.3	[3.2 - 5.8]	<b>&lt;0.001</b>	6.4	[4.7 - 8.6]	<b>&lt;0.001</b>
Diabetes mellitus	<i>yes vs no</i>	61	17	2.7	[1.5 - 4.8]	<b>&lt;0.001</b>	2.0	[0.9 - 4.4]	<b>0.083</b>	4.5	[1.9 - 10.8]	<b>&lt;0.001</b>
Thyroid disorders	<i>yes vs no</i>	135	24	1.5	[1.0 - 2.4]	<b>0.073</b>	0.8	[0.2 - 2.6]	0.693	1.6	[0.9 - 2.6]	<b>0.086</b>
Upper limb inflammatory arthritis	<i>yes vs no</i>	78	20	2.4	[1.5 - 4.1]	<b>&lt;0.001</b>	1.7	[0.8 - 4.0]	<b>0.187</b>	3.0	[1.5 - 6.0]	<b>0.001</b>
<b>OCCUPATIONAL FACTORS</b>												
<b>2. Current occupational category and length of service</b>												
Current occupational category	<i>Managers, professionals, technicians (ref)</i>	1,133	116	1			1			1		
	<i>Low-grade white-collar</i>	986	114	1.1	[0.9 - 1.5]	<b>&lt;0.001</b>	0.9	[0.5 - 1.7]	<b>0.026</b>	1.0	[0.7 - 1.4]	<b>&lt;0.001</b>
	<i>Skilled blue-collar</i>	943	135	1.5	[1.1 - 1.9]		1.5	[1.1 - 2.1]		1.9	[1.1 - 3.3]	
	<i>Unskilled blue-collar</i>	643	107	1.8	[1.3 - 2.3]		1.4	[1.0 - 2.1]		2.0	[1.3 - 3.0]	
Length of service in the current job (year)	<1(ref)	455	36	1			1			1		
	1-2	591	48	1.0	[0.7 - 1.6]	<b>&lt;0.001</b>	1.7	[0.9 - 3.2]	<b>&lt;0.001</b>	0.6	[0.3 - 1.2]	<b>&lt;0.001</b>
	3-10	1,238	127	1.3	[0.9 - 2.0]		1.9	[1.0 - 3.4]		1.0	[0.6 - 1.7]	
	> 10	1,389	257	2.6	[1.8 - 3.8]		3.6	[2.0 - 6.3]		2.0	[1.3 - 3.3]	
<b>3. Factors related to the work organization</b>												
Paced work	<i>yes vs no</i>	383	59	1.3	[1.0 - 1.8]	<b>0.078</b>	1.3	[0.8 - 1.9]	0.242	1.4	[0.9 - 2.1]	<b>0.147</b>
Work pace dependent on automatic rate	<i>yes vs no</i>	400	70	1.5	[1.2 - 2.0]	<b>0.002</b>	1.5	[1.0 - 2.1]	<b>0.043</b>	1.8	[1.2 - 2.7]	<b>0.009</b>
Work pace dependent on other technical organization	<i>yes vs no</i>	742	100	1.1	[0.9 - 1.4]	0.405	1.1	[0.8 - 1.5]	0.511	1.4	[0.9 - 2.1]	<b>0.113</b>
Work pace dependent on customers' demand	<i>yes vs no</i>	1,643	184	0.8	[0.7 - 1.0]	<b>0.025</b>	0.9	[0.7 - 1.1]	0.299	0.7	[0.5 - 0.9]	<b>0.021</b>
Work pace dependent on the colleagues' work	<i>yes vs no</i>	1,109	146	1.1	[0.9 - 1.4]	0.399	1.4	[1.1 - 1.8]	<b>0.022</b>	0.9	[0.6 - 1.2]	0.353
Work pace dependent on quantified targets	<i>yes vs no</i>	1,729	241	1.2	[1.0 - 1.5]	<b>0.030</b>	1.1	[0.8 - 1.4]	0.506	1.6	[1.2 - 2.1]	<b>0.002</b>
Job/task rotation (≥ 1 job rotation per week)	<i>yes vs no</i>	1,350	199	1.3	[1.1 - 1.6]	<b>0.004</b>	1.4	[1.1 - 1.9]	<b>0.013</b>	1.3	[1.0 - 1.7]	<b>0.086</b>
Work with temporary workers	<i>yes vs no</i>	1,106	165	1.3	[1.1 - 1.6]	<b>0.010</b>	1.3	[1.0 - 1.7]	<b>0.105</b>	1.4	[1.0 - 1.8]	<b>0.042</b>
High visual demand	<i>yes vs no</i>	2,380	331	1.4	[1.1 - 1.7]	<b>0.005</b>	1.2	[0.9 - 1.6]	0.201	1.5	[1.1 - 2.1]	<b>0.008</b>
Overtime hours	<i>yes vs no</i>	2,186	260	0.8	[0.7 - 1.0]	<b>0.055</b>	0.9	[0.7 - 1.2]	0.647	0.8	[0.6 - 1.0]	<b>0.075</b>
Prior knowledge of the workload	<i>yes vs no</i>	366	43	0.9	[0.6 - 1.3]	0.546	1.2	[0.8 - 1.7]	0.469	0.6	[0.3 - 1.2]	<b>0.140</b>
<b>4. Working postures and biomechanical constraints</b>												
High repetitiveness (≥ 4 h per day) <sup>#</sup>	<i>yes vs no</i>	958	183	2.0	[1.6 - 2.5]	<b>&lt;0.001</b>	1.8	[1.4 - 2.5]	<b>&lt;0.001</b>	2.1	[1.6 - 2.8]	<b>&lt;0.001</b>
Too little recovery time (< 10-min. break possible) <sup>#</sup>	<i>yes vs no</i>	205	50	2.4	[1.7 - 3.3]	<b>&lt;0.001</b>	1.9	[1.1 - 3.3]	<b>0.020</b>	2.5	[1.6 - 3.9]	<b>&lt;0.001</b>
High physical demand (RPE Borg scale ≥13)	<i>yes vs no</i>	1,856	309	2.1	[1.7 - 2.6]	<b>&lt;0.001</b>	2.5	[1.8 - 3.3]	<b>&lt;0.001</b>	1.9	[1.5 - 2.6]	<b>&lt;0.001</b>
Arms at or above shoulder level (≥ 2 h/day) <sup>#</sup>	<i>yes vs no</i>	487	104	2.1	[1.7 - 2.7]	<b>&lt;0.001</b>	2.6	[1.9 - 3.6]	<b>&lt;0.001</b>	1.6	[1.1 - 2.4]	<b>0.013</b>
Arms abducted (≥ 2 h/day) <sup>#</sup>	<i>yes vs no</i>	572	108	1.8	[1.4 - 2.2]	<b>&lt;0.001</b>	1.8	[1.3 - 2.4]	<b>&lt;0.001</b>	1.9	[1.3 - 2.7]	<b>&lt;0.001</b>
Holding the hand behind the trunk (≥ 2 h/day)	<i>yes vs no</i>	187	29	1.3	[0.8 - 1.9]	0.242	1.6	[0.9 - 2.7]	<b>0.084</b>	1.0	[0.5 - 1.8]	0.902
Full elbow flexion/extension movements (≥ 2 h/day) <sup>#</sup>	<i>yes vs no</i>	1,214	221	2.0	[1.6 - 2.4]	<b>&lt;0.001</b>	2.4	[1.8 - 3.1]	<b>&lt;0.001</b>	1.7	[1.2 - 2.2]	<b>&lt;0.001</b>
Working with full pronosupination movements (≥ 2 h/day) <sup>#</sup>	<i>yes vs no</i>	534	86	1.4	[1.1 - 1.8]	<b>0.011</b>	1.4	[1.0 - 1.9]	<b>0.027</b>	2.1	[1.3 - 3.4]	<b>0.004</b>
Wrist bending in extreme postures (≥ 2 h/day) <sup>#</sup>	<i>yes vs no</i>	1,236	222	2.0	[1.6 - 2.4]	<b>&lt;0.001</b>	1.8	[1.4 - 2.4]	<b>&lt;0.001</b>	2.2	[1.6 - 2.9]	<b>&lt;0.001</b>
Use of handtools (≥ 2 h/day)	<i>yes vs no</i>	1,711	251	1.4	[1.2 - 1.7]	<b>&lt;0.001</b>	1.3	[1.0 - 1.7]	<b>0.074</b>	1.8	[1.4 - 2.4]	<b>&lt;0.001</b>
Holding tools or objects in a pinch grip (≥ 4 h/day) <sup>#</sup>	<i>yes vs no</i>	297	66	2.1	[1.6 - 2.8]	<b>&lt;0.001</b>	2.1	[1.4 - 3.1]	<b>&lt;0.001</b>	2.1	[1.4 - 3.2]	<b>&lt;0.001</b>
Precise finger movements (≥ 2 h/day)	<i>yes vs no</i>	1,665	263	1.6	[1.4 - 2.0]	<b>&lt;0.001</b>	1.5	[1.1 - 1.9]	<b>0.004</b>	1.9	[1.4 - 2.5]	<b>&lt;0.001</b>
Pressing with the base of the palm (≥ 2 h/day) <sup>#</sup>	<i>yes vs no</i>	294	59	1.8	[1.4 - 2.5]	<b>&lt;0.001</b>	1.9	[1.3 - 2.7]	<b>&lt;0.001</b>	2.4	[1.3 - 4.4]	<b>0.004</b>
Use of vibrating handtools (≥ 2 h/day) <sup>#</sup>	<i>yes vs no</i>	469	73	1.3	[1.0 - 1.7]	<b>0.046</b>	1.3	[1.0 - 1.8]	<b>0.098</b>	2.5	[1.4 - 4.4]	<b>0.002</b>
Exposure to cold temperature (≥ 4 h/day) <sup>#</sup>	<i>yes vs no</i>	220	34	1.3	[0.9 - 1.9]	0.205	1.2	[0.7 - 1.9]	0.529	1.6	[0.9 - 2.8]	<b>0.127</b>
Keying and computer work (≥ 4 h/day) <sup>#</sup>	<i>yes vs no</i>	1,024	96	0.6	[0.5 - 0.8]	<b>&lt;0.001</b>	0.6	[0.4 - 0.9]	<b>0.022</b>	0.5	[0.4 - 0.7]	<b>&lt;0.001</b>
Wearing gloves (≥ 4 h/day)	<i>yes vs no</i>	584	95	1.4	[1.1 - 1.8]	<b>0.005</b>	1.3	[1.0 - 1.8]	<b>0.089</b>	1.7	[1.2 - 2.5]	<b>0.006</b>
<b>5. Psychosocial factors at work</b>												
High psychological demand (score ≥ 22) <sup>#</sup>	<i>yes vs no</i>	1,814	250	1.2	[1.0 - 1.5]	<b>0.050</b>	1.4	[1.1 - 1.9]	<b>0.009</b>	1.0	[0.8 - 1.3]	0.968
Low skill discretion (score ≤ 34)	<i>yes vs no</i>	2,016	297	1.5	[1.2 - 1.8]	<b>&lt;0.001</b>	1.4	[1.1 - 1.8]	<b>0.013</b>	1.5	[1.1 - 2.1]	<b>0.006</b>
Low decision authority (score ≤ 32) <sup>#</sup>	<i>yes vs no</i>	1,276	185	1.3	[1.1 - 1.6]	<b>0.014</b>	0.9	[0.7 - 1.3]	0.711	1.6	[1.2 - 2.2]	<b>&lt;0.001</b>
Low supervisor support (score ≤ 11)	<i>yes vs no</i>	1,427	216	1.4	[1.2 - 1.8]	<b>&lt;0.001</b>	1.4	[1.1 - 1.9]	<b>0.009</b>	1.5	[1.1 - 2.0]	<b>0.007</b>
Low coworker support (score ≤ 11)	<i>yes vs no</i>	708	111	1.4	[1.1 - 1.7]	<b>0.007</b>	1.4	[1.0 - 1.9]	<b>0.039</b>	1.3	[1.0 - 1.9]	<b>0.088</b>

See references <sup>(10,13)</sup> for details; <sup>γ</sup>In bold, p-value<0.20. <sup>#</sup> Risk factors taken into account by the European consensus.

**Table 2. Characteristics of workers participating in the French Pays de la Loire study**

	MEN		WOMEN		ALTOGETHER	
	N	(%)	N	(%)	N	(%)
Study population	2,162	(58.3)	1,548	(41.7)	3,710	(100)
Age (years) (n = 3,703)						
. < 30	514	(23.8)	361	(23.3)	875	(23.6)
. 30-35	344	(16.0)	228	(14.8)	572	(15.5)
. 35-39	307	(14.2)	201	(13.0)	508	(13.7)
. 40-44	311	(14.4)	250	(16.2)	561	(15.2)
. 45-49	301	(14.0)	237	(15.3)	538	(14.5)
. 50-54	265	(12.3)	186	(12.0)	451	(12.2)
. ≥ 55	114	(5.3)	84	(5.4)	198	(5.3)
Economic sector (n = 3,701)						
. Agriculture	31	(1.4)	25	(1.6)	56	(1.5)
. Industry	859	(39.8)	401	(26.0)	1,260	(34.0)
. Construction	189	(8.8)	25	(1.6)	214	(5.8)
. Services	1,078	(50.0)	1,093	(70.8)	2,171	(58.7)
Occupation (n = 3,705)						
. Farmers (1)	0	(0.0)	0	(0.0)	0	(0.0)
. Craftsmen (1)	13	(0.6)	3	(0.2)	16	(0.4)
. Managers and professionals	210	(9.7)	78	(5.0)	288	(7.8)
. Associate professionals and technicians	540	(25.0)	289	(18.7)	829	(22.4)
. Low-grade white-collar workers	188	(8.7)	798	(51.7)	986	(26.6)
. Skilled and unskilled blue-collar workers	1,209	(56.0)	377	(24.4)	1,586	(42.8)

(1) Farmers and most craftsmen are not surveyed by the occupational physicians in France.

**Table 3. Prevalence rates of clinically-diagnosed UE-MSDs of the upper extremities**

	MEN			WOMEN			ALTOGETHER		
	N	%	95% CI	N	%	95% CI	N	%	95% CI
Rotator cuff syndrome	142	6.6	[5.5 - 7.6]	132	8.5	[7.1 - 9.9]	274	7.4	[6.5 - 8.2]
Lateral epicondylitis	51	2.5	[1.8 - 3.1]	39	2.7	[1.9 - 3.5]	90	2.6	[2.0 - 3.1]
Ulnar tunnel syndrome	16	0.7	[0.4 - 1.1]	14	0.9	[0.4 - 1.4]	30	0.8	[0.5 - 1.1]
Carpal tunnel syndrome	51	2.4	[1.7 - 3.0]	62	4.0	[3.0 - 5.0]	113	3.1	[2.5 - 3.6]
Wrist tendinitis	19	0.9	[0.5 - 1.3]	10	0.7	[0.3 - 1.1]	29	0.8	[0.5 - 1.1]
De Quervain's Disease	13	0.6	[0.3 - 0.9]	32	2.1	[1.4 - 2.8]	45	1.2	[0.9 - 1.6]
At least one UEMSD	243	11.2	[9.9 - 12.6]	229	14.8	[13.0 - 16.6]	472	12.7	[11.7 - 13.8]
At least two UEMSDs	42	1.9	[1.4 - 2.5]	44	2.8	[2.0 - 3.7]	86	2.3	[1.8 - 2.8]

Table 4. Multivariate models for risk factors of UE-MSDs in the male and female working populations

	Men (n = 2,058)					Women (n = 1,481)				
	N <sub>sample</sub> *	n <sub>MSD</sub> *	OR	[95%CI]	p	N <sub>sample</sub> *	n <sub>MSD</sub> *	OR	[95%CI]	p
<b>PERSONAL FACTORS</b>										
<b>Age (years)</b>					<0.001					<0.001
< 30	499	22	1			349	17	1		
30-34	333	26	1.8	[1.0 - 3.3]		221	18	1.8	[0.9 - 3.6]	
35-39	291	28	2.4	[1.3 - 4.4]		189	26	2.8	[1.4 - 5.5]	
40-44	296	32	2.4	[1.3 - 4.4]		242	37	3.0	[1.6 - 5.7]	
45-49	284	50	4.5	[2.6 - 7.9]		224	51	4.5	[2.4 - 8.2]	
50-54	250	49	4.9	[2.7 - 8.6]		177	48	5.0	[2.7 - 9.3]	
≥ 55	105	20	4.0	[2.0 - 8.1]		79	20	4.4	[2.1 - 9.4]	
<b>Prior history of UE-MSDs</b>	357	93	3.1	[2.3 - 4.2]	<0.001	321	120	5.0	[3.6 - 7.0]	<0.001
<b>BMI (Kg/m<sup>2</sup>)</b>					0.014					
Normal (BMI = 18.5 – 24.9)	1,130	98	1							
Underweight (BMI <18.5)	33	0	-	-						
Overweight (BMI = 25 – 29.9)	731	97	1.2	[0.9 - 1.7]						
Obesity (BMI ≥ 30)	164	32	2.2	[1.4 - 3.6]						
<b>Diabetes mellitus</b>						20	9	4.9	[1.8 - 12.9]	0.001
<b>OCCUPATIONAL FACTORS</b>										
<b>High physical demand (RPE-Borg scale ≥ 13)</b>	1,106	166	2.0	[1.4 - 2.8]	<0.001					
<b>High repetitiveness</b>	446	74	1.5	[1.0 - 2.1]	0.027					
<b>Arms at or above shoulder level</b>	283	61	1.7	[1.1 - 2.4]	0.009					
<b>Full elbow flexion/extension movements</b>	690	115	1.6	[1.1 - 2.2]	0.006					
<b>Wrist bending in extreme postures</b>						466	104	2.0	[1.4 - 2.8]	<0.001
<b>Use of vibrating handtools</b>						61	17	2.2	[1.1 - 4.2]	0.025
<b>High psychological demand</b>	1,006	129	1.5	[1.1 - 2.1]	0.005					
<b>Low level of decision authority</b>						600	112	1.4	[1.0 - 1.9]	0.042

Note. (\*) Subjects with no missing value for the risk factors in the multivariate model; Number of subjects excluded from analyses because of missing values: 129 men and 112 women; OR, odds ratio; CI, confidence interval; Variables excluded from the model for men (in order of exclusion): current occupational category, work with temporary workers, work pace dependent on the colleagues' work, frequent job/task rotation, low level of skill discretion, low supervisor support; Variables excluded from the model for women: work pace dependent on demand of customers, arms abducted, high visual demand, frequent job/task rotation, current occupational category, work pace dependent on quantified targets, work with temporary workers, length of service in the current job, keying and computer work, low supervisor support, knowledge of the workload, high repetitiveness; Hosmer Lemeshow goodness-of-fit test:  $P = 0.016$  for the model for men and  $P = 0.319$  for the model for women; area under ROC curve = 0.78 (men) and 0.78 (women).

Table 5. Multivariate model for risk factors of UE-MSDs in the total working population

	Men and women altogether				
	(n = 3,275)				
	N <sub>sample</sub> *	n <sub>MSD</sub> *	OR	[95% CI]	p
<b>PERSONAL FACTORS</b>					
<b>Age (years)</b>					<b>&lt;0.001</b>
< 30	792	36	1		
30-34	520	41	1.8	[1.1 - 3.0]	
35-39	439	47	2.6	[1.6 - 4.2]	
40-44	496	63	2.9	[1.9 - 4.5]	
45-49	459	92	4.9	[3.2 - 7.5]	
50-54	401	92	5.6	[3.6 - 8.6]	
≥ 55	168	36	4.5	[2.6 - 7.7]	
<b>Prior history of MSDs</b>	621	188	3.3	[2.6 - 4.2]	<b>&lt;0.001</b>
<b>BMI (Kg/m<sup>2</sup>)</b>					0.056
Normal (BMI = [18.5 - 25])	1,926	205	1		
Underweight (BMI <18.5)	109	7	0.9	[0.4 - 2.0]	
Overweight (BMI = [25 - 30])	975	143	1.2	[0.9 - 1.5]	
Obesity (BMI ≥ 30)	265	52	1.6	[1.1 - 2.4]	
<b>OCCUPATIONAL FACTORS</b>					
<b>High repetitiveness</b>	858	165	1.6	[1.2 - 2.0]	<b>&lt;0.001</b>
<b>Arms at or above shoulder level</b>	430	93	1.5	[1.1 - 2.0]	<b>0.016</b>
<b>Wrist bending in extreme postures</b>	1,107	198	1.5	[1.2 - 2.0]	<b>0.002</b>
<b>Pressing with the base of the palm</b>	260	52	1.5	[1.0 - 2.1]	0.058 <sup>δ</sup>
<b>Frequent job rotation</b>	1,265	180	1.2	[1.0 - 1.5]	0.079 <sup>δ</sup>
<b>Low supervisor support</b>	1,312	198	1.3	[1.1 - 1.7]	<b>0.015</b>
<b>Interaction terms : Gender x Physical demand</b>					0.037 <sup>#</sup>
Women vs men in low physical demand			1.9	[1.3 - 2.8]	
Women vs men in high physical demand			1.2	[0.9 - 1.6]	
High vs low physical demand in males			1.8	[1.3 - 2.6]	
High vs low physical demand in females			1.1	[0.8 - 1.6]	

Note. (\*), subjects with no missing value for the risk factors in the multivariate model; Number of subjects excluded from analyses because of missing values: 435; OR., odds ratio; CI., confidence interval; Variables excluded from the model (in order of elimination): high visual demand, work pace dependent on quantified targets, work pace dependent on customers' demand, current occupational category, full elbow flexion, high psychological demand, work with temporary workers, diabetes mellitus, low level of skill discretion; Hosmer Lemeshow goodness-of-fit test:  $P = 0.243$ ; area under ROC curve = 0.78;  $\delta$ ,  $P > 0.05$ ; #, P-value for multiplicative interaction.