

# Nicotine in Environmental Tobacco Smoke - II Stability, Ratios, and Exposure Levels

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# NRC Criterion No. 4: Fairly Consistent Ratio

- Ratio relative to what?
  - Many potential “constituents of concern”
  - With exception of a few tobacco specific species, most other “COC” are found in indoor air with or without ETS present.
- Chemical stability
- Behavioral stability

# Chemical Stability Issues

- Degradation at the same rate as the components of interest
  - Nicotine degrades under high intensity UV
  - Seems to be stable at normal lighting levels
- No chemical changes following collection
  - Stability studies show nicotine stable up to 4 weeks

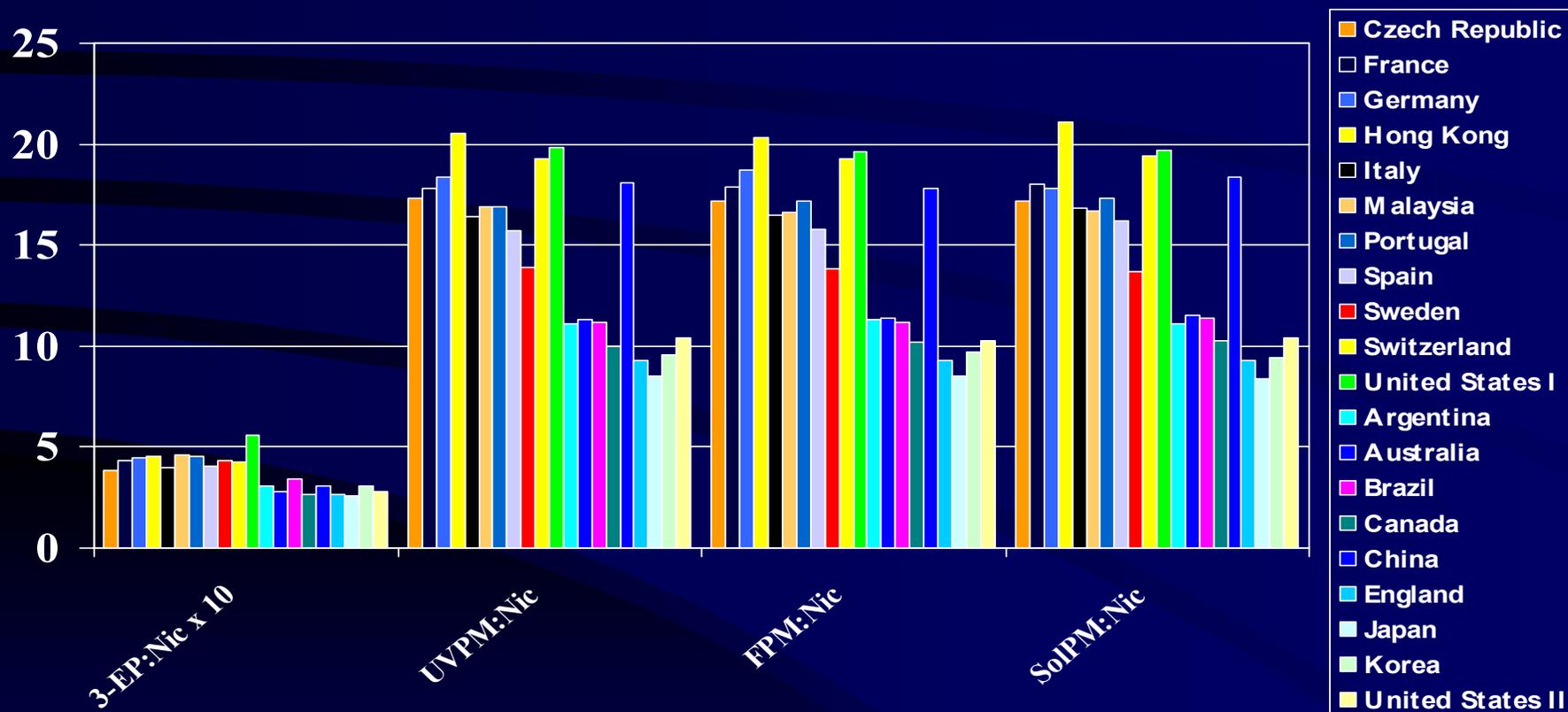
# “Behavioral Stability” Issues

- “Nicotine seems to stick to everything”
- Adsorption and desorption into air
- Chamber studies have demonstrated adsorption to metal, glass, wood, sheet rock, clothing material, ventilation systems.
- Numerous examples of airborne nicotine with no obvious ETS present.
- Analytical methods for nicotine are designed to prevent adsorption on analytical system surfaces.

# Emission Consistency

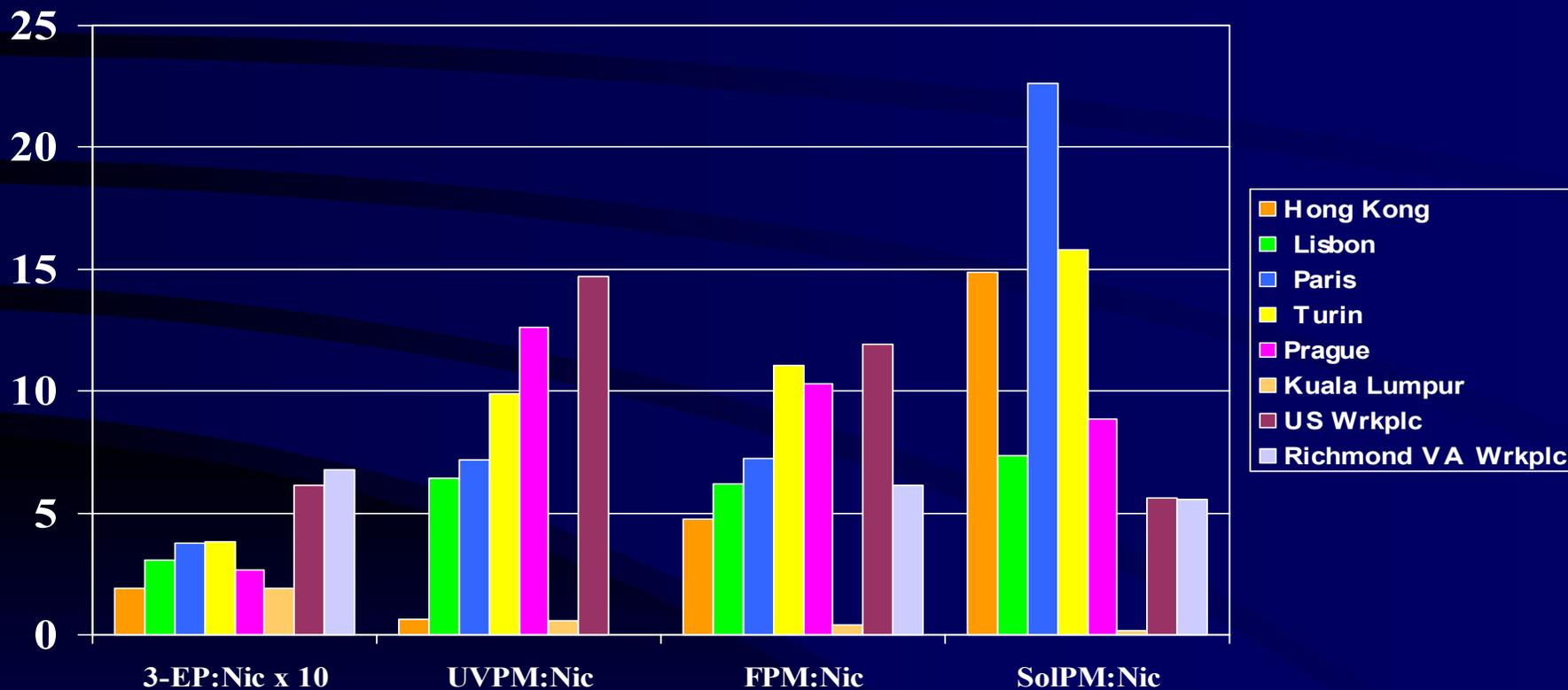
- Depends on the other components
- Tobacco nitrate levels will impact  $\text{NO}_x$  but not nicotine.
- Solanesol is 4% of Argentinian ETS RSP, and 1.5% of Canadian ETS RSP.
- Aside from the tobacco specific compounds, other sources in real environments can be substantial, and mandate apportionment studies.

# Ratios Observed in Chamber Studies: Other ETS Constituents to Nicotine



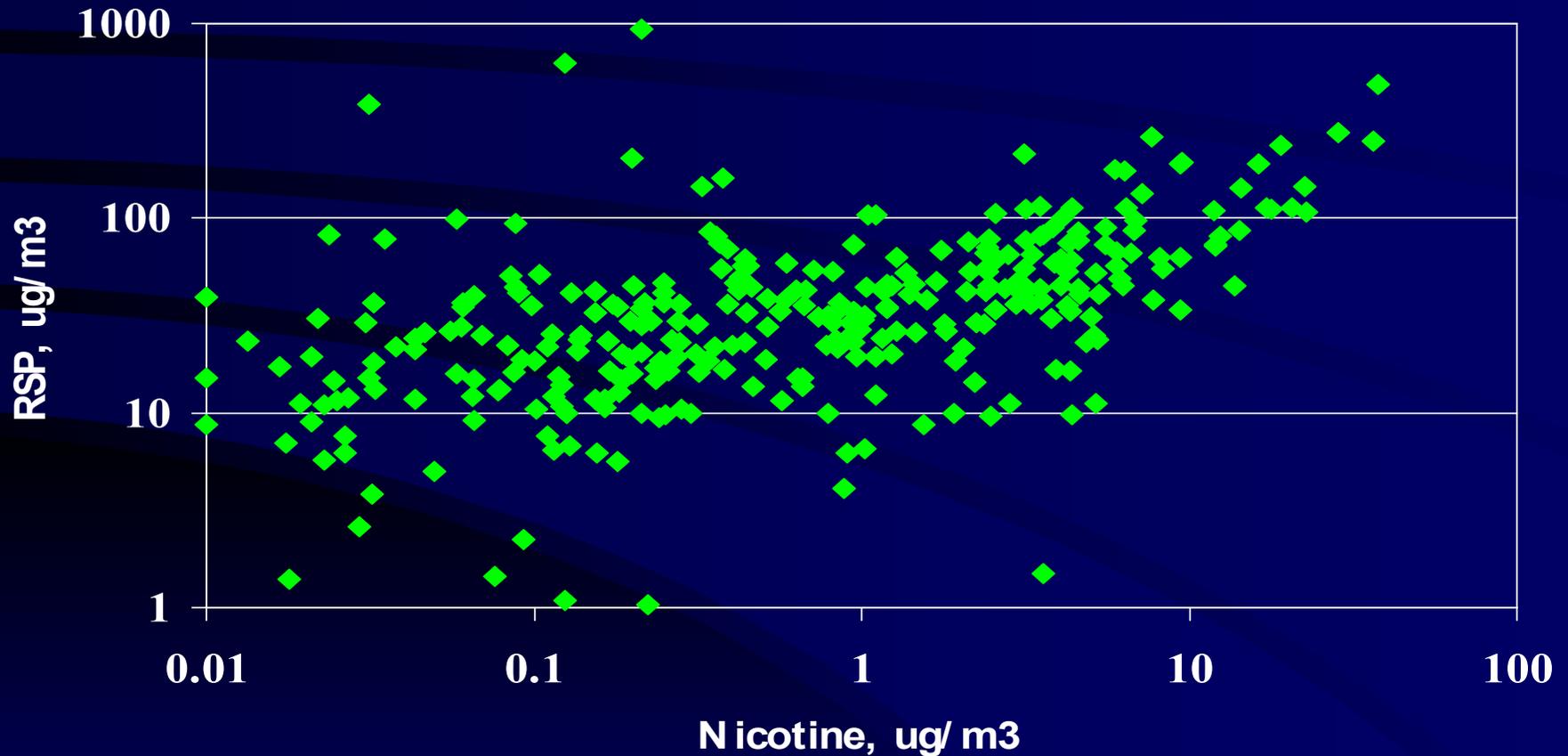
Data from Nelson et al, 1995, 1996

# Major Differences in Ratios Determined from Personal Exposure Measurements

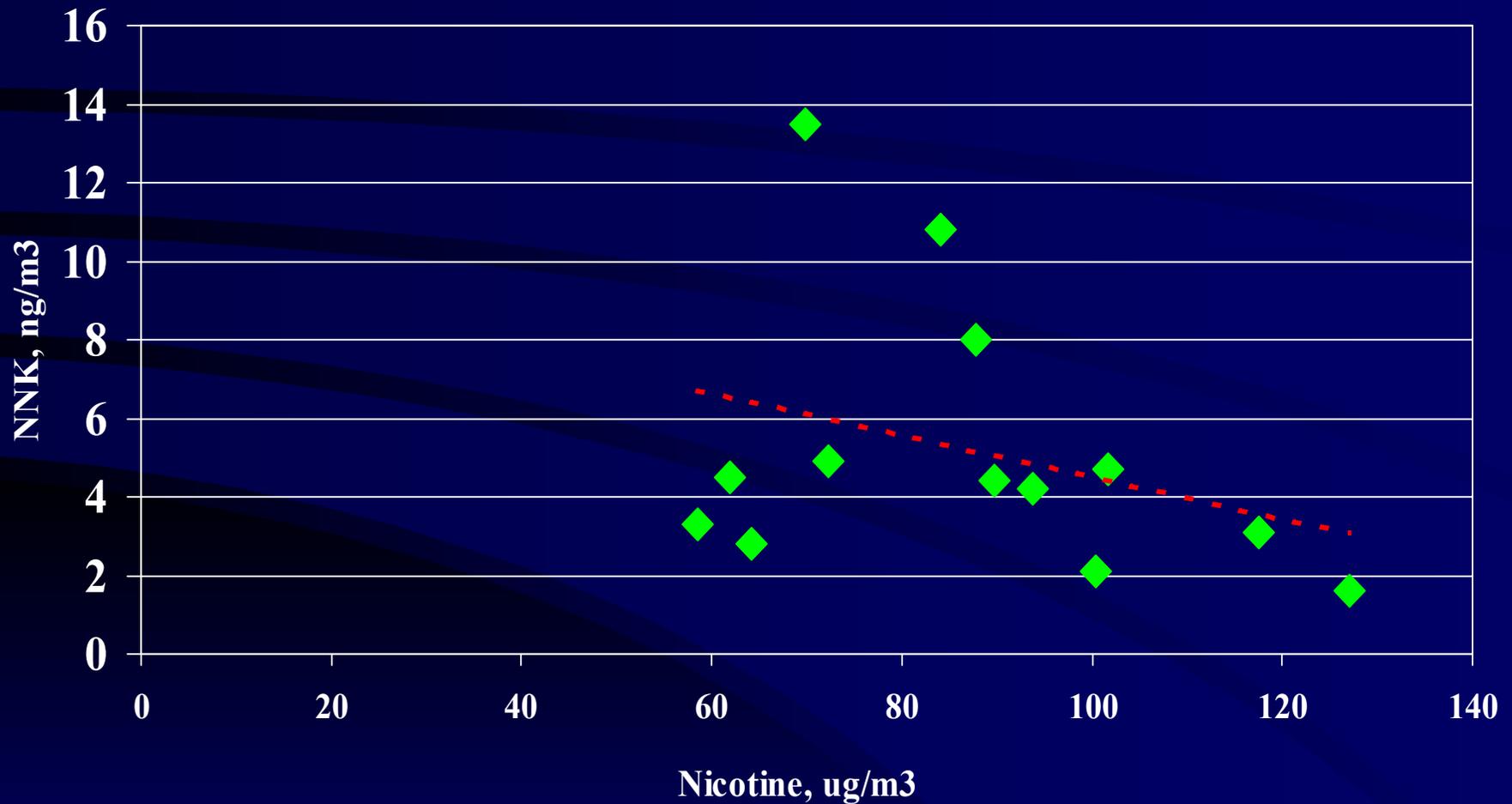


*Data from Phillips et al, 1997, 1998; Jenkins et al, 1996; Sterling et al, 1996*

# RSP vs Nicotine in Confirmed Smoking Workplaces by Personal Exposure US 16 Cities Study



# Not much of a proportional relationship between Nicotine and NNK



# Ratio Consistencies

- Chamber Studies
  - 3-EP = Solanesol = UVPM = FPM = RSP >> Nicotine
- Real-World Environments
  - 3-EP = Solanesol > FPM > UVPM > Nicotine >>> RSP

# ETS Levels and Exposure

- Nicotine continues to be employed as a marker because it can provide a **semi-quantitative** estimate of overall ETS level, it is **unique** to tobacco, and it **can be determined** by active and passive sampling.

# *Examples of Area Sampling*



Larger, more sophisticated sampling equipment



Can use small equipment in a stationary mode

# *Area Monitoring*

## Advantages

- ◆ Permits more sophisticated sampling and analysis systems to be used.
- ◆ Representative samples can be acquired despite knowledgeable target subjects.

## Disadvantages

- ◆ Only collects samples at a fixed location.
- ◆ Representative of human exposure only while subjects are in near vicinity of sampler location.

*Example of  
Personal Exposure  
System*



# *Personal Exposure Determinations*

## Advantages

- ◆ Measures (through sample collection or real time analysis) the integrated concentration of airborne species actually in the breathing zone of the subject.
- ◆ Directly reflects human activity patterns.

## Disadvantages

- ◆ Number or size of systems which can be worn by the subject without seriously affecting activity is limited.
- ◆ Knowledgeable subjects may alter their behavior patterns

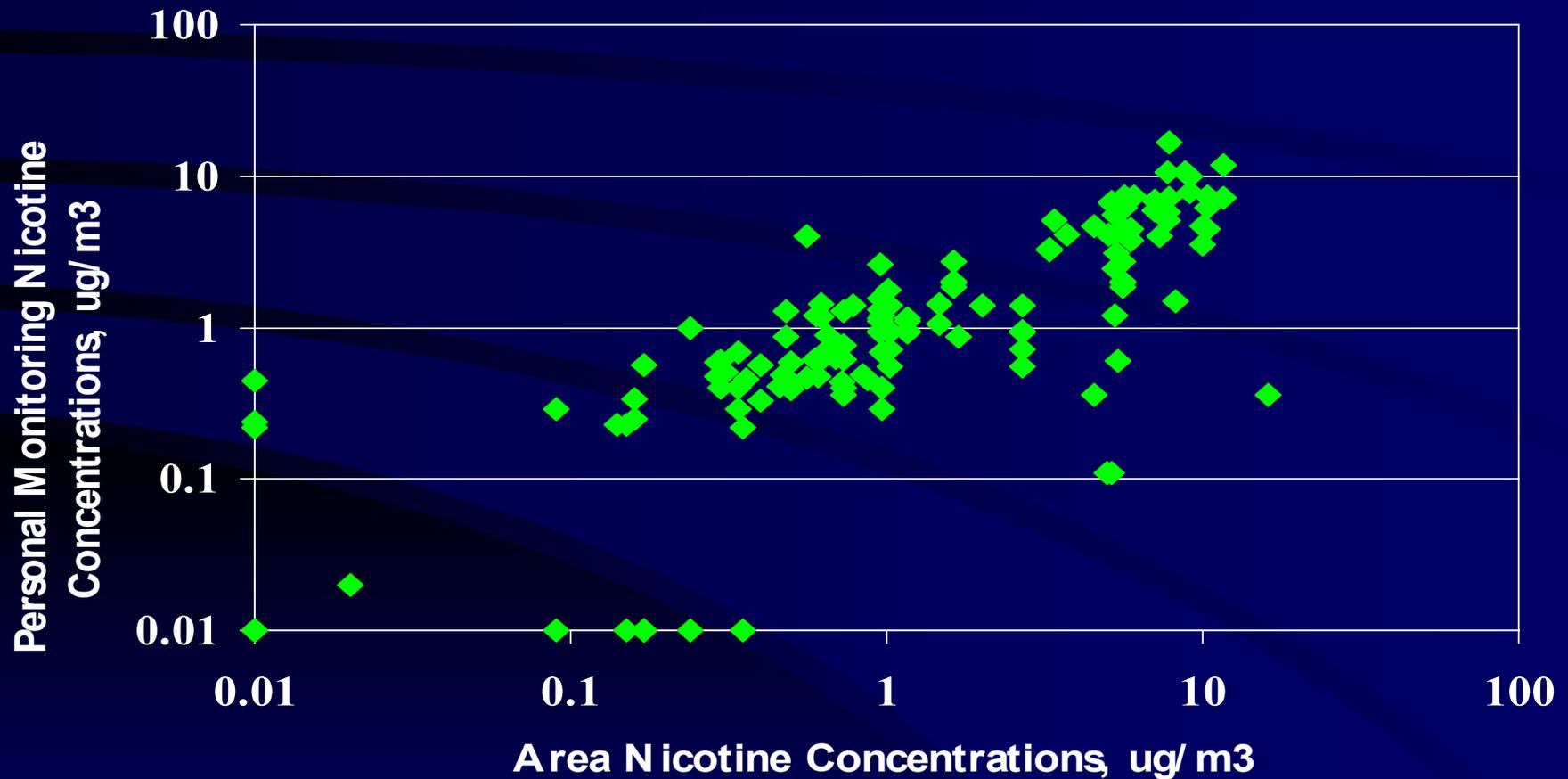
# Area vs. Personal Sampling

- Prior to 1991, most major studies employed area monitoring
  - Much less complex and costly
- Since 1992, large fraction of major studies have employed personal monitoring.
- Realization that humans move through a variety of micro-environments throughout the day.

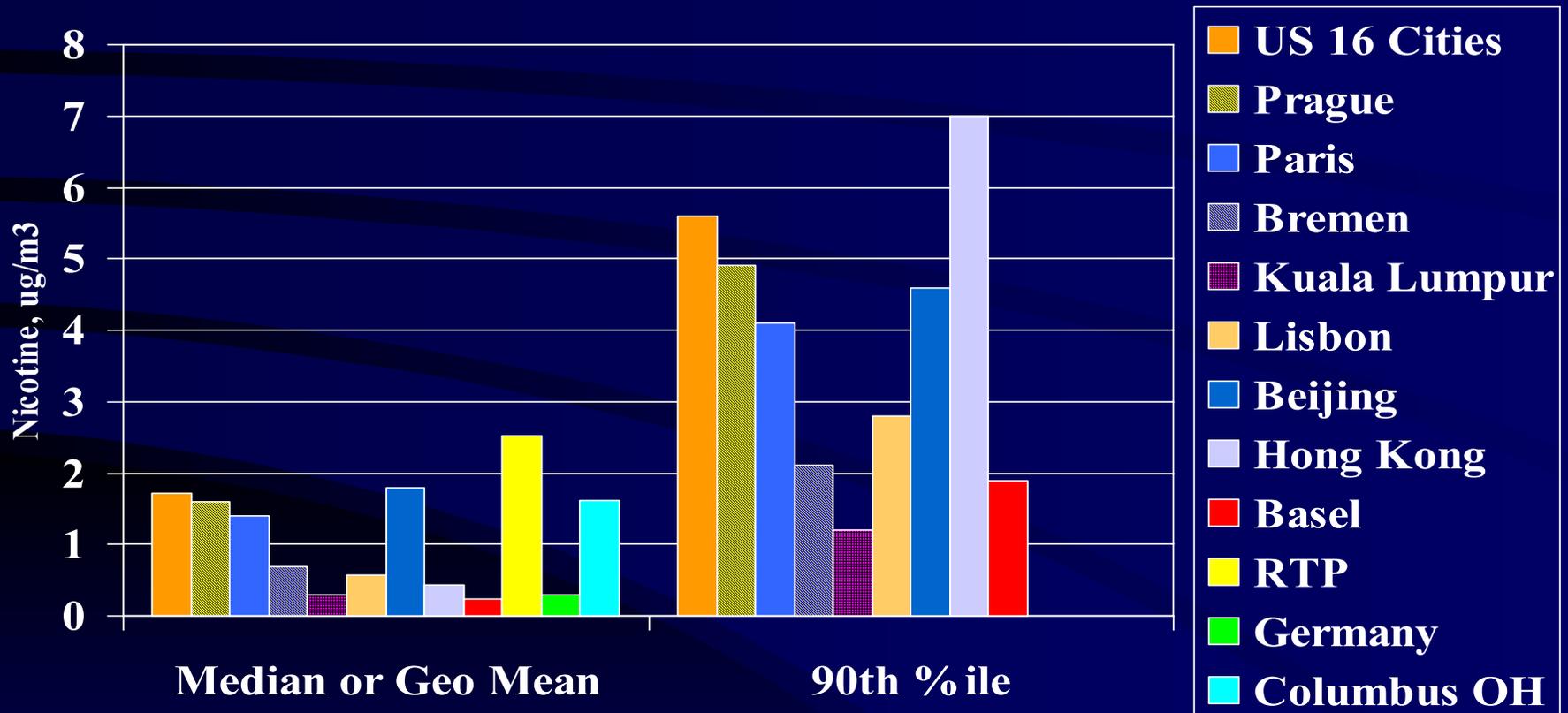
## Area vs. Personal Monitoring, cont.

- Head to head studies demonstrate that comparative statistics (group-wise) appear equivalent.
- On an individual basis, utility of area samples for prediction of personal exposure is limited.

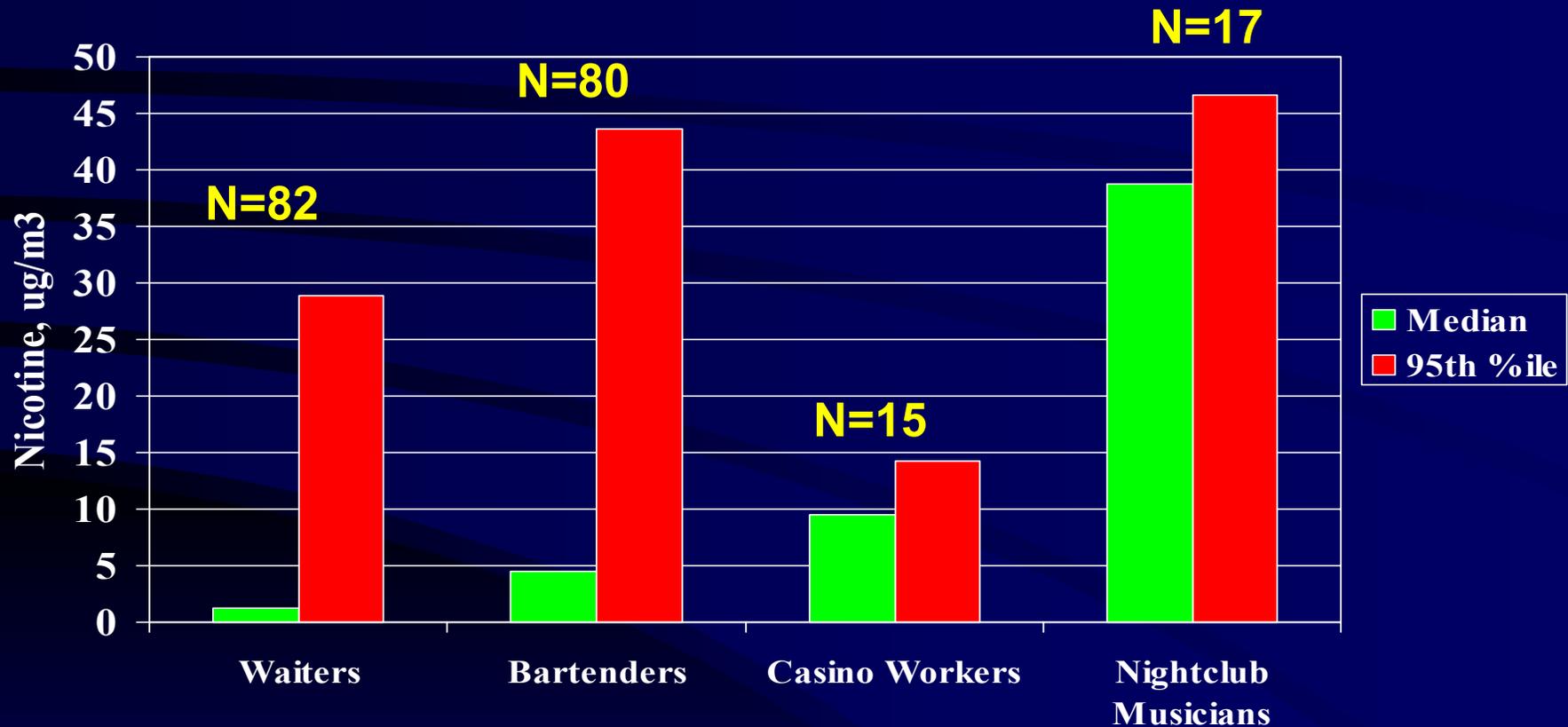
# Area vs Personal Monitoring: ORNL Wait Staff/Bartenders Study



# 24-hr TWA Nicotine Subjects Living and Working in Smoking Environments



# Personal Exposure of More Highly Exposed Occupations



*Larger studies tend to produce greater differences between medians and extremes.*

# Summary and Conclusions

- Fourth NRC Criterion, “consistent ratio” is where nicotine is “challenged.”
  - Relative to which other components?
  - High degree of surface adsorption, and some desorption.
  - Emission consistency data suggests substantial variability.
  - Seems best to use nicotine in conjunction with other markers.

## Summary and Conclusions, continued

- Nicotine is used in a large number of studies
- Levels to which subjects are actually exposed (as determined from personal monitoring) tend to be lower than estimates from previous shorter duration studies or those where non-random subject selection is used.
- Area sampling probably only works for individual microenvironments.