

## Appendix 1

<b>Physical JEM Questions (translated from Swedish)</b>		<b>Response options</b>
Heavy lifting (at least 15kg)	Do you have to lift at least 15 kg at a time several times a day?	a. Every day b. A couple of days per week c. One day per week d. A few days per month e. Not at all / rarely  a. Almost all the time b. About ¾ of the time c. Half the time d. About ¼ of the time e. About 1/10 of the time f. No not at all
Physically strenuous work	Does your work sometimes involve physically strenuous work, i.e. that you strain your body more than when you are walking and standing and moving in a usual way?	
Fast breathing	Are you exerting yourself in a way that makes you breathe faster?	
Forward bent position	Are you sometimes working in forward bent positions, while not using support from your hands or arms?	
Twisted position	Are you sometimes working in twisted positions?	
Hands above shoulder level	Are you sometimes working with your hands at shoulder height or above?	
Repetitive work	Does your work sometimes require that you merely repeat the same work movements, at least twice per minute?	
Frequent bending or twisting	In your work, do you bend or twist in the same way many times per hour and for several hours during the same day?	
<b>Psychosocial JEM questions</b>	<b>Response options</b>	
Decision Authority	Can you partially decide for yourself when different tasks are to be done?	a. Always b. Mostly c. Mostly not d. Never
	Do you have the opportunity to decide your own work rate?	
	Can you take short breaks almost at any time to talk?	
	Does it happen that you are involved and decide on the structure of your work?	

**Appendix 2.** Prevalence of covariates in different levels of physical workload measured by the JEM index score for the sample used to create quartiles of work-related exposures based on the JEMs\*

		Male workers										Female workers									
		Low n= 2087		Medium-low n=2063		Medium-high n=2068		High n= 2164		Total n= 8382		Low n=2313		Medium-low n= 2215		Medium- high n=2183		High n=2141		Total n= 8852	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<b>Age</b>	18–29	99	4,7	166	8,0	284	13,7	386	18,0	<b>935</b>	<b>11,2</b>	155	6,7	204	9,2	334	15,3	510	24,0	<b>1203</b>	<b>13,6</b>
	30–39	630	30,2	624	30,2	497	24,0	498	23,2	<b>2249</b>	<b>26,9</b>	627	27,1	611	27,6	526	24,1	485	22,8	<b>2249</b>	<b>25,5</b>
	40–49	573	27,5	553	26,8	561	27,1	577	26,8	<b>2264</b>	<b>27,1</b>	714	30,9	562	25,4	563	25,8	524	24,7	<b>2363</b>	<b>26,8</b>
	50–59	535	25,6	491	23,8	489	23,6	497	23,1	<b>2012</b>	<b>24,0</b>	569	24,6	589	26,7	564	25,8	452	21,3	<b>2174</b>	<b>24,6</b>
	60+	250	12,0	229	11,1	237	11,5	192	8,9	<b>908</b>	<b>10,9</b>	248	10,7	244	11,0	196	9,0	153	7,2	<b>841</b>	<b>9,5</b>
<b>Completed Education</b>	Primary (1,9years)	48	2,4	124	6,2	313	15,4	525	25,1	<b>1010</b>	<b>12,4</b>	75	3,3	173	8,0	178	8,3	417	20,1	<b>843</b>	<b>9,7</b>
	Secondary (12years)	415	20,4	800	39,7	1019	50,1	1322	63,3	<b>3556</b>	<b>43,5</b>	528	23,5	922	42,4	827	38,5	1316	63,5	<b>3593</b>	<b>41,5</b>
	Tertiary (12+ years)	1576	77,3	1091	54,1	702	34,5	243	11,6	<b>3612</b>	<b>44,2</b>	1647	73,2	1081	49,7	1145	53,3	340	16,4	<b>4213</b>	<b>48,7</b>
<b>Long term health condition</b>	No	1654	79,6	1573	76,8	1555	75,9	1594	74,9	<b>6376</b>	<b>76,8</b>	1766	77,0	1701	77,7	1632	75,7	1587	75,8	<b>6686</b>	<b>76,6</b>
	Yes	423	20,4	475	23,2	493	24,1	533	25,1	<b>1924</b>	<b>23,2</b>	527	23,0	489	22,3	524	24,3	508	24,2	<b>2048</b>	<b>23,4</b>
<b>Psychological distress (GHQ12 &gt; 3)</b>	No	1762	85,0	1777	87,1	1756	85,7	1852	87,2	<b>7147</b>	<b>86,2</b>	1835	80,1	1795	82,0	1711	79,1	1653	78,5	<b>6994</b>	<b>79,9</b>
	Yes	311	15,0	264	12,9	293	14,3	273	12,8	<b>1141</b>	<b>13,8</b>	457	19,9	393	18,0	452	20,9	452	21,5	<b>1754</b>	<b>20,1</b>
<b>Smoking</b>	No	1961	94,1	1894	92,3	1788	87,1	1697	79,3	<b>7340</b>	<b>88,1</b>	2077	90,1	1909	86,9	1826	84,1	1602	76,4	<b>7414</b>	<b>84,5</b>
	Yes	122	5,9	158	7,7	265	12,9	444	20,7	<b>989</b>	<b>11,9</b>	228	9,9	287	13,1	346	15,9	496	23,6	<b>1357</b>	<b>15,5</b>
<b>Leisure-time physical activity</b>	Sedentary	152	7,3	176	8,6	235	11,5	391	18,4	<b>954</b>	<b>11,5</b>	157	6,8	177	8,1	186	8,6	323	15,3	<b>843</b>	<b>9,6</b>
	Moderate	1469	70,6	1441	70,2	1356	66,1	1382	65,1	<b>5648</b>	<b>68,0</b>	1730	75,2	1620	73,7	1584	73,1	1483	70,4	<b>6417</b>	<b>73,1</b>
	Regular	460	22,1	436	21,2	461	22,5	349	16,4	<b>1706</b>	<b>20,5</b>	414	18,0	401	18,2	398	18,4	300	14,2	<b>1513</b>	<b>17,2</b>
<b>BMI</b>	Underweight/ normal	730	35,2	700	34,2	615	30,1	620	29,4	<b>2665</b>	<b>32,2</b>	1408	61,7	1273	58,7	1205	56,4	1120	54,1	<b>5006</b>	<b>57,8</b>
	Overweight	1176	56,8	1147	56,1	1193	58,5	1225	58,1	<b>4741</b>	<b>57,4</b>	702	30,8	747	34,4	736	34,5	739	35,7	<b>2924</b>	<b>33,8</b>
	Obese	165	8,0	198	9,7	232	11,4	264	12,5	<b>859</b>	<b>10,4</b>	172	7,5	150	6,9	195	9,1	213	10,3	<b>730</b>	<b>8,4</b>
<b>Decision Authority</b>	High	2002	95,9	1580	77,3	512	24,8	163	7,6	<b>4257</b>	<b>51,0</b>	2202	95,2	1410	63,8	447	20,5	284	13,4	<b>4343</b>	<b>49,2</b>
	Low	85	4,1	464	22,7	1556	75,2	1987	92,4	<b>4092</b>	<b>49,0</b>	111	4,8	800	36,2	1736	79,5	1840	86,6	<b>4487</b>	<b>50,8</b>

\*the number of cases shown for each covariate differs due to missing values

**Appendix 3 .** The association between heavy physical workload and risk of frequent musculoskeletal pain among baseline pain-free workers. Crude (OR) and adjusted odds-ratios (AOR) with 95% confidence intervals (CI,95%)

		Pain-free workers - Men n=1430				Pain-free workers - Women n=1080			
		Low	Medium-low	Medium-high	High	Low	Medium-low	Medium-high	High
<b>Physical load index</b>	<i>Cases frequent pain/n</i>	32/477	17/383	19/338	14/232	25/324	20/308	17/290	17/158
	OR (95 CI)	1	0.67 (0.36, 1.22)	0.90 (0.50, 1.62)	1.02 (0.53, 1.96)	1	0.85 (0.46, 1.57)	0.77 (0.40, 1.45)	1.54 (0.80, 2.97)
	AOR <sup>a</sup> (95% CI)	1	0.76 (0.42, 1.39)	0.91 (0.43, 1.91)	1.03 (0.42, 2.52)	1	0.73 (0.37, 1.43)	0.56 (0.24, 1.27)	0.92 (0.38, 2.25)
	AOR <sup>b</sup> (95% CI)	1	0.66 (0.35, 1.23)	0.84 (0.39, 1.84)	0.93 (0.35, 2.47)	1	0.59 (0.30, 1.17)	0.42 (0.17, 0.99)	0.59 (0.22, 1.56)
<b>Heavy lifting (at least 15kg)</b>	<i>Cases frequent pain/n</i>	27/453	21/387	23/354	11/236	22/302	18/285	14/274	25/219
	OR (95 CI)	1	0.90 (0.50, 1.62)	1.18 (0.66, 2.09)	0.87 (0.42, 1.80)	1	0.88 (0.46, 1.69)	0.72 (0.36, 1.43)	1.69 (0.92, 3.09)
	AOR <sup>a</sup> (95% CI)	1	0.90 (0.50, 1.63)	1.10 (0.58, 2.09)	0.77 (0.32, 1.86)	1	0.87 (0.45, 1.67)	0.71 (0.34, 1.51)	1.53 (0.68, 3.49)
	AOR <sup>b</sup> (95% CI)	1	0.85 (0.46, 1.57)	1.08 (0.55, 2.12)	0.73 (1.28, 1.86)	1	0.80 (0.41, 1.55)	0.62 (0.29, 1.32)	1.34 (0.59, 3.08)
<b>Physically strenuous work</b>	<i>Cases frequent pain/n</i>	27/455	23/420	19/321	15/234	26/321	13/286	24/316	16/157
	OR (95 CI)	1	0.86 (0.48, 1.54)	1.10 (0.60, 2.00)	1.17 (0.60, 2.29)	1	0.55 (0.28, 1.09)	0.95 (0.53, 1.70)	1.37 (0.70, 2.64)
	AOR <sup>a</sup> (95% CI)	1	0.86 (0.48, 1.54)	1.22 (0.57, 2.61)	1.23 (0.54, 2.82)	1	0.54 (0.26, 1.11)	0.78 (0.38, 1.61)	1.06 (0.44, 2.33)
	AOR <sup>b</sup> (95% CI)	1	0.84 (0.46, 1.54)	1.23 (0.56, 2.67)	1.24 (0.51, 3.06)	1	0.55 (0.27, 1.13)	0.78 (0.38, 1.59)	0.89 (0.38, 2.07)
<b>Fast breathing</b>	<i>Cases frequent pain/n</i>	25/455	23/420	19/321	15/234	25/309	18/295	19/303	17/173
	OR (95 CI)	1	1.01 (0.56, 1.81)	1.16 (0.63, 2.15)	1.33 (0.68, 2.60)	1	0.75 (0.40, 1.40)	0.78 (0.42, 1.45)	1.30 (0.68, 2.49)
	AOR <sup>a</sup> (95% CI)	1	0.99 (0.55, 1.80)	1.32 (0.64, 2.72)	1.48 (0.66, 3.85)	1	0.77 (0.40, 1.47)	0.64 (0.31, 1.30)	0.93 (0.43, 2.00)
	AOR <sup>b</sup> (95% CI)	1	1.02 (0.56, 1.86)	1.23 (0.58, 2.63)	1.49 (0.61, 3.61)	1	0.83 (0.43, 1.58)	0.61 (0.30, 1.26)	0.84 (0.38, 1.82)
<b>Forward bent position</b>	<i>Cases frequent pain/n</i>	27/452	23/433	22/326	10/219	25/288	20/315	11/298	23/179
	OR (95 CI)	1	0.90 (0.51, 1.60)	1.21 (0.67, 2.17)	0.88 (0.41, 1.85)	1	0.74 (0.40, 1.36)	0.41 (0.20, 0.85)	1.63 (0.89, 2.98)
	AOR <sup>a</sup> (95% CI)	1	0.93 (0.52, 1.65)	1.27 (0.57, 2.82)	0.87 (0.32, 2.31)	1	0.67 (0.36, 1.26)	0.27 (0.11, 0.67)	0.95 (0.40, 2.24)
	AOR <sup>b</sup> (95% CI)	1	0.88 (0.48, 1.60)	1.22 (0.53, 2.80)	0.82 (0.29, 2.33)	1	0.59 (0.31, 1.12)	0.27 (0.11, 0.67)	0.85 (0.36, 2.03)
<b>Twisted position</b>	<i>Cases frequent pain/n</i>	25/468	23/400	20/324	14/238	25/311	18/302	18/275	18/192
	OR (95 CI)	1	1.10 (0.62, 1.98)	1.26 (0.69, 2.31)	1.23 (0.62, 2.44)	1	0.73 (0.39, 1.36)	0.82 (0.44, 1.55)	1.32 (0.64, 2.30)
	AOR <sup>a</sup> (95% CI)	1	1.26 (0.70, 2.27)	1.50 (0.69, 3.26)	1.45 (0.62, 3.40)	1	0.63 (0.32, 1.23)	0.55 (0.23, 1.35)	0.74 (0.29, 1.88)
	AOR <sup>b</sup> (95% CI)	1	1.14 (0.62, 2.10)	1.42 (0.64, 3.21)	1.42 (0.57, 3.57)	1	0.52 (0.26, 1.04)	0.39 (0.15, 1.01)	0.52 (0.19, 1.39)
<b>Hands above shoulder level</b>	<i>Cases frequent pain/n</i>	29/458	20/407	14/324	19/241	24/307	20/294	18/301	17/178
	OR (95 CI)	1	0.80 (0.44, 1.43)	0.72 (0.38, 1.40)	1.45 (0.79, 2.67)	1	0.87 (0.47, 1.62)	0.77 (0.41, 1.44)	1.32 (0.68, 2.54)
	AOR <sup>a</sup> (95% CI)	1	0.89 (0.49, 1.61)	0.86 (0.40, 1.89)	1.61 (0.73, 3.57)	1	0.80 (0.41, 1.56)	0.47 (0.19, 1.14)	0.73 (0.30, 1.79)
	AOR <sup>b</sup> (95% CI)	1	0.83 (0.45, 1.52)	0.75 (0.33, 1.70)	1.52 (0.64, 3.62)	1	0.73 (0.37, 1.42)	0.51 (0.21, 1.23)	0.63 (0.25, 1.60)
<b>Repetitive work</b>	<i>Cases frequent pain/n</i>	22/452	24/367	23/367	13/244	20/330	27/259	18/285	14/206
	OR (95 CI)	1	1.44 (0.79, 2.61)	1.37 (0.75, 2.50)	1.28 (0.63, 2.61)	1	1.83 (1.00, 3.36)	1.07 (0.55, 2.07)	1.19 (0.59, 2.43)
	AOR <sup>a</sup> (95% CI)	1	1.41 (0.78, 2.57)	1.43 (0.77, 2.63)	1.25 (0.57, 2.75)	1	1.86 (1.00, 3.50)	1.25 (0.61, 2.38)	0.76 (0.45, 1.38)
	AOR <sup>b</sup> (95% CI)	1	1.35 (0.73, 2.49)	1.34 (0.71, 2.52)	1.21 (0.53, 2.76)	1	1.46 (0.77, 2.79)	0.91 (0.43, 1.94)	0.75 (0.34, 1.65)

Frequent bending or twisting	Cases frequent pain/n	25/450	20/384	24/369	13/227	25/322	17/316	21/276	16/166
	OR (95% CI)	1	0.95 (0.52, 1.73)	1.26 (0.71, 2.25)	1.19 (0.59, 2.39)	1	0.69 (0.36, 1.31)	1.02 (0.55, 1.87)	1.36 (0.70, 2.64)
	AOR <sup>a</sup> (95% CI)	1	1.06 (0.58, 1.92)	1.30 (0.69, 2.46)	1.29 (0.55, 2.98)	1	0.59 (0.29, 1.20)	0.91 (0.47, 1.76)	0.93 (0.41, 2.10)
	AOR <sup>b</sup> (95% CI)	1	0.95 (0.52, 1.76)	1.30 (0.67, 2.51)	1.30 (0.52, 3.16)	1	0.53 (0.26, 1.08)	0.54 (0.26, 1.16)	0.54 (0.21, 1.37)
Crude analysis adjusted for age									
AOR <sup>a</sup> adjusted for age, long term health condition, psychological distress, smoking, BMI, leisure-time physical activity and decision authority									
AOR <sup>b</sup> adjusted for age, completed education, long term health condition, psychological distress, smoking, BMI, leisure-time physical activity and decision authority									

**Appendix 4 .** The association between overall heavy physical workload and risk of frequent musculoskeletal pain among workers that did not change exposure throughout the follow-up period. Crude (OR) and adjusted odds-ratios (AOR) with 95% confidence intervals (CI,95%)

		Male workers with occasional pain n=1962 (25% excluded from main sample, n = 727)				Female workers with occasional pain n=2394 (15% excluded from main sample, n = 430)			
		Low	Medium-low	Medium-high	High	Low	Medium-low	Medium-high	High
Physical load index	Cases frequent pain/n	67/558	57/479	59/432	75/493	108/796	74/528	103/545	113/525
	OR (95% CI)	1	1.03 (0.70, 1.50)	1.29 (0.88,1.88)	1.42 (1.00,2.04)	1	1.05 (0.76,1.44)	1.52(1.13,2.04)	1.80(1.34,2.42)
	AOR <sup>a</sup> (95% CI)	1	0.99 (0.68, 1.46)	1.16 (0.71, 1.90)	1.36 (0.82,2.26)	1	1.14 (0.84,1.53)	1.38 (0.95,2.01)	1.58 (1.08,2.30)
	AOR <sup>b</sup> (95% CI)	1	0.94 (0.63,1.41)	1.05 (0.63,1.77)	1.18 (0.68,2.05)		1.12 (0.82,1.51)	1.36 (0.92,1.99)	1.52 (1.01,2.27)
Crude analysis adjusted for age									
AOR <sup>a</sup> adjusted for age, long term health condition, psychological distress, smoking, BMI, leisure-time physical activity and decision authority									
AOR <sup>b</sup> adjusted for age, completed education, long term health condition, psychological distress, smoking, BMI, leisure-time physical activity and decision authority									