Principals of Exposure Assessment, EOH 2504
Lecture 6: Microenvironmental Monitoring: A Special Case of Indirect Environmental Exposure Assessment

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Microenvironmental monitoring is a special case of environmental monitoring in which the location where measurements are made is considered to be homogeneous with respect to concentrations of the target pollutants over the averaging time of interest.

Key Points-

1. Concentration considered homogenous in each microenvironment.
2. Mostly used for air pollution exposure assessment and can include any target pollutant-dust-mist- fume-gas or vapor.
3. The time that the specific type of individual of interest spends in each microenvironment is thus the numerator-generally over the course of 24 hours (the denominator).

What is a microenvironment?

- It is a generalized location where people, depending on age, health and other factors, spend considerable or noteworthy time during each day or for the period under study.
- Microenvironments can include outdoor or indoor and occupational and non-occupational settings.

Why are analysis of microenvironments valid at all for exposure assessment?

- Human activity patterns tend to be highly regular.
- For instance, many people tend to follow daily routines with respect to how long they sleep and the time they depart for work.
- Additionally, basic routines are fairly uniform across individuals, diary data from several studies has shown that the distribution of time reported in the microenvironments that comprise the majority of the day (i.e., inside at home and inside at work/school) exhibit relatively little variation from year to year within a given study population or from place to place within the USA (Robinson, 1985; Schwab et al., 1990).

Important microenvironments for air pollution exposure assessment

Outdoor Microenvironments

a. Urban metropolitan areas where air pollution levels are high as a result of high density of mobile and stationary sources. Could use a sampling station like Lawrenceville maintained by ACHD for PM 2.5 or priority pollutants.

b. Suburban small- to medium-sized cities where air pollution levels tend to be lower than in metropolitan areas, although transport of urban pollution can affect local air quality under certain conditions. Generally, area monitoring needs to be done to characterize this specific microenvironment.

c. Rural agricultural communities and small towns with few major anthropogenic sources of air pollution. Air pollution levels tend to be low, although transport of urban and suburban pollution can affect local air quality under certain conditions. Generally, area monitoring needs to be done to characterize this specific microenvironment.

Microenvironments for air pollution exposure assessment

Indoor-Occupational Microenvironments

1. Industrial manufacturing and production processes, such as steel mills, petrochemical plants, pulp mills, power plants, and smelters. (Target pollutant levels vary depending on each specific process.)

2. Non-industrial primarily service industries where workers are not involved in manufacturing and production processes, such as insurance companies, law offices, and retail sales outlets. (Non-industrial exposures can be affected by location of the office setting, ventilation rates, the permissibility of smoking in the building, and outdoor pollution levels).

Microenvironments for air pollution exposure assessment

Outdoors-Occupational

1. Construction activities such as ironworking, cement pouring and even sandblasting.

2 Outdoor plant production such as coke oven batteries, by-product plants.

In each case above occupational 8 hour time weighted average exposures of target pollutants could be used to estimate exposure during the work day.

Microenvironments for air pollution exposure assessment

Indoors-Non-occupational Microenvironments

- Residential -single-family houses, apartments, mobile homes, condominiums.
- Commercial -restaurants, retail stores, banks, supermarkets.
- Public -post offices, courthouses, sports arenas, convention halls.
- Institutional -schools, hospitals, convalescent homes.

Microenvironments for air pollution exposure assessment

Indoors-Transportation Microenvironments

- Private automobiles.
- Public buses, subways, trains, commercial airlines.

Equation used to calculate time-weighted integrated exposure from micro environmental monitoring data

$$E = \frac{1}{T}\sum C_{ijk}t_k$$

Where

- *E* is the time-weighted integrated exposure (e.g., for PM 10 -mg/m3).
- *C* is the concentration (e.g., mg/m3).
- *t* is the unit time (e.g., minute).
- *T* is the total elapsed time (e.g., minutes).
- The subscripts

i, j and *k* denote the medium, the pathway and the microenvironment respectively (Duan, 1982).

The assumptions inherent in using the microenvironment models are:

- The concentration *C*j in microenvironment *j* is assumed to be constant during the time that person *i* is there.
- The concentration *C*j within microenvironment *j* and the time that person *i* spends there are assumed to be independent events. (So people don’t leave the microenvironment based on concentration).
- The number of microenvironments necessary to characterize personal exposure adequately is assumed to be small.

Simple Example of Microenvironment Model Usage for 5 Major Microenvironments to Calculate a Time-Weighted, Integrated Exposure to Respirable Particulate-Over a 24 Hour Total Period.

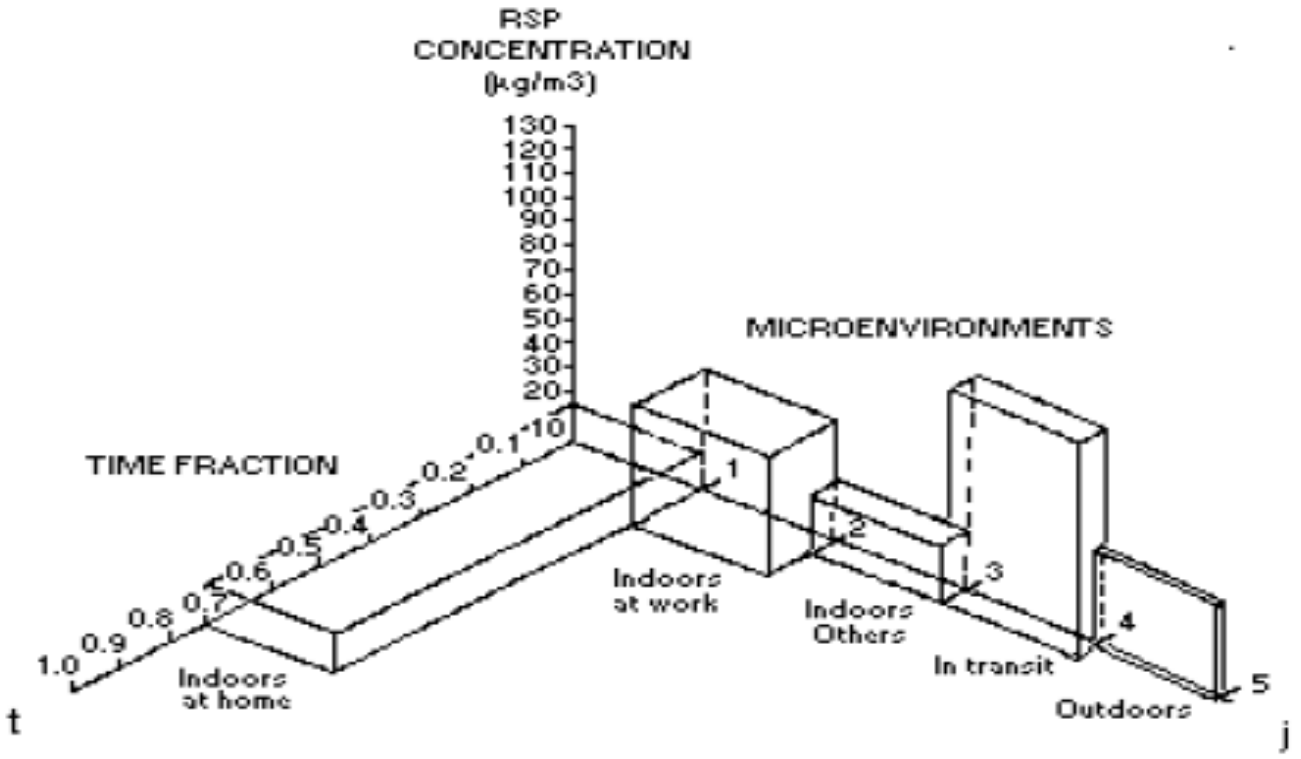
Microenvironment type	RSP concentration (C_j, $\mu g/m^3$)	Time fraction[a] (t_{ij})	$C_j \times t_{ij}$ ($\mu g/m^3$)	Microenvironment contribution to (%)[b]
Indoors at home	15	0.75	11.25	47
Indoors at work	50	0.15	7.5	31
Indoors, other	25	0.04	1.00	4
In transit	90	0.04	3.60	15
Outdoors	40	0.02	0.80	3
			$E_j = \Sigma\ C_j \times t_{ij} =$	24.15 $\mu g/m^3$

[a] Fraction of 24 h spent in each environment

[b] Percentage that each microenvironment contributes to the 24 h, time-weighted, integrated exposure (E_j).

Fig. 10. Examples of the relative contributions from specific microenvironments to an individual's time-weighted, integrated exposure to RSP. From: Secton & Ryan (1988)

Representation of Concentration vs Time Fraction in Multiple Microenvironments.



Important Points and Uses of Microenvironment Concentration and Exposure Data

- Neglecting to report even short-duration activities in high-concentration microenvironments will have more effect than underestimating a similar amount of time in a low-concentration microenvironment in which a large portion of the day is spent.
- Analyses of specific microenvironment study results suggest that variations in activities or locational attributes (e.g., variations in source strength) that are finer than those captured by simple microenvironments explain much of the variability in population exposure.
- Can use data already in hand such as EPA priority pollutant data to estimate outdoor exposures and can use data on concentrations from a number of well done studies to substitute for microenvironment data.
- Can use to generate risk allocation for population subgroups or activities (generalized).