Health Effects of Ultrafine Particles

Systematic literature search

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Aims

- Investigate health effects of ultrafine particles, independent of other pollutants
- Systematic literature review
- Epidemiological studies
- Based on prior HEI review from 2013

Methods

- Combined literature search strategy:
  - MEDLINE (National Institut of Health, USA)
  - plus LUDOK (Dokumentationsstelle Luftverschmutzung und Gesundheit, SwissTPH)
  - plus hand search (review articles, search by author, conference proceedings)

- Time period 2011 - 2017

Inclusion criteria

- Quantifiable measures of association
- Containing at least one UFP metric **and/or** containing at least one quasi-UFPs metric (submicron range)
- Health outcomes: Mortality, diseases, symptoms, emergency department visits, hospital admissions, subclinical outcomes

Exclusion criteria

- Toxicological studies, controlled exposure studies, animal experiments, in-vitro studies
- Exposure to industrially engineered nanoparticles, occupational settings, source-related indoor nanoparticles, Diesel particles, BC or EC only
- Distance measures in substitution of exposure measurements
- Health outcomes of unclear health relevance, e.g. epigenetics, metabolomics, methylation

Quality assessment

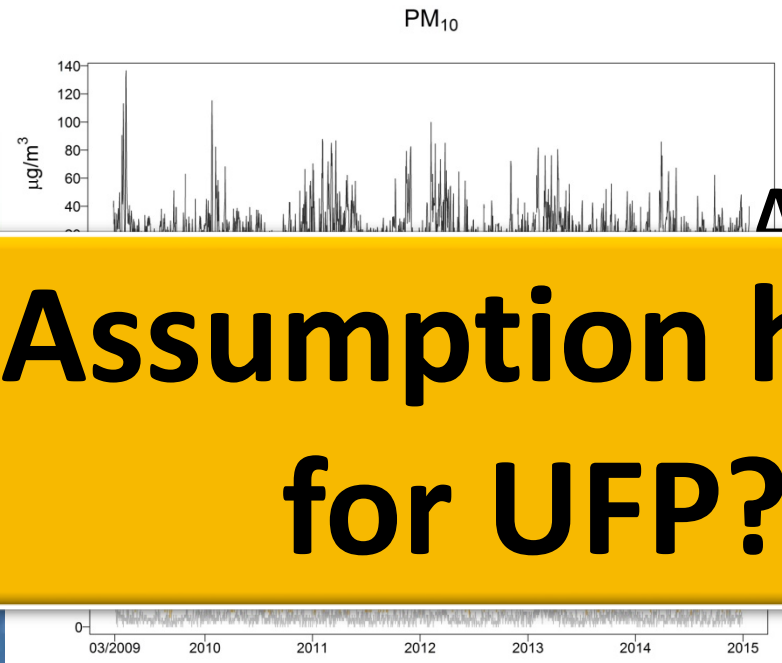
Included:

- Exposure
  - Type of exposure assessment
  - Description of size ranges
  - Exposure assessment for co-pollutants
- Analysis
  - Adjustment for other air pollutants

Why is exposure assessment such a big deal?

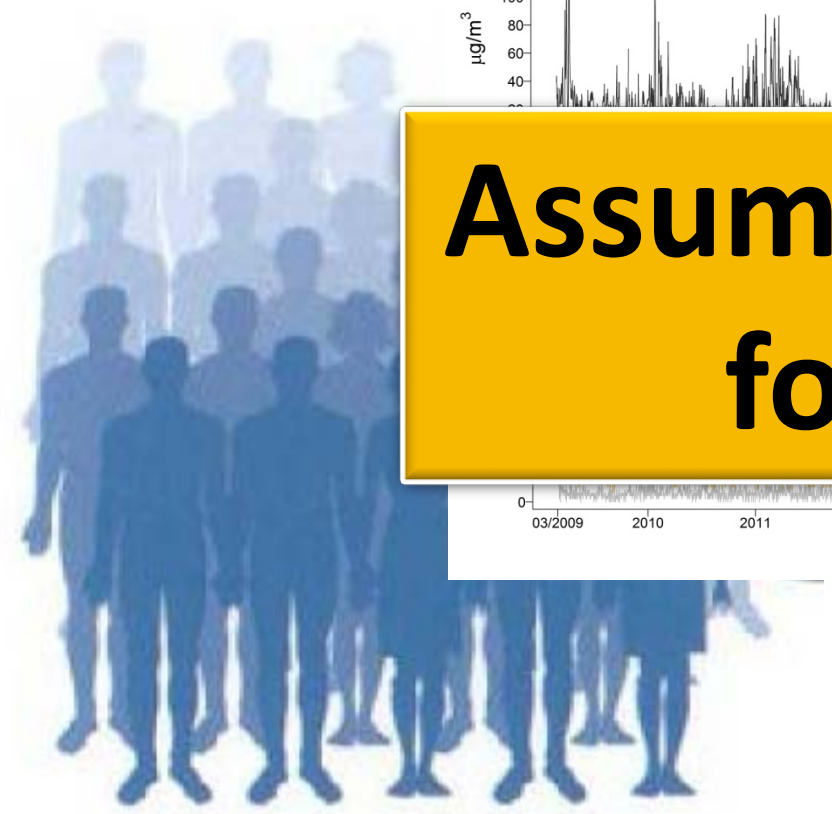
Studies on short-term effects

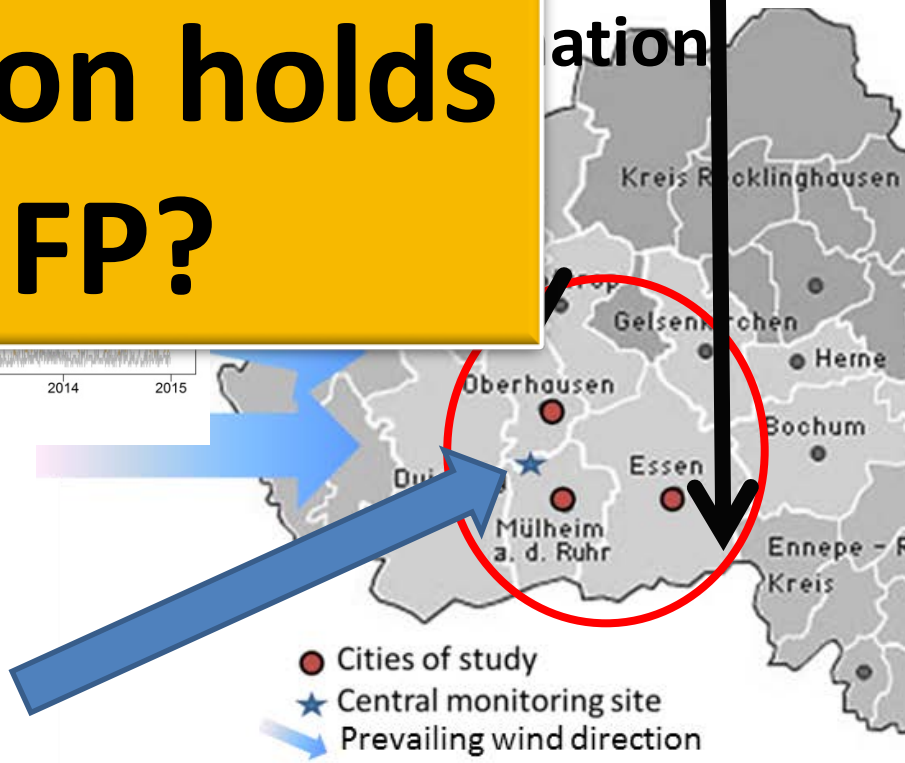
Assumption:
Δ PMx = Δ PMy



ΔPM: basis for health
ation

Assumption holds for UFP?



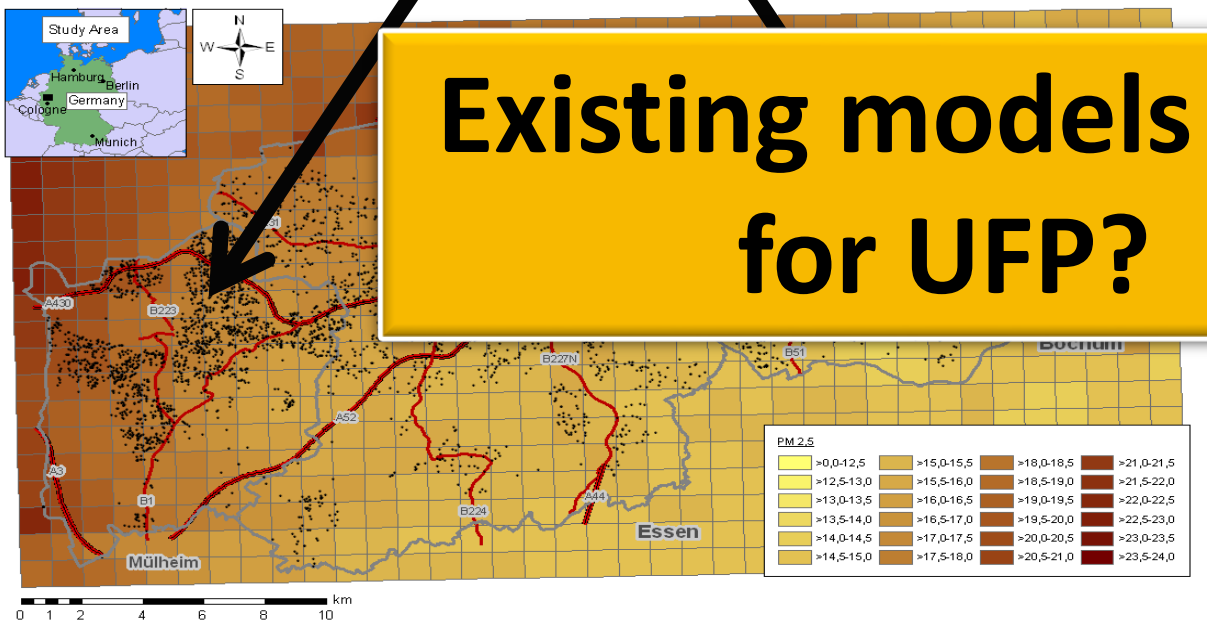


Studies on long-term effects

Assumption:
PMx ≠ PMy

Spatial difference basis for exposure assessment

Existing models valid for UFP?



Consequences for health effect assessment

- Underestimation of true variability of UFP exposure

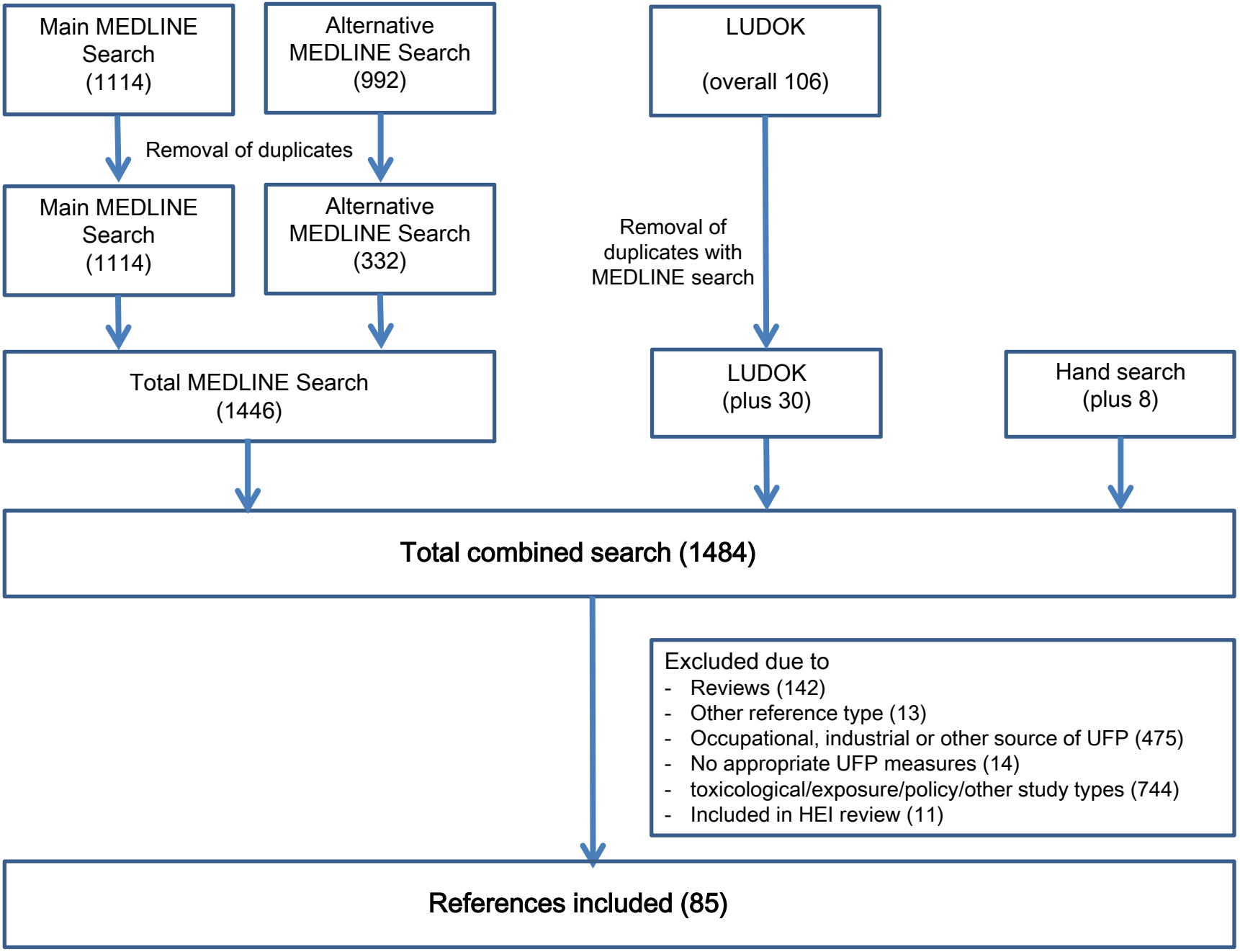
-> Underestimation of health effects

- Correlation between „conventional“ PM-measures and UFP high

- Estimation of effects of PM more precise than effects of UFP

-> in multipollutant models, overall effect will be „drawn“ to the most precisely measured pollutant

Results


Main MEDLINE Search (1114)
Alternative MEDLINE Search (992)
LUDOK (overall 106)
Removal of duplicates
Main MEDLINE Search (1114)
Alternative MEDLINE Search (332)
Removal of duplicates with MEDLINE search
Total MEDLINE Search (1446)
LUDOK (plus 30)
Hand search (plus 8)
Total combined search (1484)
Excluded due to
- Reviews (142)
- Other reference type (13)
- Occupational, industrial or other source of UFP (475)
- No appropriate UFP measures (14)
- toxicological/exposure/policy/other study types (744)
- Included in HEI review (11)
References included (85)

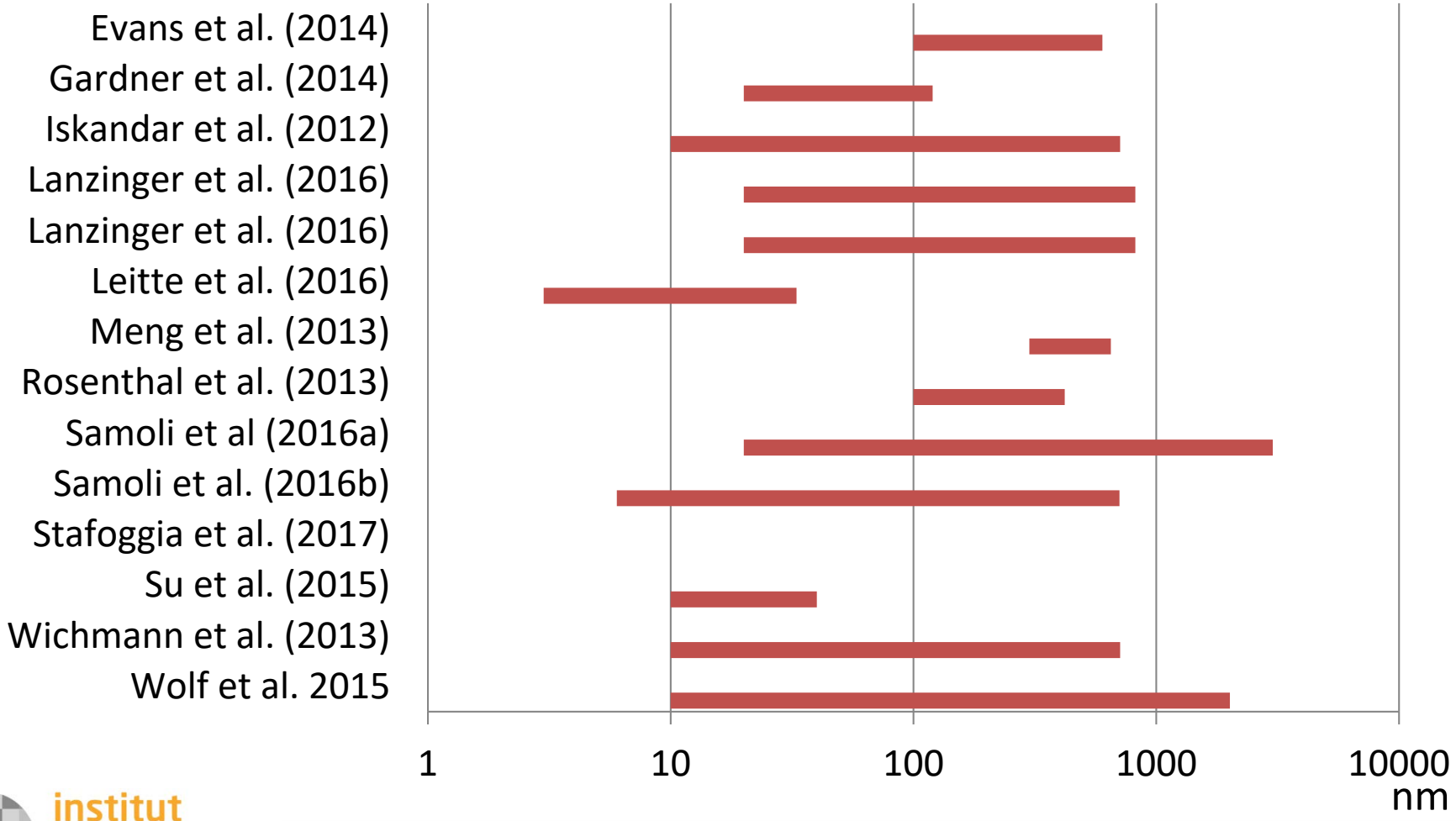
Study charcteristics (n=85)

World region	Number of studies	%
Africa	0	0.0%
North America	37	43.5%
Middle/ South America	1	1.2%
Western Europe	27	31.8%
Eastern Europe	2	2.4%
South-East-Asia	1	1.2%
Western-Pacific	12	14.1%
Multiple study regions	5	5.9%
Total	85	100.0%

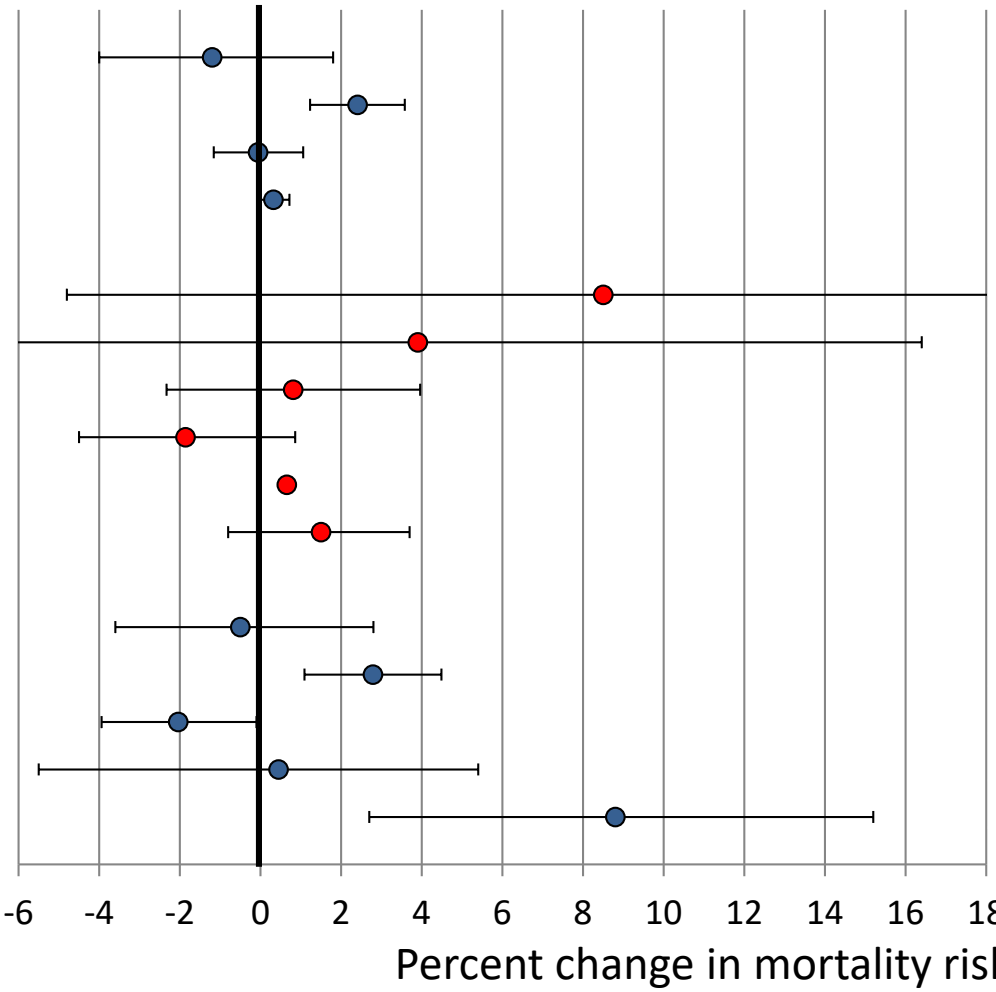
Characteristics	short-term (N=75)	long-term (N=10)	Total (N=85)
Study design			
Case-cohort	-	1	1
Case-control	-	1	1
Cohort	4	4	8
Cross-sectional	4	4	8
Panel	32	-	32
Case-crossover	8	-	8
Scripted exposure	16	-	16
Time-series	11	-	11
Exposure assessment technique			
Model based	2	9	11
Measurement	73	1	74
Exposure metric			
UFP	9	5	14
quasi-UFP	45	5	50
UFP + quasi-UFP	19	0	19
Co-pollutants	32	1	33
Outcome type			
Mortality	7	1	8
Morbidity	7	4	11
Emergency	11	0	11
Subclinical	55	5	60
Outcome - organ related			
Total mortality	4	1	5
Cardiovascular	47	4	51
Respiratory	24	1	25
Inflammation	26	3	29
Oxidative stress	4	0	4
Neurocognitive	3	1	4
Other	2	3	5

Size range

(mortality/morbidity studies with co-pollutant adjustment only)

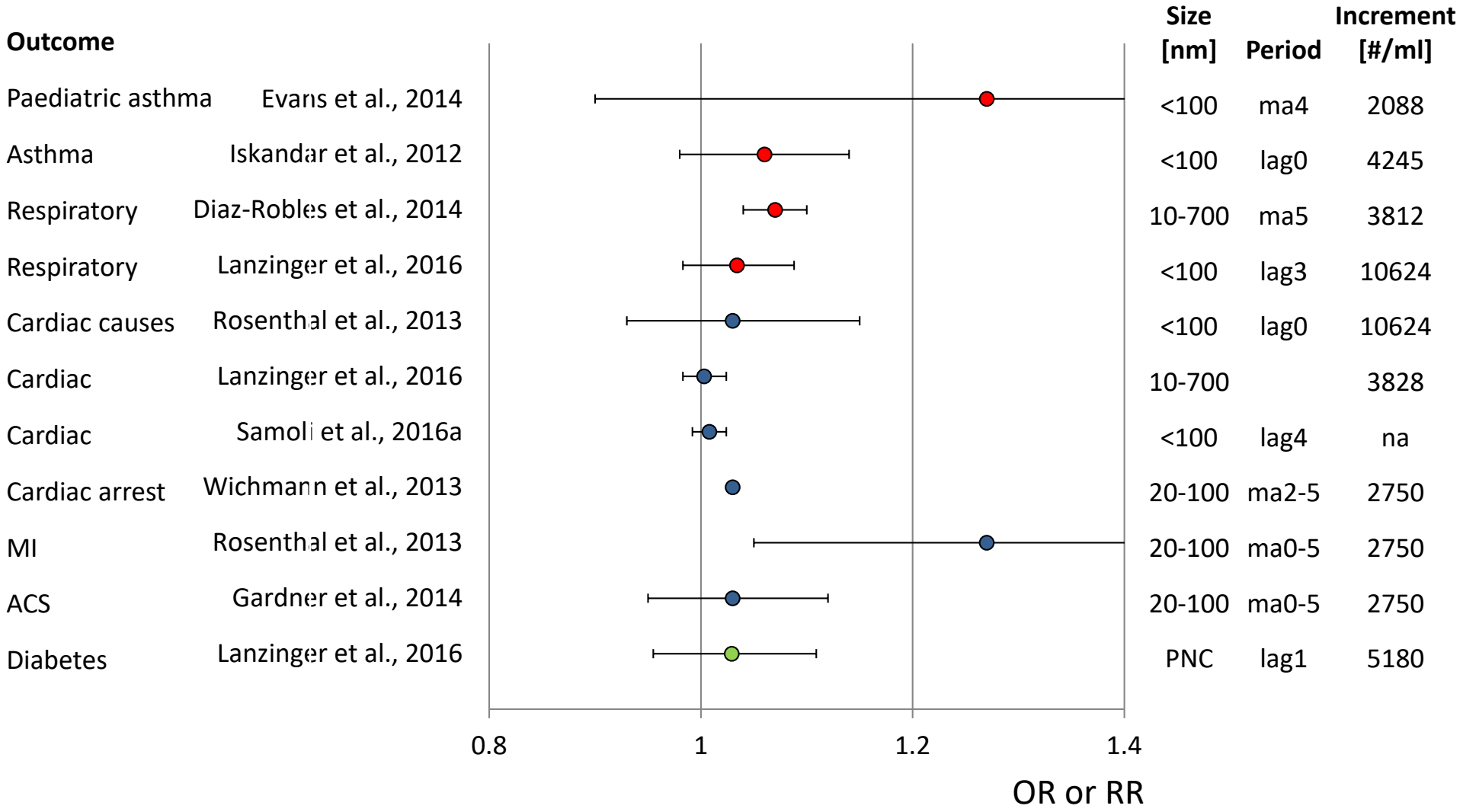


Mortality



	Size [nm]	Period	Increment [#/ml]
Natural			
Lanzinger et al. 2016a	20-100	ma2-5	2750
Meng et al., 2013	250-280	ma0-1	2600
Samoli et al., 2016a	PNC	lag1	5180
Stafoggia et al., 2017	PNC	lag5	10000
Respiratory			
Lanzinger et al. 2016a	20-100	ma2-5	2750
Leitte et al., 2012	3-100	ma0-4	13000
Meng et al., 2013	300-350	ma0-1	1510
Samoli et al., 2016a	PNC	lag2	5180
Stafoggia et al., 2017	PNC	lag6	10000
Wolf et al., 2015	10-2000	lag0	6800
Cardiovascular			
Lanzinger et al. 2016a	20-100	ma0-1	2750
Meng et al., 2013	250-280	ma0-1	2600
Samoli et al., 2016a	PNC	lag1	5180
Stafoggia et al., 2017	PNC	lag7	10000
Su et al., 2015	3-100	ma5	8328

ED visits/hospital admissions



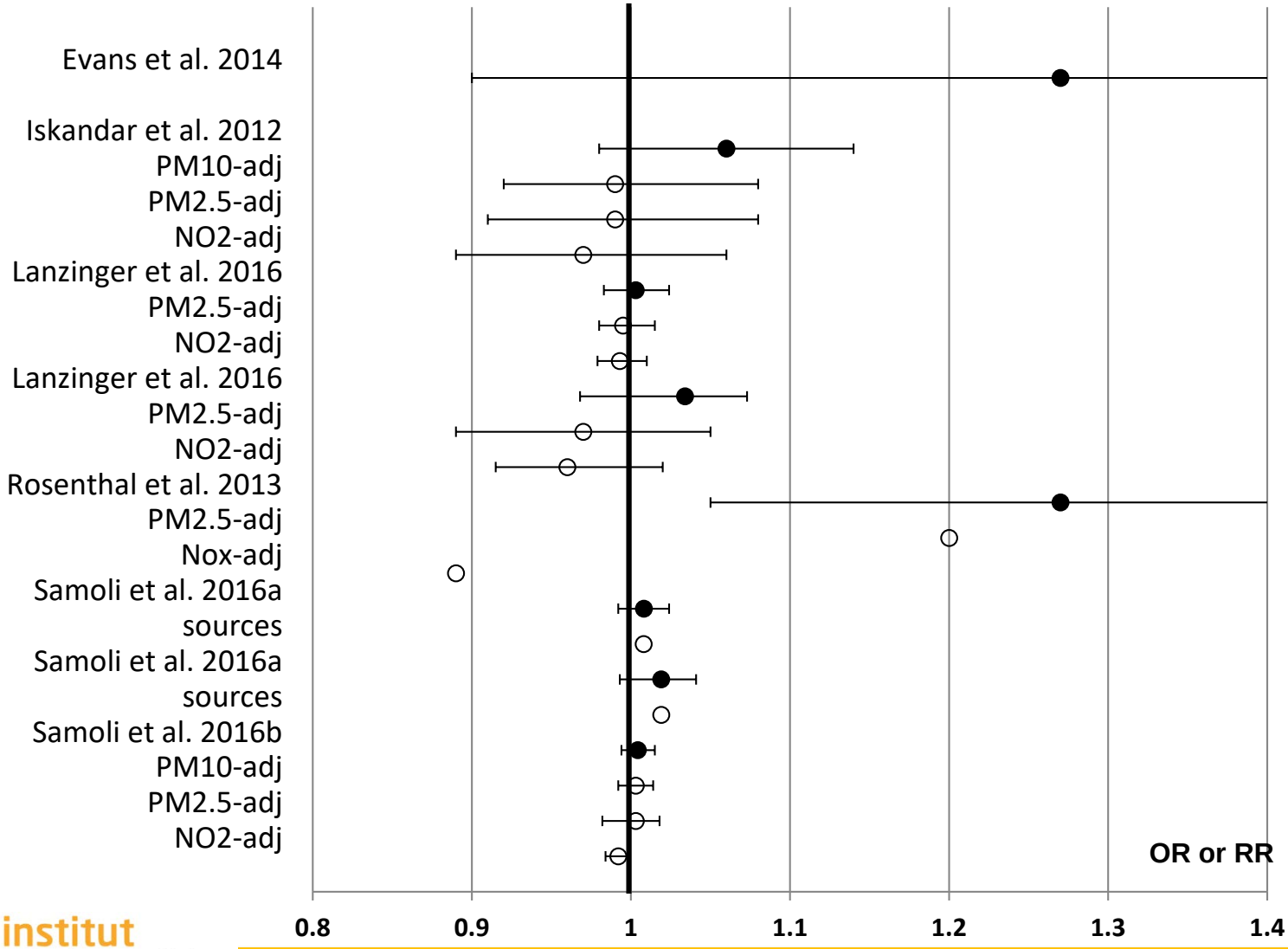
Subclinical outcomes

Outcome	Number of studies	Number of studies with associations in expected direction without co-pollutant adjustment	Number of studies with associations in expected direction with co-pollutant adjustment
Respiratory indices	11	4/11	3/3
Blood pressure	13	9/13	2/4
HRV	16	12/16	3/5
Arrhythmia	1	1/1	-
Vascular function	7	4/7	1/2
Pulmonary inflammation	12	12/12	2/2
Systemic inflammation	18	7/18	2/5
Neurocognitive outcomes	2	1	-

Novel: Long-term studies

Outcome type/ study	Outcome	Associations w/o co-pollutant adjustment	Associations with co-pollutant adjustment
Mortality Ostro et al. 2015	- all-cause	0	nc
	- cardiovascular/ IHD	(+)/0	nc
	- pulmonary	0	nc
Morbidity Li et al. 2017	- Cardiometabolic	(+)	nc
Laurent et al. 2014/2016b	- low birth weight	+/(+)	nc
Laurent 2016a	- preterm birth	-/+	nc
Subclinical			
Aguilera et al. 2016	- carotid-intima-media thickness (PNC/LDSA)	+/+	-/(+)
Viehmann et al. 2015	- hs-CRP/ fibrinogen/ WBC	(+)/+/(+)	nc
Lane et al. 2015	- hs-CRP/ IL-6	(+)/(+)	nc
Lane et al. 2016	- hs-CRP/ IL-6/ TNRFIII/ fibrinogen	(+)/(+)/(+)/(-)	nc
Sunyer et al. 2016	- working memory,	(+)	
	- superior working memory,	+	
	- inattentiveness	+	

Adjustment for co-pollutants - morbidity



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umweltmedizin

Overall summary

Outcome	Single pollutant effect	Consistency of general pattern	Multi-pollutant effect	Consistency of general pattern
Short-term	**49/79***	**21/49**	**18/32**	**7/18**
Mortality	5/7	2/5	4/6	1/4
Morbidity	3/7	0/3	-	-
Hospital admission	4/10	2/4	0/5	-
Subclinical	37/55	17/37	14/21	6/14
Long-term	**8/10**	**1/1**	**0/1**	**-**
Mortality	1/1	1/1	-	-
Morbidity	3/4	-	-	-
Hospital admission	-	-	-	-
Subclinical	4/5	-	0/1	-

Conclusions

- Exposure assessment remains the major challenge
- Inconsistency across endpoints
  - Most consistent for subclinical outcomes (lung function, cardiovascular effects)
  - First studies on long-term effects
- Few studies with co-pollutant adjustment, often leading to attenuation (specifically NO_2-adjustment)
- Improvement of exposure assessment methodology necessary

Thank you!

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