

# Health effects from Combustion UFP

## Controlled Human Exposure Studies

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National Research Centre  
for the Working Environment

# Combustion particles and health

Cause



Effect

Exposure is common  
Misclassification

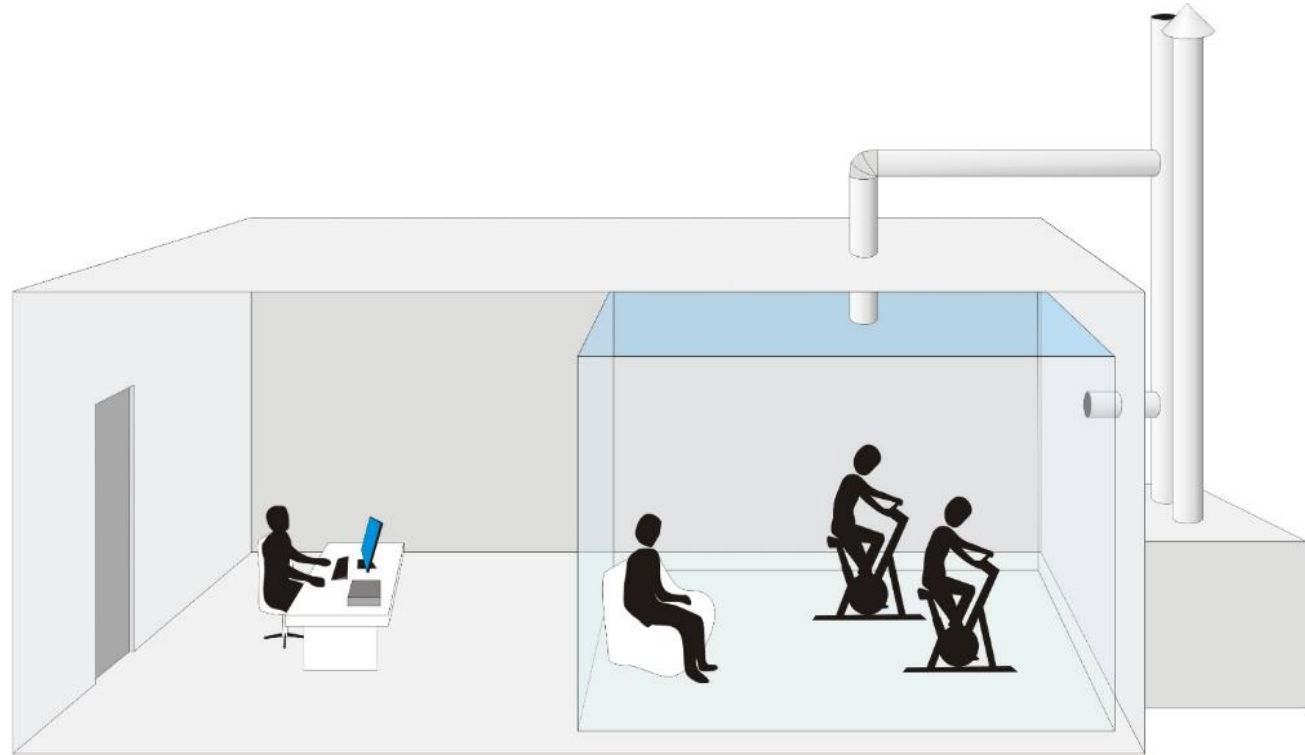
Multiple etiologies



## Exposure facilities



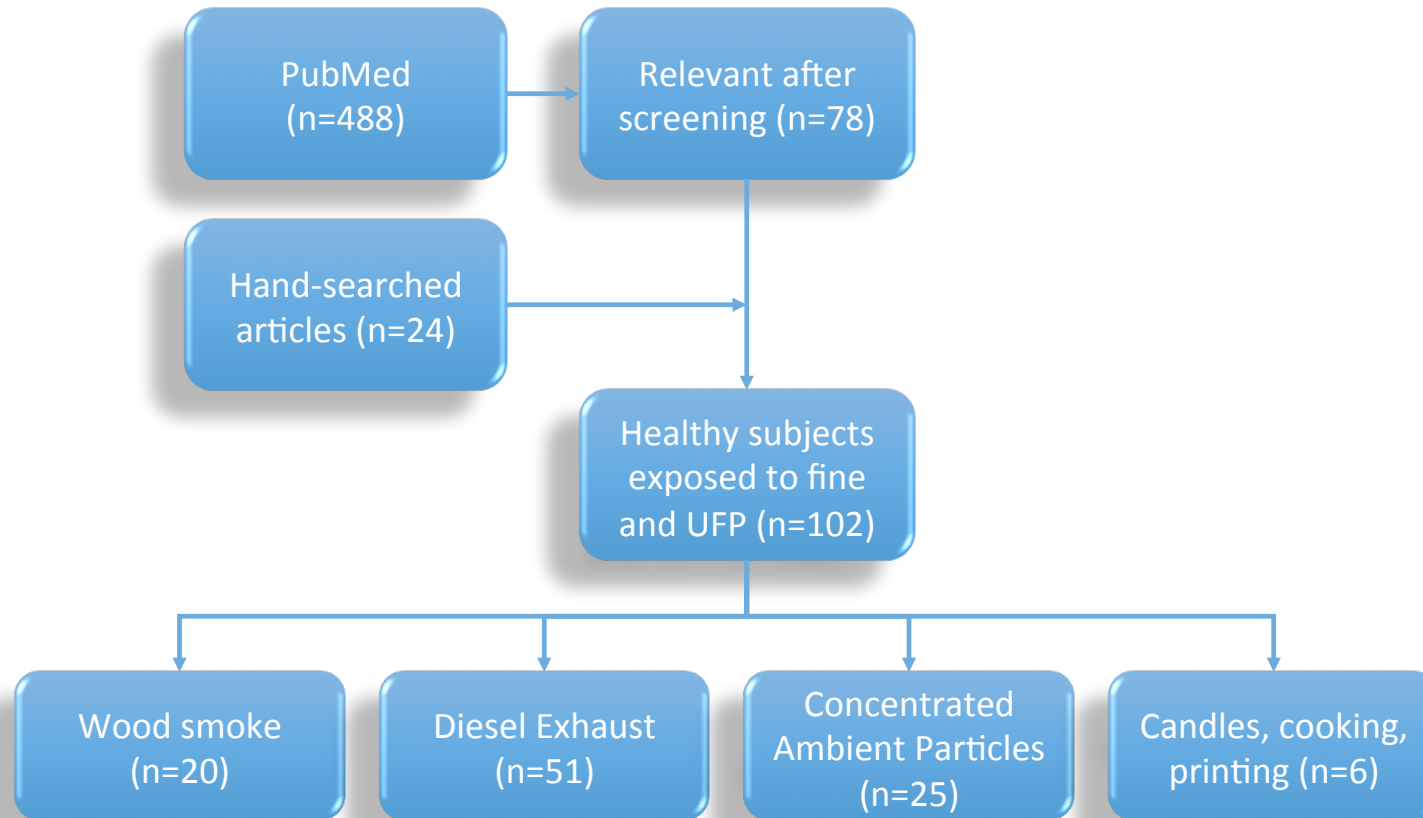
Facemask



Chamber facility



## Studies included



## Combustion sources

Source	Number of studies (and articles)	Number of exposed-subjects
Wood smoke	12 (20)	243
Diesel exhaust	33 (51)	580
Concentrated ambient particles	15 (25)	391
Indoor sources (candles, cooking, printing)	4 (6)	124

64 studies published in 102 articles,  
involving a total of 1,338 subjects



## Study designs

Source	Design	PM concentration average (range) ( $\mu\text{g}/\text{m}^3$ )	Exposure duration	Physical exercise	Wash out period
Wood smoke	4 sequential, 1 parallel groups and 7 crossover	368 (50-1100)	1 h to 4 h	7 with and 5 without	1 to 3 weeks
Diesel exhaust	2 sequential and 31 crossover	252 (25-388)	21 min to 3 h	19 with, 12 without and 2 unknown	2 days to 1 month
CAPs	1 sequential, 1 parallel groups and 13 crossover	149 (50-278)	2 h	6 with, 8 without and 1 unknown	2 days to 1 month
Indoor	4 crossover	101 (38-200)	1 h to 4 h	4 without	5 days to 2 weeks

47% used facemask

Candle burning study with  $48 \mu\text{g}/\text{m}^3$  ( $\text{PM}_{10}$ ), for 2h, had  $2 \times 10^6 \text{ \#/cm}^3$



## Health effects indicators

Marker and matrix/functional method		Wood smoke (n=12)	Diesel Exhaust (n=33)	CAPs (n=15)	Indoor (n=4)	All studies (n=64)
<b>Airway inflammation</b>	Nasal secretions, BL, BAL and FeNO	8	11	8	2	29 (45%)
<b>Lung function</b>	Spirometry and plethysmography	5	10	7	3	25 (39%)
<b>Systemic inflammation</b>	Blood	6	19	12	1	36 (56%)
<b>Oxidative stress</b>	Blood, urine and airway samples	6	8	3	2	19 (29%)
<b>Genotoxicity</b>	Blood and urine	2	1	2	1	6 (9%)
<b>Thrombogenicity</b>	Blood	4	10	8	-	22 (34%)
<b>Heart rate variability</b>	ECG or frequency counter	3	5	9	1	18 (28%)
<b>Vascular function</b>	Vascular challenge, BP, pulse wave analysis and blood	5	15	6	1	27 (42%)
<b>Arrhythmia</b>	ECG	2	2	4	-	8 (13%)
<b>Neurotoxicity</b>	Blood, urine and EEG	-	3	1	-	4 (6%)



## Consistent observations

Endpoint	Studies (subjects)	Wood Smoke (n=12)			Diesel exhaust (n=33)			CAP (n=15)			Indoor (n=4)		
		×	÷	?	×	÷	?	×	÷	?	×	÷	?
Airway inflammation	29 (539)	5 (102)	2 (39)	1 (14)	9 (126)	2 (36)	0 (0)	2 (49)	4 (106)	2 (18)	1 (26)	1 (23)	0 (0)
Lung function	25 (476)	0 (0)	5 (73)	0 (0)	5 (81)	5 (73)	0 (0)	1 (17)	6 (121)	0 (0)	1 (55)	2 (49)	0 (0)
Systemic inflammation	36 (658)	2 (23)	3 (47)	0 (0)	4 (51)	15 (268)	0 (0)	4 (112)	7 (134)	0 (0)	0 (0)	1 (23)	0 (0)
Oxidative stress	19 (377)	2 (23)	3 (53)	1 (13)	4 (61)	4 (73)	0 (0)	2 (80)	1 (25)	0 (0)	0 (0)	2 (49)	0 (0)
Genotoxicity	6 (151)	1 (13)	1 (20)	0 (0)	0 (0)	1 (18)	0 (0)	2 (75)	0 (0)	0 (0)	0 (0)	1 (23)	0 (0)
Thrombogenicity	22 (383)	2 (26)	2 (36)	0 (0)	5 (69)	5 (113)	0 (0)	1 (34)	7 (105)	0 (0)	0 (0)	0 (0)	0 (0)
Heart rate variability	18 (320)	2 (24)	1 (20)	0 (0)	3 (34)	2 (46)	0 (0)	8 (157)	1 (19)	0 (0)	1 (20)	0 (0)	0 (0)
Vascular function	27 (647)	2 (62)	3 (50)	0 (0)	13 (228)	2 (33)	0 (0)	5 (185)	1 (34)	0 (0)	1 (55)	0 (0)	0 (0)
Arrhythmia	8 (176)	0 (0)	2 (29)	0 (0)	0 (0)	2 (46)	0 (0)	3 (82)	1 (19)	0 (0)	0 (0)	0 (0)	0 (0)
Neurotoxicity	4 (103)	0 (0)	0 (0)	0 (0)	2 (20)	1 (28)	0 (0)	0 (0)	1 (55)	0 (0)	0 (0)	0 (0)	0 (0)

×, effect observed;  
 ÷, no effect observed;  
 ?, inconsistent observation;

Highlighted if 75% of the studies that investigated the effect marker from the same source were consistent (and with more than 50 study subjects),

red indicates effect observed,  
 blue indicates no-effect.





## Consistent observations

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		×	÷	?	×	÷	?	×	÷	?	×	÷	?
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- Endpoint
- Timing
- Method
- Population
- Exposure dose
- Combustion

×, effect observed;

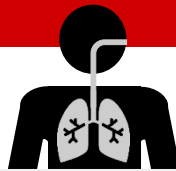
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?, inconsistent observation;

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blue indicates no-effect.

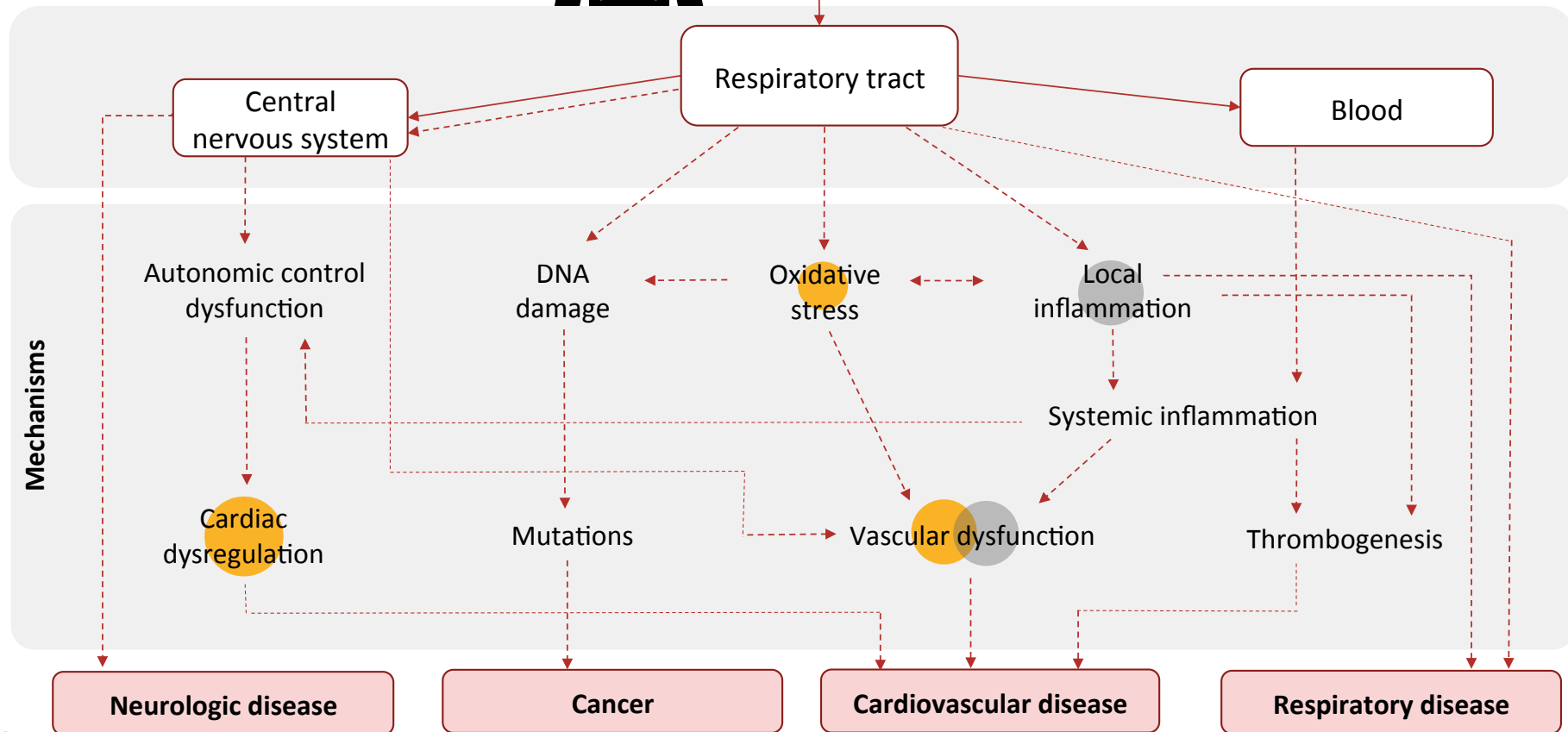


## Consistent observations



UFP  
Inhalation

- Consistent observations for CAP
- Consistent observations for DE



# Thank you

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for the Working Environment**

