



# Emerging Substances in Indoor Air

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## Some facts

- Exposure plays an important role in risk assessment and analysis
- Total Human Exposure means: all routes/all sources
- Exposure to Air Pollutants includes both indoor/outdoor environments
- The time we spend indoors amounts to approx. 85-90% of the total time. Human exposure to the majority of (air) pollutants occurs mainly indoors.
- Exposure is a key issue in the Commission's Environment and Health Strategy (Action Plan: 2004-2010)

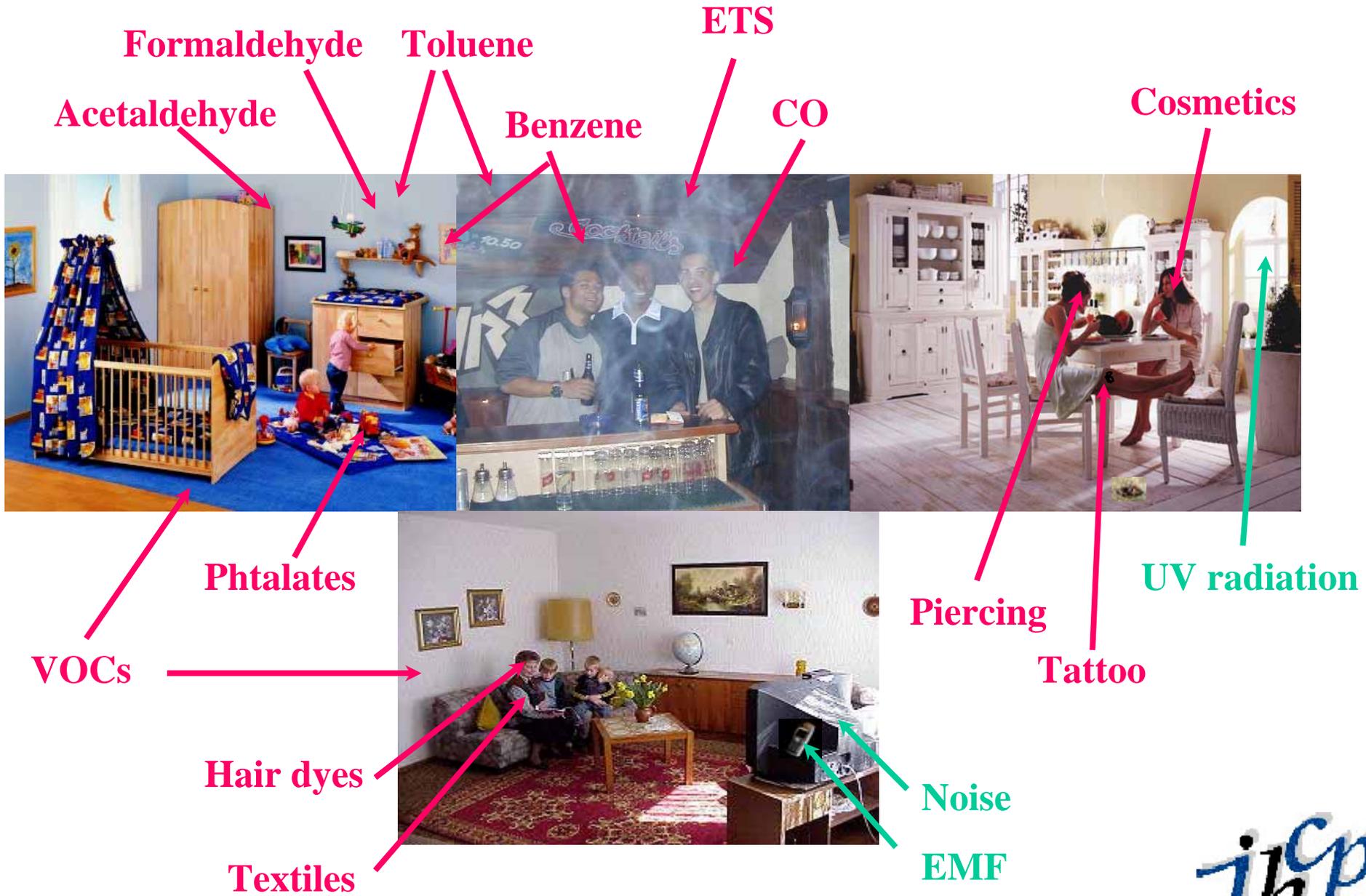


- Exposure to single compounds or to mixtures of compounds?
- Chronic low dose exposure?
- Sampling: passive or active?
- Personal exposure concentrations or area concentrations
- Link to epidemiological studies



# Personal EXPOSURE to chemical and physical agents

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## The INDEX project

-Critical appraisal of the setting and implementation of indoor exposure limits in the EU-

**Group 1 (high priority):** benzene, formaldehyde, carbon monoxide, nitrogen dioxide, and naphthalene

**Group 2 (second priority):** m&p-xylenes, o-xylene, acetaldehyde, styrene, toluene

**Group 3 (chemicals requiring further research with regard to human exposure and dose/response):** NH<sub>3</sub>, d-limonene, α-pinene.



## The AIRMEX project

(European Indoor Air Monitoring and Exposure Assessment Study)

The pollutant concentrations have been examined at three separate levels:

→ Personal exposure monitoring

→ Indoor air

→ Outdoor Measurements (ambient air)

→ Additionally daily questionnaires were prepared for each volunteer, describing movements, activities and accidental exposures to high concentrations (e.g. renovation)



VOCs

Hexane

*Benzene*

Toluene

Ethylbenzene

m/p-Xylene

o-Xylene

1,3,5-Trimethylbenzene

a-Pinene

d-Limonene

Carbonyls

*Formaldehyde*

Acetaldehyde

Propanal

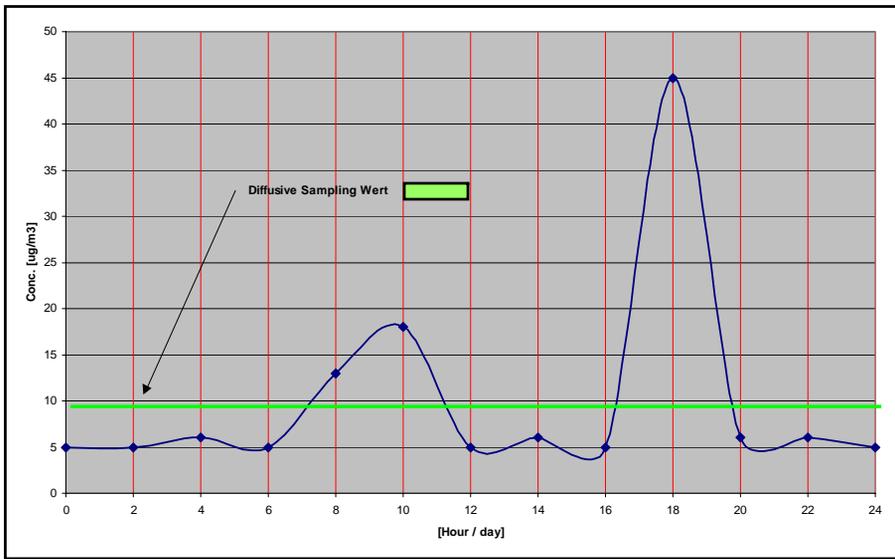
Hexanal



# How do we measure ?

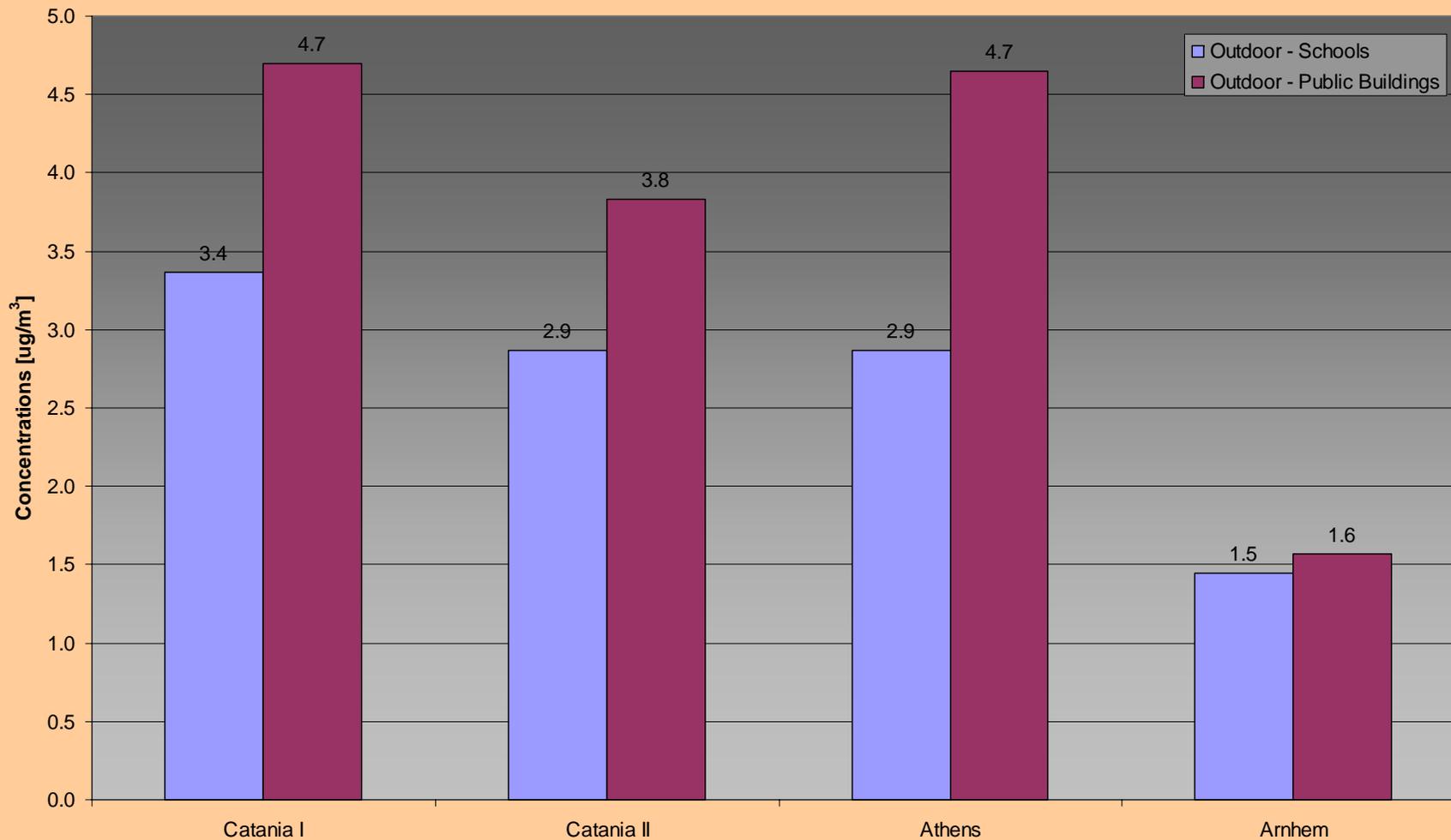
Passive or diffusive sampling technique

Advantage: Results are average values over a defined period of time. Active sampling sometimes gives less representative spot values.



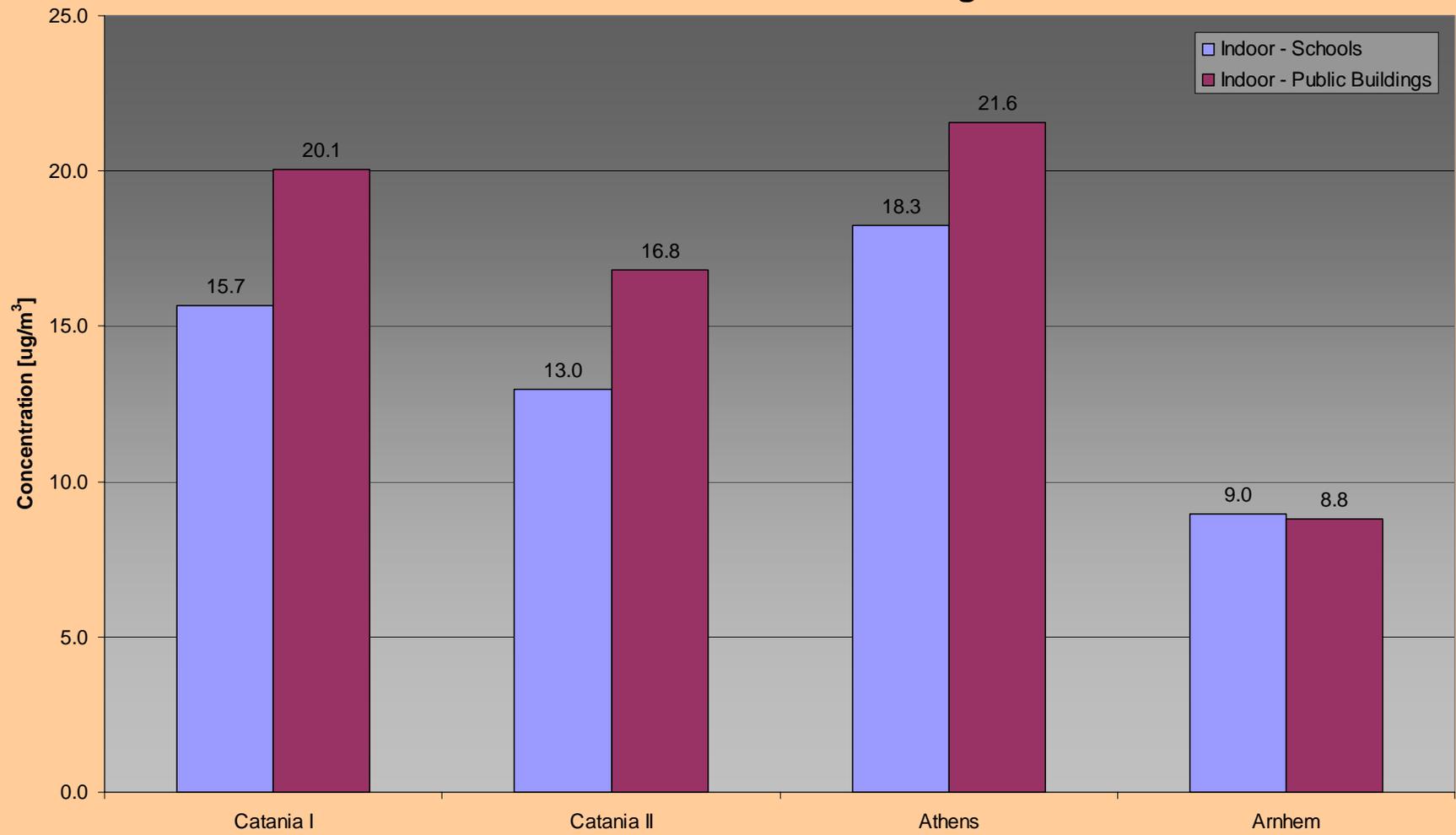


### Comparison Outdoor Concentrations Formaldehyde Schools / Public Buildings



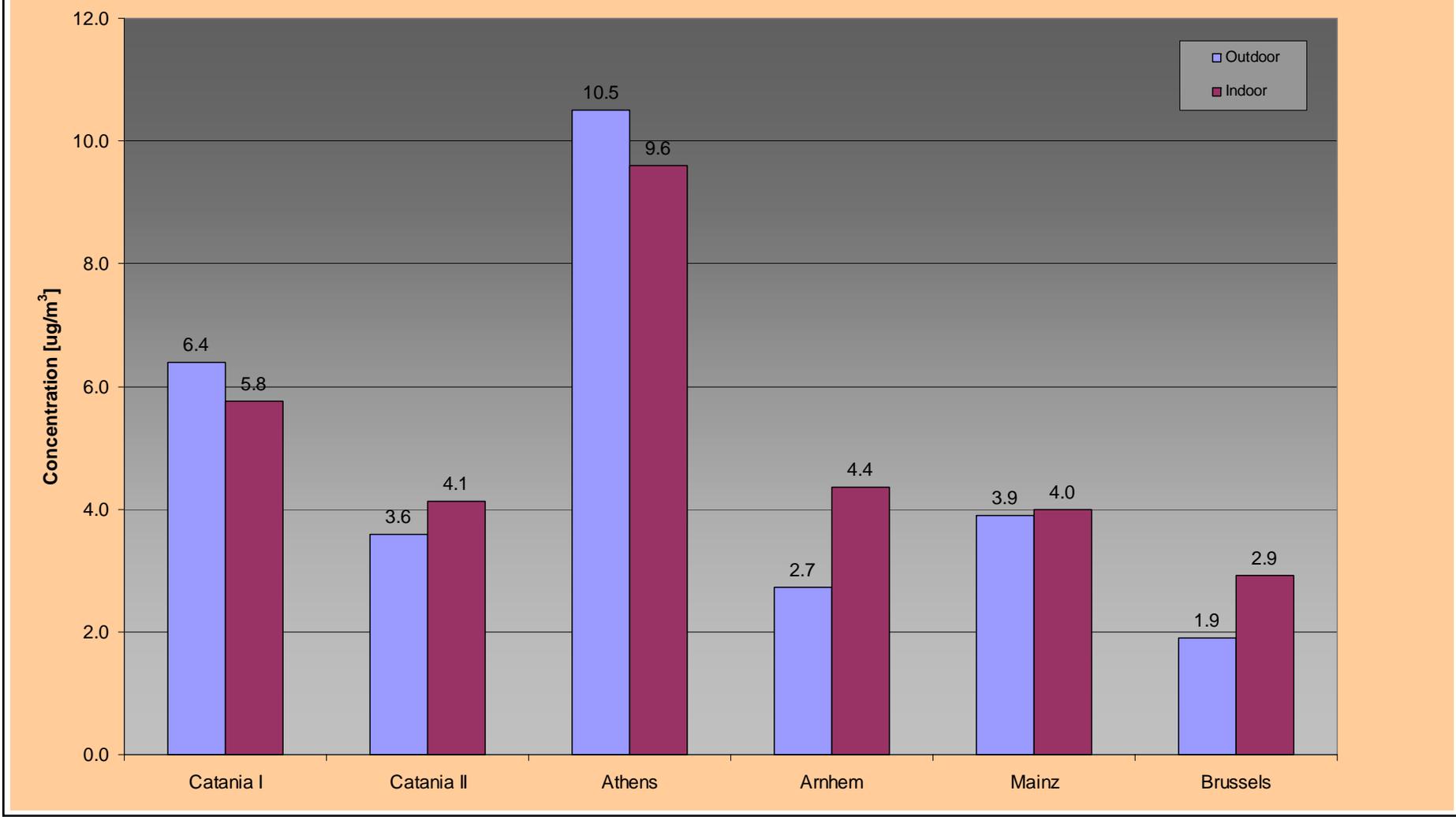


### Comparison Indoor Concentrations of Formaldehyde Schools / Public Buildings





### Comparison Benzene - Indoor / Outdoor in Public Buildings



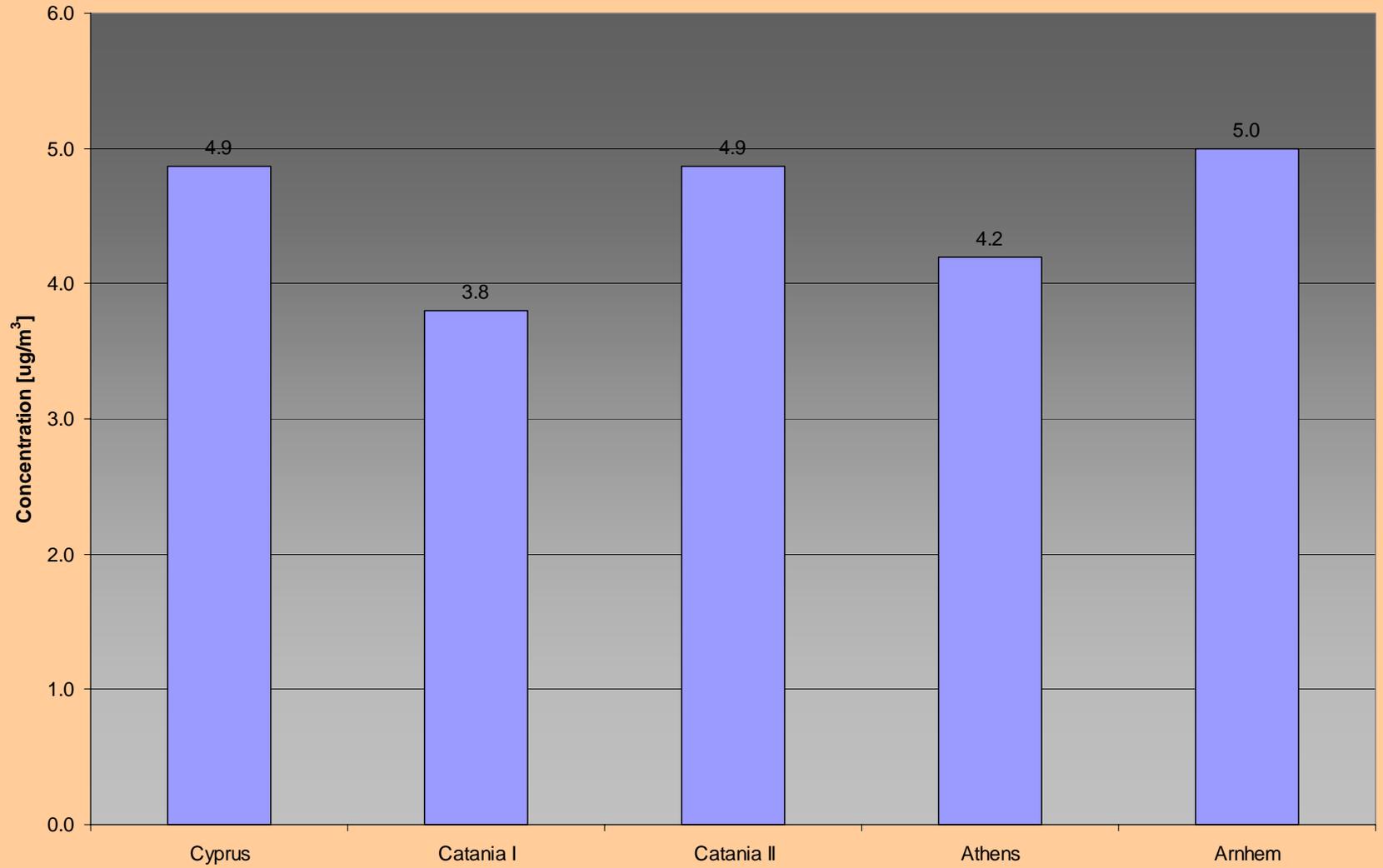


Comparison of BTEX in the "Sede Distretto Sanitario Catania 2"  
AIRMEX Catania





### Personal Exposure of Teachers to Benzene





## VOC[t] Edifici Pubblici

Citta'	VOC <sub>[t]</sub> Outdoor	VOC <sub>[t]</sub> Indoor	VOC <sub>[t]</sub> Personal	Benzene Outdoor	Benzene Indoor	Benzene Personal
<b>Catania</b> (Ottobre)	44.8 – 105.8 ( 67 )	39.6 – 157.1 ( 63.8 )	91 – 149 ( 112.5 )	5.5 – 8.0 ( 6.4 )	4.9 – 17.1 ( 7.4 )	4.7 – 8.2 ( 6.2 )
<b>Catania</b> (Maggio)	21.9 – 52.3 ( 43.6 )	20.9 – 40.4 ( 27.0 )	58.2 – 136.4 ( 79.1 )	2.8 – 4.7 ( 3.6 )	2.8 – 4.8 ( 3.9 )	3.1 – 7.0 ( 4.9 )
<b>Atene</b> (Dicembre)	49.4 – 125.2 ( 87.3 )	62.4 – 159.2 ( 112.4 )	174.4 – 312.6 ( 243.5 )	6.8 – 14.2 ( 10.5 )	7.3 – 13.3 ( 10.9 )	17 – 18.6 ( 17.8 )
<b>Nijmegen</b> (Marzo)	15	20.2 – 26.2 ( 23.2 )	42.1 – 65.4 ( 53.8 )	3.7	3.1 – 5.4 ( 4.3 )	2.4 – 7.8 ( 5.1 )
<b>Arnhem</b> (Marzo)	7.7 – 10.7 ( 9.2 )	8.3 – 28.1 ( 21.7 )	28.0 – 74.8 ( 51.0 )	1.9 – 2.6 ( 2.3 )	1.8 – 6.2 ( 3.5 )	2.7 – 5.7 ( 4.0 )
<b>Salonicco</b> (Novembre)	40.2 – 153.7 ( 80.7 )	58.5 – 281.8 ( 143.6 )	80.0 – 164.8 ( 131.7 )	4.4 – 15.2 ( 8.7 )	8.0 – 63.7 ( 33.0 )	8.8 – 14.2 ( 11.3 )
<b>Bruxelles</b> (Settembre)	10.5 – 17.3 ( 13.9 )	17.5 – 34.0 ( 22.7 )	37.4 – 101.5 ( 66.3 )	1.3 – 2.5 ( 1.9 )	1.9 – 3.9 ( 2.9 )	1.5 – 6.0 ( 3.4 )



## VOC[t] Scuole ed Asili

Citta'	VOC <sub>[t]</sub> Outdoor	VOC <sub>[t]</sub> Indoor	VOC <sub>[t]</sub> Personal	Benzene Outdoor	Benzene Indoor	Benzene Personal
<b>Catania</b> (Ottobre)	22.2 - 55.5 (36.1)	(25.4 - 53.2) (36.6)	68.1 - 100.8 (88)	3.1 - 5.6 (4.2)	3.1 - 4.4 (3.8)	2.5 - 5.6 (3.8)
<b>Catania</b> (Maggio)	14.9 - 28.2 (22.0)	17.9 - 192.7 (76.7)	65.5 - 186 (85.7)	2.0 - 2.9 (2.5)	2.3 - 2.8 (2.6)	4.0 - 6.1 (4.9)
<b>Atene</b> (Dicembre)	31.7 - 39.5 (35.6)	57.1 - 99.5 (78.3)	104.2 - 130.7 (117.5)	5.2 - 6.9 (5.9)	4.9 - 10.7 (7.4)	3.4 - 4.8 (4.2)
<b>Nijmegen</b> (Marzo)	8.1	19.6	24.1	2.5	2.1	2.3
<b>Arnhem</b> (Marzo)	9.0	36.1	69.8	2.3	3	7.7
<b>Salonicco</b> (Novembre)	13.3 - 74.9 (48.0)	55.7 - 122.2 (88.0)	78.5 - 150.6 (114.9)	1.8 - 6.9 (4.6)	2.6 - 7.5 (5.8)	2.9 - 8.4 (6.1)
	-	-	-	-	-	-



## Conclusions:

- Personal Conc.  $>$  Indoor Conc.  $\geq$  Outdoor Conc.
- Concentrations in southern cities always higher
- In south, indoor conc. more similar to outdoor conc. than in north
- Concentrations in schools lower than in public buildings
- True personal exposure cannot be determined directly from measurements pertaining from fixed ambient background monitoring stations.



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