

**Airborne occupational exposures and the risk of developing respiratory symptoms and airway obstruction in the Lifelines Cohort study**

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**Online supplementary material**

### **Appendix 1: Conversion of ISCO-08 into ISCO-88.**

To be able to use the ALOHA+ JEM to estimate the level of occupational exposure, we converted the ISCO-08 codes into ISCO-88 codes. For this conversion, we used the conversion table provided by the International Labour Organization and the conversion SPSS-syntax provided by Ganzeboom and Treiman. For ISCO-08 codes that could be converted into multiple ISCO-88 codes, we selected the ISCO-88 code with the highest exposure estimate. For example, ISCO-08 code 5164 (Pet groomers and animal care workers) could be recoded to either ISCO-88 5139 (Personal care and related workers not elsewhere classified) or ISCO-88 6129 (Market-oriented animal producers and related workers not elsewhere classified). As 6129 had higher levels of estimated exposures according to the JEM than 5139, we recoded ISCO-08 5164 into ISCO-88 6129. In addition, some categories were combined in ISCO-08 compared to ISCO-88 (e.g., ISCO-08 8160 - Food and related product machine operators - had different codes in ISCO-88 depending on the type of food/product - ISCO-88 8271 till 8279). For these combined categories, we reviewed the types of jobs and manually recoded them to the correct ISCO-88 category. After this conversion, the ALOHA+ JEM was used to estimate the occupational exposure into no, low, or high exposure categories (0/1/2) for all occupational exposures: biological dust, mineral dust, gases and fumes, insecticides, herbicides, fungicides, aromatic solvents, chlorinated solvents, other solvents, and heavy metals.

**Appendix 2: Definition of respiratory symptoms.**

Chronic cough was defined as “Usual coughing first thing in the morning, or during the day, or at night in winter for at least three months in a year.”

Chronic phlegm was defined as “Usual bringing up any phlegm first thing in the morning, or during the day, or at night in winter for at least three months in a year.

Supplementary table E1: Distribution of the occupational exposures at baseline stratified by respiratory outcomes.

Occupational exposures	Chronic cough (n=31,368)						Chronic phlegm (31,704)					
	No (n=29,480)			Yes (n=1,888)			No (n=30,209)			Yes (n=1,495)		
	No	Low	High	No	Low	High	No	Low	High	No	Low	High
	n %	n %	n %	n %	n %	n %	n %	n %	n %	n %	n %	n %
<b>Biological dust</b>	19410 (65.8)	8660 (29.4)	1410 (4.8)	1220 (64.6)	531 (28.1)	137 (7.3)	19859 (65.7)	8904 (29.5)	1446 (4.8)	986 (66.0)	413 (27.6)	96 (6.4)
<b>Mineral dust</b>	23620 (80.1)	4289 (14.5)	1571 (5.3)	1410 (74.7)	316 (16.7)	162 (8.6)	24197 (80.1)	4400 (14.6)	1612 (5.3)	1113 (74.4)	264 (17.7)	118 (7.9)
<b>Gases/fumes</b>	16259 (55.2)	11528 (39.1)	1693 (5.7)	929 (49.2)	794 (42.1)	165 (8.7)	166636 (55.1)	11833 (39.2)	1740 (5.8)	752 (50.3)	619 (41.4)	124 (8.3)
<b>Pesticides</b>	28014 (95.0)	1130 (3.8)	336 (1.1)	1753 (92.8)	97 (5.1)	38 (2.0)	28699 (95.0)	1165 (3.9)	345 (1.1)	1396 (93.4)	67 (4.5)	32 (2.1)
<b>Solvents</b>	20829 (70.7)	7393 (25.1)	1258 (4.3)	1290 (68.3)	499 (26.4)	99 (5.2)	21347 (70.7)	7587 (25.1)	1275 (4.2)	1043 (69.8)	374 (25.0)	78 (5.2)
<b>Metals</b>	28114 (95.4)	797 (2.7)	569 (1.9)	1763 (93.8)	71 (3.8)	54 (2.9)	28821 (95.4)	807 (2.7)	581 (1.9)	1395 (93.3)	61 (4.1)	39 (2.6)

CONTINUED												
Occupational exposures	Chronic bronchitis (28,890)						Airway obstruction (n=11,341)					
	No (28180)			Yes (710)			No (n=10830)			Yes (n=508)		
	No	Low	High	No	Low	High	No	Low	High	No	Low	High
	n %	n %	n %	n %	n %	n %	n %	n %	n %	n %	n %	n %
<b>Biological dust</b>	18537 (65.8)	8319 (29.5)	1324 (4.7)	450 (63.4)	205 (28.9)	55 (7.7)	7248 (66.9)	3065 (28.3)	517 (4.8)	322 (63.4)	160 (31.5)	26 (5.1)
<b>Mineral dust</b>	22657 (80.4)	4062 (14.4)	1461 (5.2)	524 (73.8)	131 (18.5)	55 (7.7)	8686 (80.2)	1577 (14.6)	567 (5.2)	410 (80.7)	63 (12.4)	35 (6.9)
<b>Gases/fumes</b>	15592 (55.3)	11004 (39.0)	1584 (5.6)	335 (47.2)	316 (44.5)	59 (8.3)	6015 (55.5)	4195 (38.7)	620 (5.7)	257 (50.6)	217 (42.7)	34 (6.7)
<b>Pesticides</b>	26793 (95.1)	1072 (3.8)	315 (1.1)	653 (92.0)	38 (5.4)	19 (2.7)	10333 (95.8)	387 (3.6)	110 (1.0)	479 (94.3)	19 (3.7)	10 (2.0)
<b>Solvents</b>	19905 (70.6)	7097 (25.2)	1178 (4.2)	482 (67.9)	195 (27.5)	33 (4.6)	7675 (70.9)	2686 (24.8)	469 (4.3)	342 (67.3)	141 (27.8)	25 (4.9)
<b>Metals</b>	26909 (95.5)	744 (2.6)	527 (1.9)	665 (93.7)	31 (4.4)	14 (2.0)	10295 (95.1)	327 (3.0)	208 (1.9)	486 (95.7)	11 (2.2)	11 (2.2)

**Supplementary table E2: Association between occupational exposures and the development of respiratory symptoms in subjects without any respiratory symptoms at baseline. The logistic regression was adjusted for baseline age, sex, education, monthly income, pack-years, and smoking.**

Occupational exposures	N (30491)	Chronic cough OR (95%CI)	N (30490)	Chronic phlegm OR (95%CI)	N (28890)	Chronic bronchitis OR (95%CI)
<b>Biological dust</b>						
No	20055	Ref.	20052	Ref.	18987	Ref.
Low	8957	0.94 (0.84;1.06)	8958	0.91 (0.79;1.04)	8524	0.96 (0.80;1.15)
High	1479	1.22 (0.99;1.51)	1480	1.16 (0.91;1.49)	1379	<b>1.46 (1.07;1.99)</b>
<b>Mineral dust</b>						
No	24395	Ref.	24394	Ref.	23181	Ref.
Low	4442	0.92 (0.79;1.07)	4445	0.98 (0.83;1.16)	4193	1.02 (0.82;1.27)
High	1654	1.18 (0.96;1.44)	1651	1.07 (0.85;1.36)	1516	1.08 (0.78;1.49)
<b>Gases and fumes</b>						
No	16763	Ref.	16761	Ref.	15927	Ref.
Low	11952	1.04 (0.93;1.16)	11952	0.98 (0.86;1.12)	11320	1.11 (0.93;1.32)
High	1776	1.17 (0.95;1.43)	1777	0.97 (0.76;1.24)	1643	1.16 (0.84;1.59)
<b>Pesticides</b>						
No	28954	Ref.	28952	Ref.	27446	Ref.
Low	1174	1.09 (0.86;1.41)	1176	1.07 (0.81;1.43)	1110	1.36 (0.95;1.93)
High	363	<b>1.48 (1.03;2.14)</b>	362	<b>1.65 (1.11;2.47)</b>	334	<b>1.99 (1.19;3.31)</b>
<b>Solvents</b>						
No	21508	Ref.	21506	Ref.	20387	Ref.
Low	7680	1.08 (0.97;1.22)	7680	0.99 (0.87;1.14)	7292	1.12 (0.94;1.33)
High	1303	1.11 (0.88;1.39)	1304	1.01 (0.77;1.32)	1211	0.92 (0.64;1.34)
<b>Metals</b>						
No	29071	Ref.	29069	Ref.	27574	Ref.
Low	830	1.14 (0.87;1.49)	831	1.05 (0.77;1.43)	775	1.21 (0.81;1.80)
High	590	1.08 (0.79;1.48)	590	0.83 (0.56;1.23)	541	0.73 (0.41;1.29)

OR= Odds ratio; CI=Confidence interval, No exposure as reference group

**Supplementary table E3: Association between occupational exposures and the development of respiratory symptoms and airway obstruction. The logistic regression was adjusted for baseline age, sex, education, monthly income, pack-years, and smoking. In this model, each exposure was compared to a common group consisting of no exposure to all six occupational agents under study.**

Occupational exposures	N (26842)	Chronic cough	N (27147)	Chronic phlegm	N (24815)	Chronic bronchitis	N (9658)	Airway obstruction
		OR (95%CI)		OR (95%CI)		OR (95%CI)		OR (95%CI)
<b>Biological dust</b>								
No	16104	Ref.	16288	Ref.	14912	Ref.	5889	Ref.
Low	9191	1.00 (0.88;1.13)	9317	0.96 (0.83;1.1)	8524	1.06 (0.87;1.29)	3226	1.15 (0.92;1.44)
High	1547	<b>1.34 (1.08;1.66)</b>	1542	1.15 (0.9;1.47)	1379	<b>1.70 (1.22;2.37)</b>	543	1.14 (0.72;1.80)
<b>Mineral dust</b>								
No	16104	Ref.	16288	Ref.	14912	Ref.	5889	Ref.
Low	4605	0.96 (0.82;1.12)	4664	1.01 (0.85;1.20)	4193	1.10 (0.85;1.41)	1640	0.86 (0.62;1.19)
High	1733	<b>1.25 (1.01;1.54)</b>	1730	1.07 (0.84;1.36)	1516	1.15 (0.81;1.63)	602	1.42 (0.92;2.19)
<b>Gases and fumes</b>								
No	16104	Ref.	16288	Ref.	14912	Ref.	5889	Ref.
Low	12322	1.05 (0.94;1.18)	12452	0.99 (0.88;1.13)	11320	1.13 (0.95;1.36)	4413	1.10 (0.89;1.35)
High	1858	1.15 (0.94;1.40)	1730	1.03 (0.82;1.29)	1643	1.17 (0.85;1.61)	654	1.16 (0.76;1.76)
<b>Pesticides</b>								
No	16104	Ref.	16288	Ref.	14912	Ref.	5889	Ref.
Low	1227	1.24 (0.97;1.59)	1232	1.08 (0.81;1.44)	1110	1.60 (1.08;2.36)	406	1.18 (0.70;2.00)
High	374	<b>1.52 (1.05;2.20)</b>	377	<b>1.57 (1.05;2.35)</b>	334	<b>2.35 (1.37;4.02)</b>	120	<b>2.28 (1.13;4.59)</b>
<b>Solvents</b>								
No	16104	Ref.	16288	Ref.	14912	Ref.	5889	Ref.
Low	7892	1.11 (0.98;1.25)	7961	1.02 (0.89;1.17)	7292	1.20 (0.99;1.46)	2828	1.16 (0.93;1.45)
High	1357	1.09 (0.87;1.38)	1353	1.09 (0.84;1.41)	1211	1.05 (0.71;1.55)	494	1.05 (0.66;1.67)
<b>Metals</b>								
No	16104	Ref.	16288	Ref.	14912	Ref.	5889	Ref.
Low	868	1.10 (0.83;1.45)	868	1.16 (0.85;1.58)	775	1.38 (0.89;2.14)	338	0.81 (0.43;1.55)
High	623	1.14 (0.83;1.58)	620	1.06 (0.73;1.53)	541	0.85 (0.46;1.57)	219	1.18 (0.58;2.43)

OR=Odds ratio; CI=Confidence interval, No exposure as reference group

**Supplementary table E4: Association between occupational exposures and the development of respiratory symptoms and airway obstruction in subjects without asthma. The logistic regression was adjusted for baseline age, sex, education, monthly income, pack-years, and smoking.**

Occupational exposures	N (28990)	Chronic cough	N (29275)	Chronic phlegm	N (26865)	Chronic bronchitis	N (10557)	Airway obstruction
		OR (95%CI)		OR (95%CI)		OR (95%CI)		OR (95%CI)
<b>Biological dust</b>								
No	19066	Ref.	19235	Ref.	17644	Ref.	7032	Ref.
Low	8476	0.93 (0.82;1.05)	8589	0.95 (0.83;1.09)	7918	1.00 (0.83;1.22)	3014	1.19 (0.96;1.48)
High	1448	<b>1.25 (1.01;1.55)</b>	1451	1.17 (0.92;1.50)	1303	<b>1.55 (1.11;2.16)</b>	511	0.92 (0.55;1.54)
<b>Mineral dust</b>								
No	23128	Ref.	23343	Ref.	21541	Ref.	8469	Ref.
Low	4266	0.89 (0.77;1.04)	4331	0.97 (0.81;1.15)	3916	0.89 (0.70;1.14)	1526	<b>0.68 (0.48;0.95)</b>
High	1596	1.18 (0.96;1.45)	1601	1.22 (0.97;1.54)	1408	1.11 (0.79;1.57)	562	1.25 (0.81;1.92)
<b>Gases and fumes</b>								
No	15896	Ref.	16050	Ref.	14803	Ref.	5833	Ref.
Low	11368	1.05 (0.93;1.18)	11486	1.05 (0.92;1.20)	10525	1.19 (0.99;1.44)	4114	1.03 (0.83;1.28)
High	1726	1.12 (0.91;1.38)	1739	1.05 (0.82;1.33)	1537	1.10 (0.77;1.56)	610	1.19 (0.76;1.86)
<b>Pesticides</b>								
No	27496	Ref.	27766	Ref.	25505	Ref.	10065	Ref.
Low	1144	1.19 (1.42;2.08)	1156	1.08 (0.82;1.44)	1045	1.34 (0.91;1.96)	379	0.81 (0.44;1.51)
High	350	1.42 (0.96;2.08)	353	<b>1.77 (1.19;2.63)</b>	<b>315</b>	<b>2.24 (1.32;3.81)</b>	113	<b>2.29 (1.13;4.66)</b>
<b>Solvents</b>								
No	20455	Ref.	20691	Ref.	18967	Ref.	7452	Ref.
Low	7272	1.08 (0.95;1.21)	7323	1.06 (0.92;1.21)	6763	1.18 (0.98;1.43)	2634	1.20 (0.96;1.50)
High	1263	1.07 (0.85;1.35)	1261	1.05 (0.80;1.37)	1135	0.85 (0.56;1.29)	471	1.17 (0.73;1.85)
<b>Metals</b>								
No	27610	Ref.	27888	Ref.	25635	Ref.	10032	Ref.
Low	796	1.01 (0.76;1.35)	801	1.03 (0.74;1.41)	721	1.10 (0.70;1.72)	317	0.80 (0.42;1.54)
High	584	1.16 (0.85;1.58)	586	1.02 (0.71;1.46)	509	0.70 (0.38;1.31)	208	1.22 (0.62;2.38)

OR=Odds ratio; CI=Confidence interval, No exposure as reference group

**Supplementary table E5: Association between biological dust and the development of respiratory symptoms and airway obstruction in subjects who were exposed only to biological dust but not to pesticides. The logistic regression was adjusted for baseline age, sex, height, education, monthly income, pack-years, and smoking.**

Occupational exposures	N (29769)	Chronic cough	N (30097)	Chronic phlegm	N (27448)	Chronic bronchitis	N (10815)	Airway obstruction
		OR (95%CI)		OR (95%CI)		OR (95%CI)		OR (95%CI)
<b>Biological dust</b>								
No	20630	Ref.	20845	Ref.	18987	Ref.	7572	Ref.
Low	8640	0.93 (0.83;1.05)	8762	0.91 (0.80;1.03)	8029	0.93 (0.77;1.12)	3055	1.07 (0.86;1.33)
High	499	1.16 (0.84;1.60)	490	1.02 (0.70;1.48)	432	1.12 (0.66;1.89)	188	1.27 (0.68;1.81)

OR=Odds ratio; CI=Confidence interval, No exposure as reference group