

Appendix 1

Physical JEM Questions (translated from Swedish)		Response options
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
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?	
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?	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
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?	
Psychosocial JEM questions (translated from Swedish)		Response options
Decision Authority	Can you partially decide when tasks should be done?	a. Always b. Mostly c. Mostly not d. Never
	Do you have the opportunity to decide your own work pace?	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
	Can you take short breaks to talk pretty much any time?	
	Are you ever involved in deciding how your work is organised?	a. Always b. Mostly c. Mostly not d. Never

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

*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
Physical load index	<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 ^a (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 ^b (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)
Heavy lifting (at least 15kg)	<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 ^a (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 ^b (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)
Physically strenuous work	<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 ^a (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 ^b (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)
Fast breathing	<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 ^a (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 ^b (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)
Forward bent position	<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 ^a (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 ^b (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)
Twisted position	<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 ^a (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 ^b (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)
Hands above shoulder level	<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 ^a (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 ^b (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)
Repetitive work	<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 ^a (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 ^b (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 ^a (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 ^b (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^a adjusted for age, long term health condition, psychological distress, smoking, BMI, leisure-time physical activity and decision authority
AOR^b 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 ^a (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 ^b (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^a adjusted for age, long term health condition, psychological distress, smoking, BMI, leisure-time physical activity and decision authority
AOR^b adjusted for age, completed education, long term health condition, psychological distress, smoking, BMI, leisure-time physical activity and decision authority