STUDY OF PERSONAL EXPOSURE TO AIRBORNE RESPIRABLE PARTICLES AND CARBON MONOXIDE

M. FUGAŠ, K. ŠEGA, and A. ŠIŠOVIĆ
Institute for Medical Research and Occupational Health, Zagreb, Yugoslavia

(Received 23 December, 1981)

Abstract. Simultaneous measurements of CO and respirable particles (RP) at outdoor network stations and of personal exposure in a sample of twelve volunteers were carried out during the winter and summer season of 1980/81 in order to evaluate how well personal exposure can be assessed from outdoor network station data.

The results have shown that personal exposure of our subjects to both CO and RP is in best correlation with exposure at home where subjects spend in the average nearly 70% of their time. While personal exposure to CO can hardly be related to outdoor CO levels, personal exposure to RP is in fair agreement with simultaneously measured outdoor concentrations in winter (but not in summer). A large intercept on WAE axis of the WAE/RP relationship indicates that a considerable part of personal exposure to RP should be attributed to particles which are not of indoor origin. This part does not follow the seasonal and day-to-day changes in outdoor RP concentration and causes a negative, but highly significant correlation between WAE/RP ratio and RP.

1. Introduction

The objective of the study was to work out a sampling scheme which could serve as a basis for a realistic appraisal of exposure to air pollutants of individuals or population groups defined by a common denominator, and to evaluate how well a personal exposure could be assessed from outdoor network stations data. The study area was the city of Zagreb and the air pollutants measured were respirable particles and carbon monoxide. The investigation is a part of a WHO sponsored international research project on human exposure to air pollution.

1.1. DESCRIPTION OF THE STUDY AREA

Zagreb is situated at 15° 59’ E longitude and 45° 49’ N latitude, between the southwest slopes of the 1035 m high Mt. Medvednica and the banks of the river Sava, 122–160 m above the sea [1].

It has a population of over 700000 in an area of 1300 km². Average monthly temperatures are between 0 and 10 °C in winter and between 18 and 22 °C in summer. The heating season lasts about 7 months. The city centre has a population density of over 20000 per km² with an age median of 45. Most houses are more than 50 yr old and have individual heating. In the area built between 1918 and 1950 the age median of inhabitants is about 37. It is characterized by three to five floor apartment houses with central heating systems. In the new residential area the age median is about 30. People live in large apartment blocks with heating provided from a district heating plant.

Twenty years ago coal and wood were mostly used for heating. Gradually they have
been substituted by oil or gas. Gas-pipe network has been spread out in the last fifteen years and one branch has reached the city centre, so that more and more individual stoves and apartment heating systems have been converted to gas. As a consequence, \( \text{SO}_2 \) concentration has dropped considerably (annual mean from over 200 \( \mu \text{g m}^{-3} \) down to 90 \( \mu \text{g m}^{-3} \)) in the city centre [2]. However, suspended particulate matter has persisted at a rather high level (annual mean 140 \( \mu \text{g m}^{-3} \)).

The number of registered vehicles in the city centre is over 6000 per \( \text{km}^2 \). According to 1979 records the number of cars passing the busy crossings at rush hours can reach more than 10000 \( \text{h}^{-1} \). The narrow streets of the city centre often become congested.

1.2 Programme of investigation
Simultaneous measurements of the pollutants at outdoor network stations and of personal exposure in a sample of twelve volunteers were carried out during the winter and summer season of 1980/81. Each subject was monitored for seven consecutive days in order to avoid weekend/weekdays bias. Outdoor samplers for respirable particles operated continuously over the whole study period at three referent sampling stations, while CO was measured at each of the six sampling sites over the same period over which the subject for whom this was a reference station was monitored. Personal exposure was divided into three separately monitored parts: exposure at home, exposure at work and 'other' exposure, from which a time weighted 7-day average exposure was calculated [3].

1.3 Selection of subjects
Subjects were selected among the employees of the Institute for Medical Research and Occupational Health living in various parts of Zagreb. A questionnaire composed for this purpose was distributed to fifty potential subjects. Thirty-six of them responded. Sixteen of these were selected of whom eight volunteered for both CO and respirable particles, and eight only for one of the two pollutants. Priority was given to subjects living in different parts of the city, with different heating systems and cooking facilities, commuting with different means of transportation, nonsmokers or occasional smokers only, and people who were willing and who could be trusted to carry a personal sampler, to make the readings and charge the batteries, to accomodate the measuring instruments at home and to operate them, and to keep a diary.

2. Carbon Monoxide

2.1. Equipment and methods

2.1.1. Outdoor Measurements
An Ecolyzer, Model 2000 was situated at each of the six reference crossings during the same week that personal exposure of subjects living in the respective area was measured. The instrument was in continuous day and night operation. The readings were integrated first to average one-hour concentrations and then to an eight-hour and seven-day average.