

Associations between bioaerosols, lung function work-shift changes and inflammatory markers: A study of recycling workers¹

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1. Supplementary material
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Table S1 Pearson pairwise correlation coefficients for the bioaerosol exposures

Bioaerosol	Inhalable dust	Endotoxin	Bacteria	Fungi (25 °C)	Fungi (37 °C)
Inhalable dust	1				
Endotoxin	0.53	1			
Bacteria	0.52	0.46	1		
Fungi (25 °C)	-0.03	-0.01	-0.05	1	
Fungi (37 °C)	0.43	0.52	0.32	-0.02	1

Table S2 Absolute adjusted work-shift change in lung function by production characteristics among recycling workers

Production characteristics	Persons	Samples	Change in FEV1 (L/min)			Change in FVC (L/min)			Change in FEV1/FVC		
			AM	SD	β^a (95 % CI)	AM	SD	β^a (95 % CI)	AM	SD	β^a (95 % CI)
Administrative worker	13	19	-0.06	0.25	Reference	-0.05	0.28	Reference	0.00	0.02	Reference
Production worker	78	124	-0.06	0.38	-0.06 (-0.27-0.14)	-0.09	0.31	-0.08 (-0.25-0.10)	0.00	0.06	0.00 (-0.04-0.03)
Work task ^b											
Sorting	40	64	-0.04	0.40	-0.03 (-0.24-0.18)	-0.08	0.33	-0.06 (-0.24-0.12)	0.00	0.07	0.00 (-0.04-0.03)
Machine operation	17	25	-0.11	0.44	-0.13 (-0.37-0.11)	-0.14	0.29	-0.11 (-0.31-0.09)	0.00	0.08	-0.01 (-0.05-0.03)
Driving	22	31	-0.04	0.31	-0.07 (-0.30-0.17)	-0.08	0.32	-0.08 (-0.28-0.12)	0.01	0.03	0.00 (-0.04-0.04)
Cleaning and maintenance	3	4	-0.18	0.13	-0.08 (-0.50-0.34)	-0.15	0.11	-0.05 (-0.40-0.31)	-0.02	0.03	-0.02 (-0.09-0.05)
Waste fraction ^b											
Paper/cardboard	13	18	-0.08	0.69	-0.06 (-0.33-0.21)	-0.09	0.39	-0.07 (-0.329-0.16)	-0.01	0.12	-0.01 (-0.06-0.03)
Metal	14	19	-0.05	0.24	-0.07 (-0.34-0.20)	-0.11	0.35	-0.09 (-0.32-0.14)	0.01	0.03	0.00 (-0.05-0.04)
Plastic	8	13	-0.18	0.52	-0.16 (-0.43-0.11)	-0.13	0.20	-0.08 (-0.30-0.15)	-0.02	0.10	-0.02 (-0.06-0.02)
Biowaste	5	7	-0.06	0.19	-0.07 (-0.39-0.25)	-0.09	0.23	-0.06 (-0.33-0.21)	0.00	0.02	-0.01 (-0.06-0.05)
Electronics and hazardous ^c	13	23	-0.12	0.31	-0.06 (-0.29-0.18)	-0.17	0.45	-0.14 (-0.34-0.06)	0.00	0.04	0.01 (-0.03-0.05)
Metal/plastic/glass	13	20	0.07	0.21	0.09 (-0.18-0.36)	0.03	0.18	0.09 (-0.13-0.33)	0.01	0.03	0.00 (-0.04-0.05)
Mixed ^d	16	24	-0.06	0.18	-0.02 (-0.27-0.23)	-0.11	0.17	-0.05 (-0.26-0.16)	0.00	0.03	0.00 (-0.04-0.04)
Location/ventilation ^{b,e}											
No room/vehicle ventilation (indoor)	19	23	-0.02	0.26	Reference	-0.08	0.31	Reference	0.01	0.03	Reference
Room/vehicle ventilation (indoor)	47	70	-0.09	0.46	-0.07 (-0.25-0.11)	-0.11	0.35	-0.05 (-0.20-0.10)	0.00	0.08	-0.01 (-0.04-0.02)
Outdoor	20	31	-0.02	0.26	0.04 (-0.25-0.17)	-0.05	0.20	0.00 (-0.17-0.18)	0.00	0.02	-0.01 (-0.05-0.02)
Personal protective equipment (PPE) ^e											
No PPE	12	13	-0.01	0.38	Reference	-0.13	0.35	Reference	0.02	0.04	Reference
Face mask ^f	13	16	-0.13	0.19	-0.10 (-0.36-0.17)	-0.21	0.23	-0.07 (-0.29-0.15)	0.01	0.02	-0.01 (-0.06-0.03)
Other PPE ^g	66	95	-0.05	0.40	-0.02 (-0.25-0.20)	-0.07	0.31	0.11 (-0.08-0.29)	0.00	0.07	-0.03 (-0.07-0.01)

^a Linear mixed effect model with time of measurement, season, smoking, allergy and asthma status, BMI, and age as fixed effects and worker as random effect. Change measured as afternoon measurement minus morning measurement. Presented as adjusted β -coefficients with 95% confidence interval (CI). β -coefficients express the absolute difference compared with the reference.

^b Primary. For repeated measurements, a person can appear in two categories

^c Classified as hazardous waste, e.g. light bulbs, paint, and spray cans

^d More than one fraction of waste fraction, including working at a recycling station

^e Only among production workers

^f Filtering face piece-2 or -3 (FFP2 or FFP3) respirators, surgical masks, or air-supplied respirator

^g Plastic apron, gloves, visor or safety goggles

Table S3 Adjusted ratios of inflammatory marker concentrations by production characteristics among recycling workers

Production characteristics	Persons	Samples	CRP ^a (mg/L)		SAA ^a (mg/L)		CC16 ^a (ng/ml)		IL-1 β ^a (pg/ml)		IL-2 ^a (pg/ml)	
			% below		% below		% below		% below		% below	
			Exp(β) ^a (95% CI)	MDD	Exp(β) ^a (95% CI)	MDD	Exp(β) ^a (95% CI)	MDD	Exp(β) ^a (95% CI)	MDD	Exp(β) ^a (95% CI)	MDD
Administrative worker	14	21	Reference	0	Reference	0	Reference	0	Reference	29	Reference	76
Production worker	88	149 ^b	0.75 (0.36-1.55)	1	1.15 (0.57-2.31)	1	0.94 (0.77-1.15)	0	1.36 (0.80-2.33)	27	1.82 (0.77-4.35)	57
Work task ^b												
Sorting	46	78	0.77 (0.35-1.68)	1	1.08 (0.52-2.27)	1	0.91 (0.73-1.14)	0	1.51 (0.86-2.64)	11	1.73 (0.70-4.25)	28
Machine operation	19	28	0.80 (0.34-1.90)	0	1.04 (0.45-2.38)	0	0.97 (0.76-1.23)	0	1.04 (0.55-1.99)	7	1.65 (0.60-4.59)	7
Driving	25	36 ^b	0.68 (0.31-1.48)	0	1.16 (0.53-2.50)	0	0.96 (0.78-1.19)	0	1.46 (0.80-2.67)	5	2.42 (0.93-6.29)	12
Cleaning and maintenance	5	7	1.21 (0.35-4.18)	0	3.21 (0.93-11.03)	0	0.84 (0.60-1.18)	0	0.96 (0.36-2.54)	1	0.63 (0.13-3.01)	3
Waste fraction ^b												
Paper/cardboard	17	28 ^b	0.58 (0.23-1.43)	0	0.92 (0.39-2.21)	1	0.82 (0.63-1.06)	0	1.73 (0.90-3.33)	4	2.69 (0.95-7.60)	5
Metal	15	21	1.01 (0.39-2.61)	0	1.77 (0.72-4.35)	0	0.96 (0.72-1.27)	0	1.03 (0.52-2.01)	5	1.47 (0.48-4.55)	8
Plastic	11	17	1.15 (0.46-2.84)	0	1.47 (0.59-3.63)	0	1.04 (0.81-1.33)	0	0.99 (0.49-2.02)	5	1.58 (0.53-4.69)	4
Biowaste	6	10	0.45 (0.13-1.53)	0	0.83 (0.27-2.58)	0	0.91 (0.63-1.32)	0	1.15 (0.51-2.60)	1	1.55 (0.37-6.43)	4
Electronics and hazardous ^c	14	27	0.68 (0.27-1.71)	0	0.78 (0.33-1.85)	0	0.84 (0.64-1.12)	0	1.42 (0.77-2.63)	3	1.52 (0.55-4.25)	10
Metal/plastic/glass	13	22	0.94 (0.34-2.58)	0	1.05 (0.41-2.70)	0	1.06 (0.79-1.43)	0	1.05 (0.53-2.07)	4	1.16 (0.34-3.98)	11
Mixed ^d	16	24	0.36 (0.14-0.89)	1	1.24 (0.51-2.98)	0	0.79 (0.61-1.03)	0	2.29 (1.20-4.37)	2	2.86 (0.97-8.46)	8
Location/ventilation ^{b,c}												
No room/vehicle ventilation (indoor)	22	30 ^b	Reference	0	Reference	1	Reference	0	Reference	8	Reference	12
Room/vehicle ventilation (indoor)	55	86	1.30 (0.79-2.12)	0	1.42 (0.82-2.48)	0	1.05 (0.94-1.17)	0	1.59 (1.02-2.47)	14	1.37 (0.71-2.64)	32
Outdoor	22	33	0.68 (0.36-1.29)	1	0.99 (0.50-1.97)	0	0.93 (0.80-1.08)	0	1.72 (1.01-2.93)	5	1.42 (0.63-3.21)	13
Personal protective equipment (PPE) ^e												
No PPE	13	15	Reference	0	Reference	0	Reference	0	Reference	3	Reference	6
Face mask ^f	14	18	1.44 (0.72-2.85)	0	1.07 (0.47-2.44)	0	0.93 (0.80-1.09)	0	0.85 (0.43-1.70)	3	1.14 (0.42-3.11)	6
Other PPE ^g	76	116 ^b	1.20 (0.71-2.05)	1	1.11 (0.57-2.15)	1	0.97 (0.86-1.09)	0	0.90 (0.52-1.58)	21	1.11 (0.50-2.47)	45

^a Linear mixed effect model with time of measurement, season, smoking, allergy and asthma status, BMI, and age as fixed effects and worker as random effect. Presented as adjusted β -coefficients (Exp(β)) with 95% confidence interval (CI). Exp(β)-coefficients express the ratio between the means compared with the reference. Statistically significant results marked with bold.

^b Primary. For repeated measurements, a person can appear in two categories

^c Classified as hazardous waste, e.g. light bulbs, paint, and spray cans

^d More than one fraction of waste fraction, including working at a recycling station

^e Only among production workers

^f Filtering face piece-2 or -3 (FFP2 or FFP3) respirators, surgical masks, or air-supplied respirator

^g Plastic apron, gloves, visor or safety goggles

^h For one sample there was not enough serum to measure IL1- β , IL-2, IL-6, IL-8, IL-10, and TNF- α ,

Table S3 Adjusted ratios of inflammatory marker concentrations by production characteristics among recycling workers (continued)

Production characteristics	IL-6 ^a (pg/ml)		IL-8 ^a (pg/ml)		IL-10 ^a (pg/ml)		TNF- α ^a (pg/ml)	
	Exp(β) ^a (95% CI)	% below MDD	Exp(β) ^a (95% CI)	% below MDD	Exp(β) ^a (95% CI)	% below MDD	Exp(β) ^a (95% CI)	% below MDD
Administrative worker	Reference	24	Reference	5	Reference	24	Reference	14
Production worker	1.13 (0.60-2.14)	21	1.00 (0.58-1.73)	0	1.36 (1.06-1.75)	11	1.41 (0.72-2.74)	13
Work task ^b								
Sorting	1.16 (0.59-2.28)	11	1.07 (0.61-1.88)	0	1.43 (1.11-1.85)	4	1.38 (0.67-2.83)	7
Machine operation	0.93 (0.43-2.02)	4	0.75 (0.40-1.43)	0	1.21 (0.90-1.63)	2	1.47 (0.66-3.28)	2
Driving	1.21 (0.58-2.51)	4	1.21 (0.65-2.25)	0	1.41 (1.06-1.86)	3	1.35 (0.63-2.89)	2
Cleaning and maintenance	1.39 (0.44-4.40)	0	0.72 (0.27-1.90)	0	1.12 (0.71-1.75)	1	1.78 (0.54-5.86)	0
Waste fraction ^b								
Paper/cardboard	1.33 (0.60-2.95)	3	2.40 (1.32-4.36)	0	1.57 (1.16-2.14)	1	3.27 (1.50-7.13)	1
Metal	0.86 (0.38-1.97)	4	0.46 (0.25-0.85)	0	1.35 (0.99-1.86)	2	0.89 (0.40-1.99)	2
Plastic	1.23 (0.53-2.86)	1	0.82 (0.44-1.53)	0	1.18 (0.85-1.63)	2	1.16 (0.52-2.61)	1
Biowaste	1.24 (0.45-3.37)	1	1.08 (0.51-2.29)	0	1.25 (0.85-1.84)	1	1.00 (0.37-2.71)	1
Electronics and hazardous ^c	0.73 (0.34-1.58)	5	1.32 (0.75-2.33)	0	1.34 (1.01-1.80)	2	1.72 (0.81-3.66)	1
Metal/plastic/glass	1.26 (0.53-2.97)	4	0.61 (0.33-1.16)	0	1.24 (0.89-1.71)	2	0.62 (0.27-1.46)	4
Mixed ^d	1.79 (0.81-3.97)	0	1.35 (0.74-2.46)	0	1.69 (1.25-2.30)	1	2.15 (0.98-4.74)	1
Location/ventilation ^{b,e}								
Room/vehicle ventilation (indoor)	Reference	5	Reference	0	Reference	4	Reference	3
No room/vehicle ventilation (indoor)	1.16 (0.67-2.00)	14	1.21 (0.80-1.85)	0	1.11 (0.90-1.37)	5	1.04 (0.62-1.74)	8
Outdoor	1.06 (0.55-2.03)	3	1.16 (0.69-1.93)	0	1.17 (0.90-1.51)	2	1.03 (0.54-1.93)	2
Personal protective equipment (PPE) ^e								
No PPE	Reference	3	Reference	0	Reference	2	Reference	2
Face mask ^f	1.10 (0.48-2.52)	2	1.36 (0.72-2.56)	0	1.24 (0.90-1.71)	1	1.60 (0.74-3.44)	1
Other PPE ^g	1.19 (0.61-2.36)	16	1.31 (0.78-2.20)	0	1.06 (0.81-1.38)	9	1.53 (0.82-2.86)	9

^a Linear mixed effect model with hour of measurement, season, smoking, allergy and asthma status, BMI, and age as fixed effects and worker as random effect. Presented as adjusted β -coefficients (Exp(β)) with 95% confidence interval (CI). Exp(β)-coefficients express the ratio between the means compared with the reference. Statistically significant results marked with bold.

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^g Plastic apron, gloves, visor or safety goggles

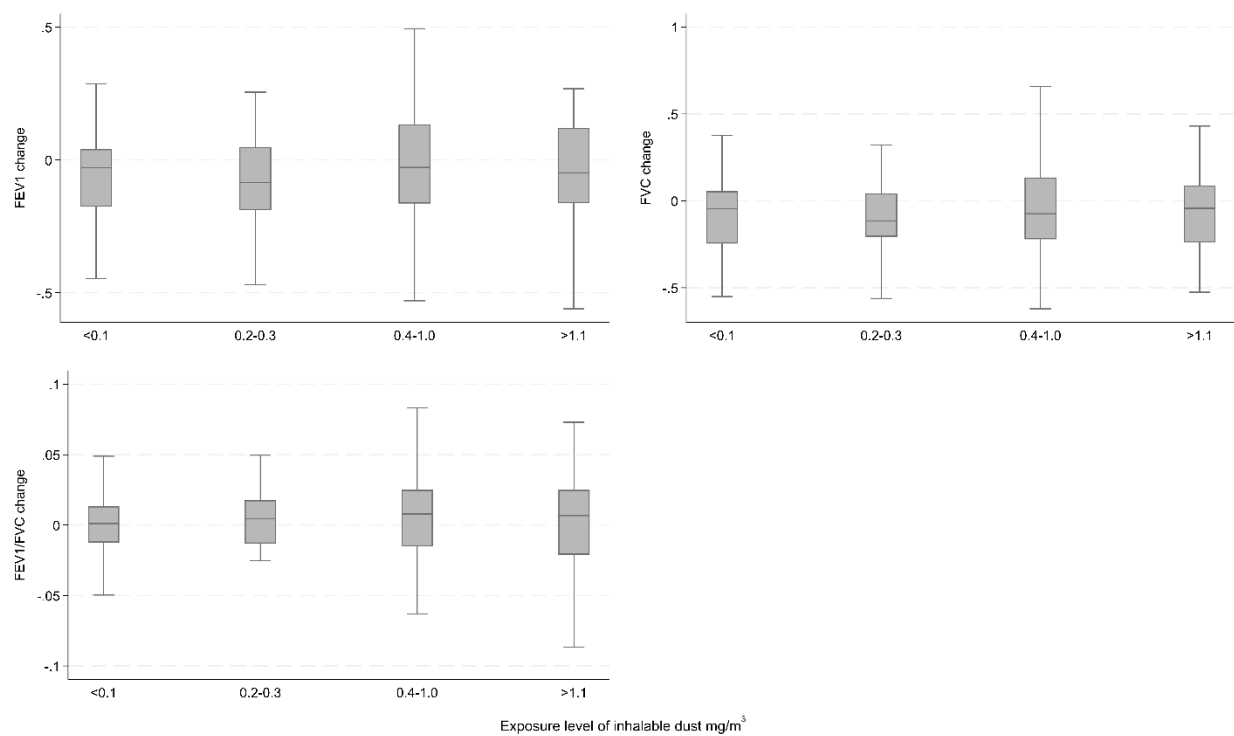


Figure S1 Unadjusted work-shift change in lung function change by exposure level of inhalable dust among recycling workers

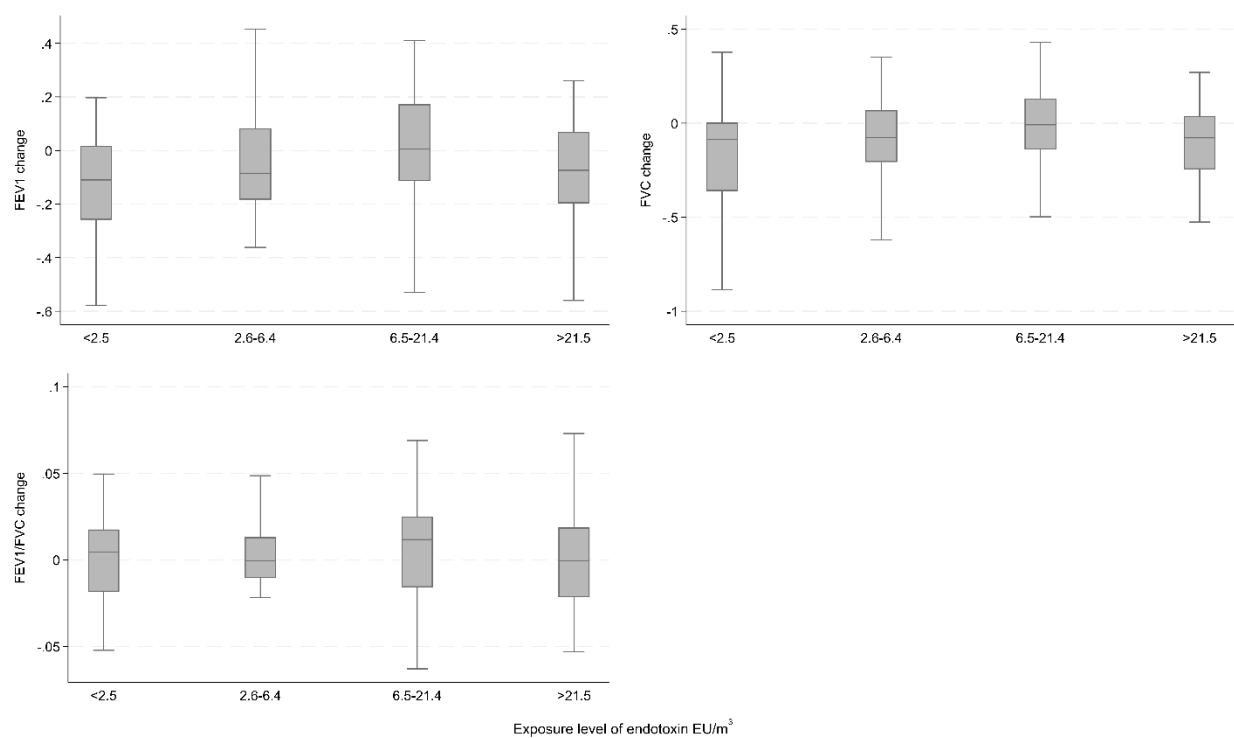


Figure S2 Unadjusted work-shift change in lung function change by exposure level of endotoxin among recycling workers

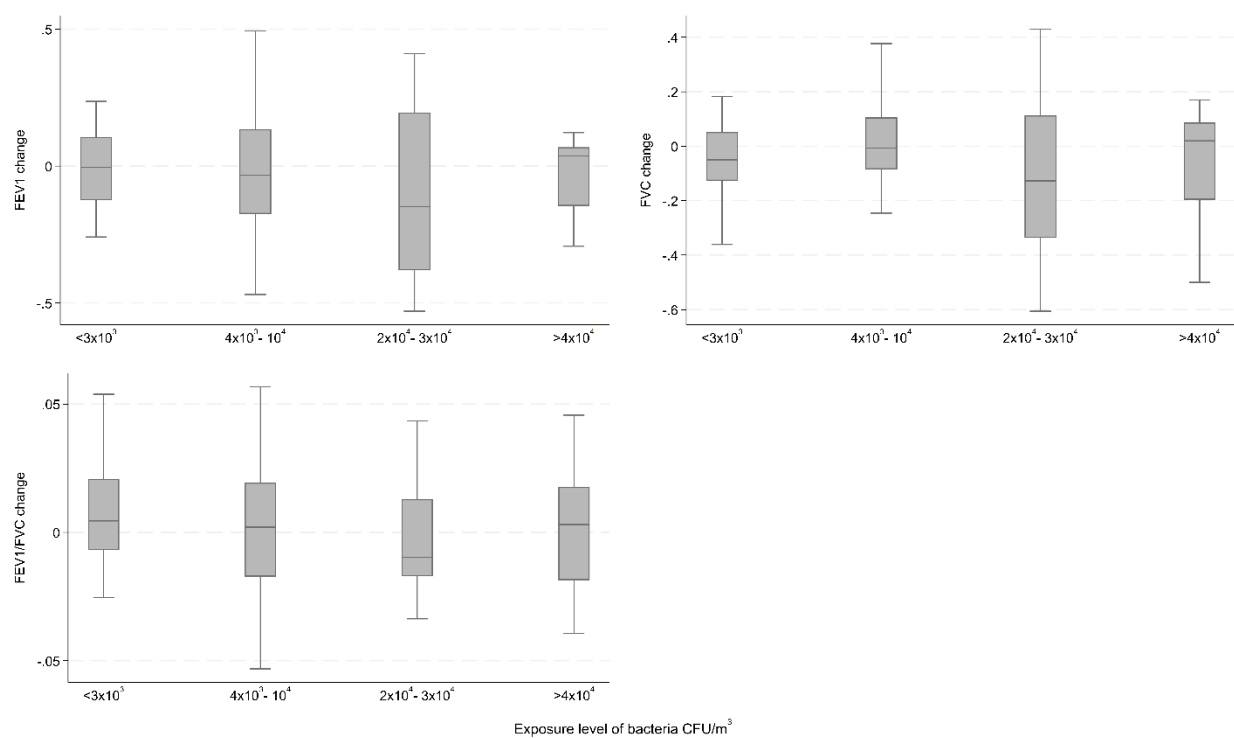


Figure S3 Unadjusted work-shift change in lung function change by exposure level of bacteria among recycling workers

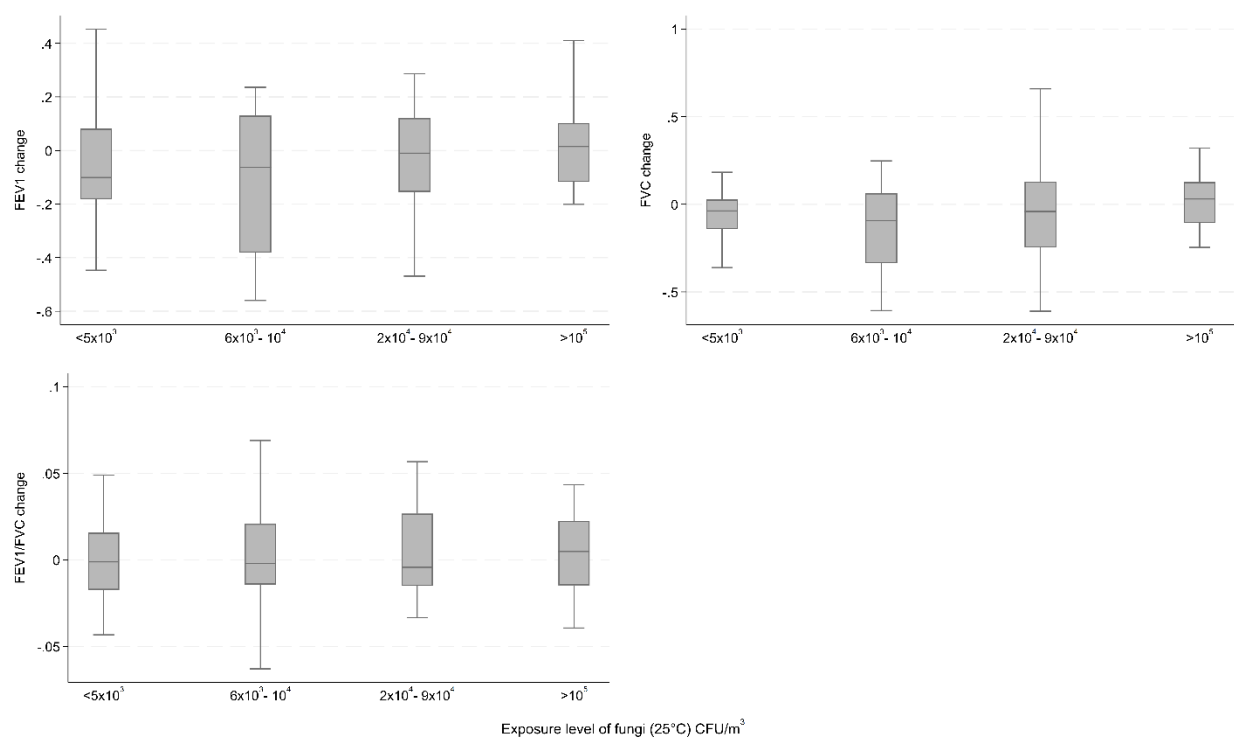


Figure S4 Unadjusted work-shift change in lung function change by exposure level of fungi (25 °C) among recycling workers

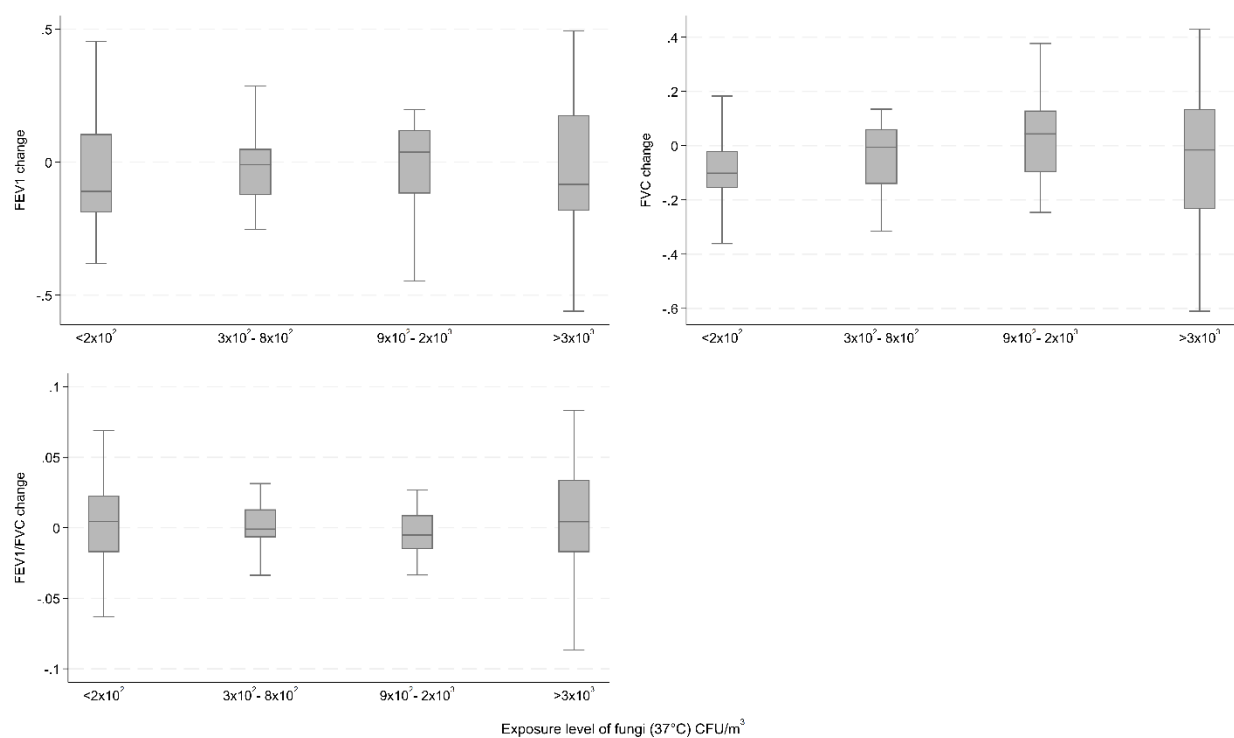


Figure S5 Unadjusted work-shift change in lung function change by exposure level of fungi (37 °C) among recycling workers

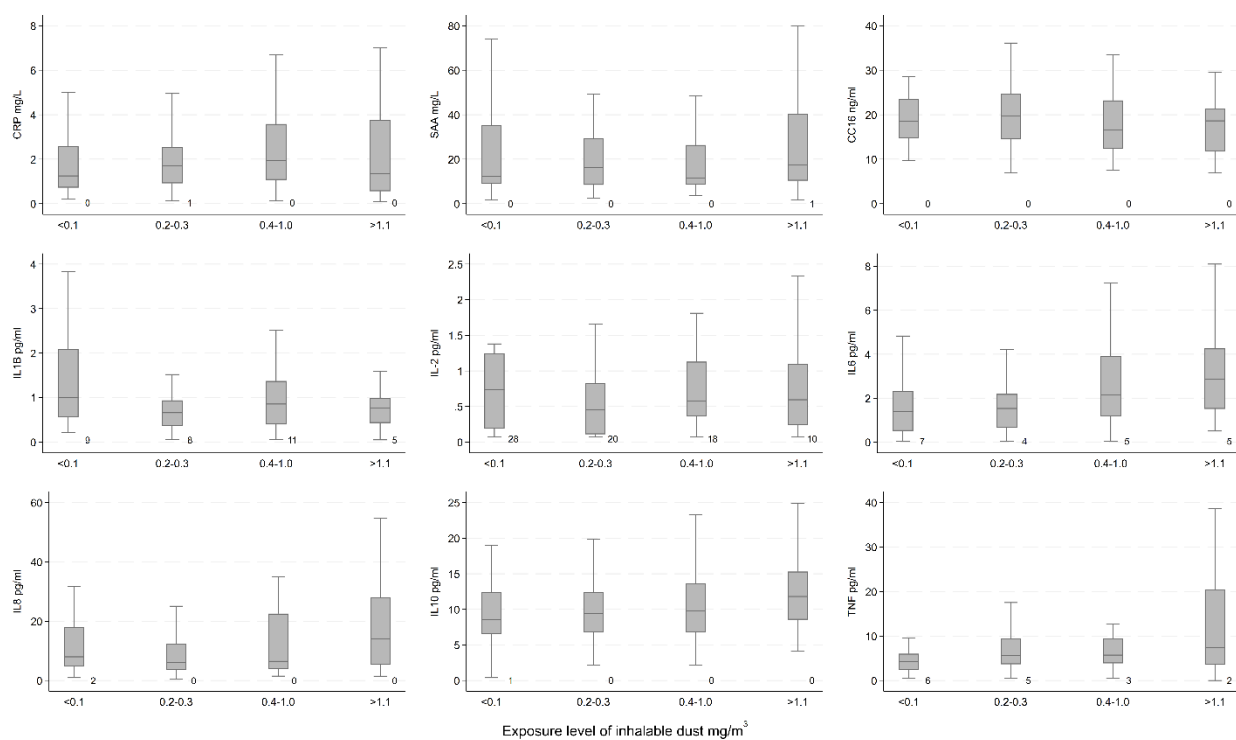


Figure S6 Unadjusted inflammatory marker concentrations by exposure level of inhalable dust among recycling workers. Number of measurements below MDD at the bottom to the right of each boxplot.

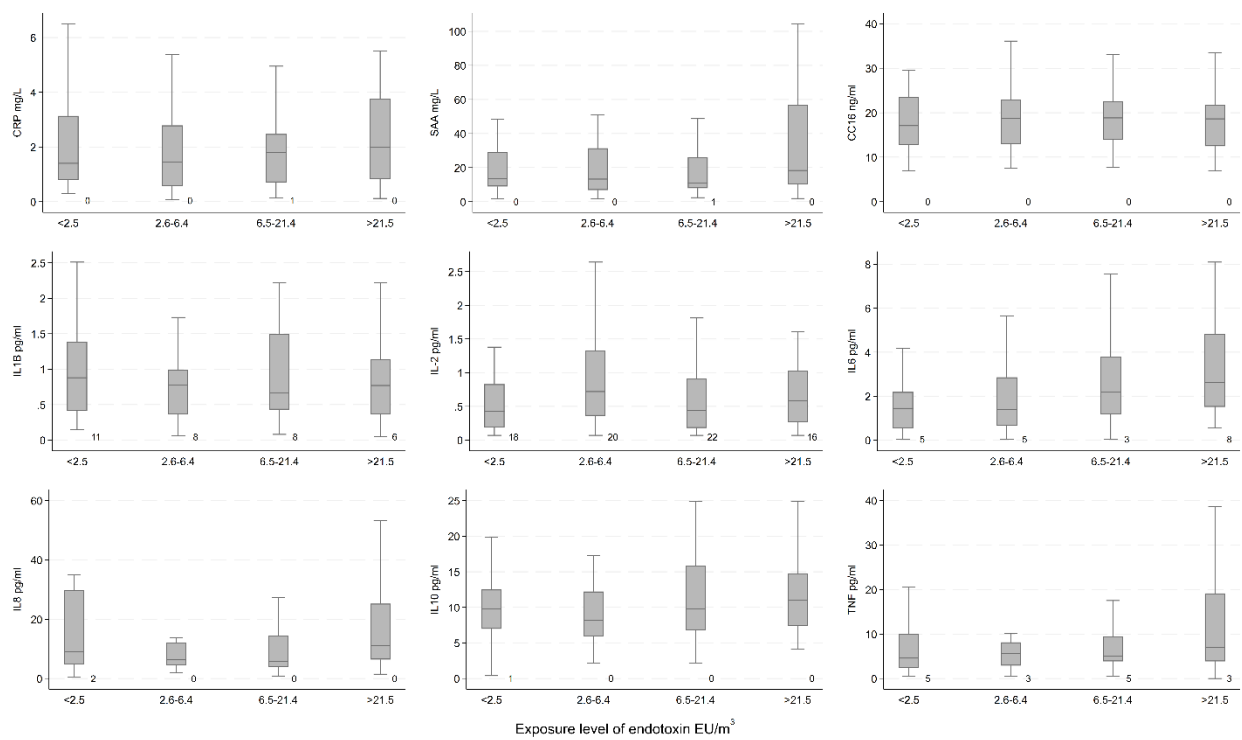


Figure S7 Unadjusted inflammatory marker concentrations by exposure level of endotoxin among recycling workers. Number of measurements below MDD at the bottom of each boxplot.

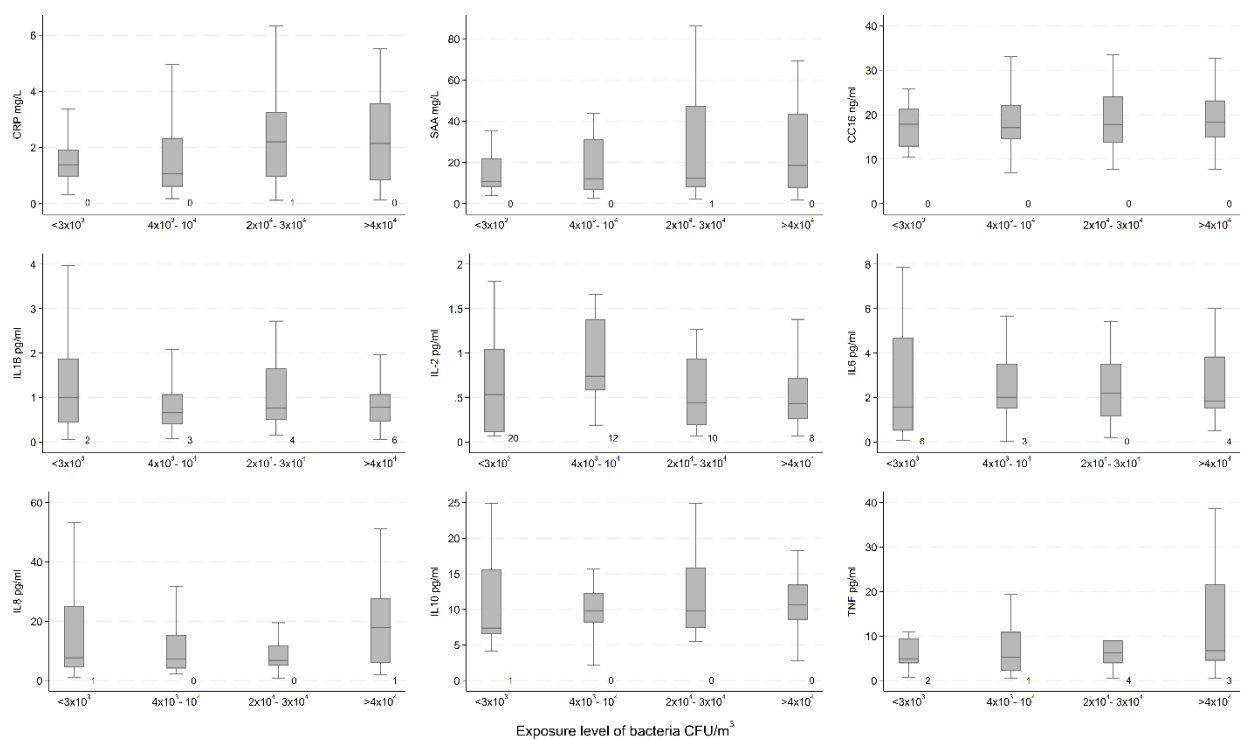


Figure S8 Unadjusted inflammatory marker concentrations by exposure level of bacteria among recycling workers. Number of measurements below MDD at the bottom of each boxplot.

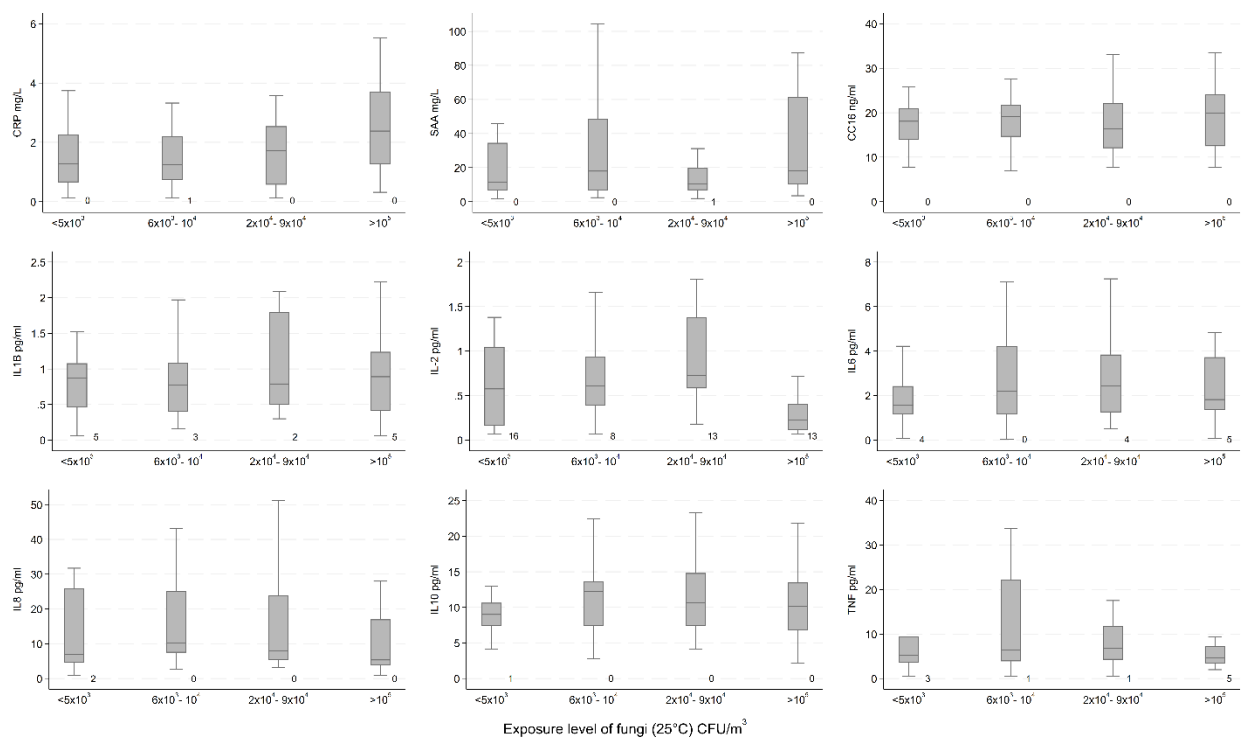


Figure S9 Unadjusted inflammatory marker concentrations by exposure level of fungi (25 °C) among recycling workers. Number of measurements below MDD at the bottom of each boxplot.

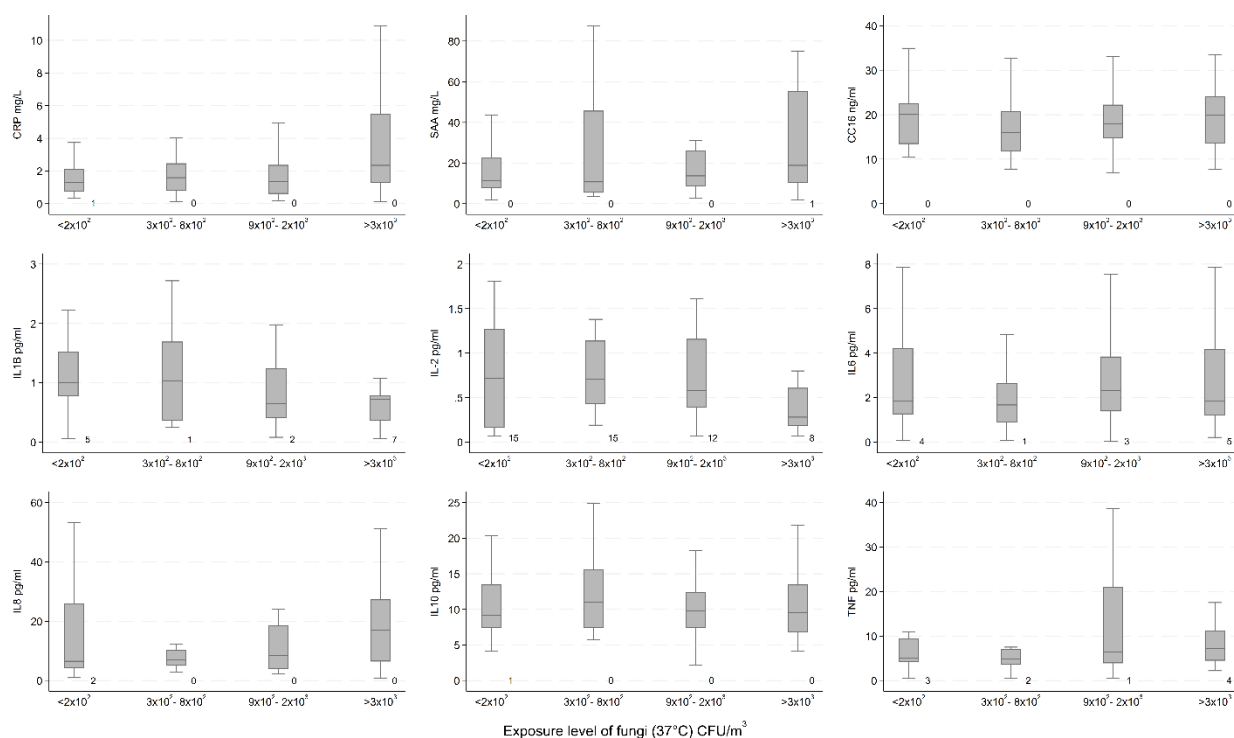


Figure S10 Unadjusted inflammatory marker concentrations by exposure level of fungi (37 °C) among recycling workers. Number of measurements below MDD at the bottom of each boxplot.

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