Personal exposure to air pollutants

There is increased complexity of personal exposures when compared with exposures to ambient outdoor air concentrations alone.

The air quality limit values which the European Commission has been working on for the last couple of years apply to ambient air. In this sense, 'ambient air' is defined as outdoor air in the troposphere, excluding workplaces. The purpose of the air quality limit values is to help attain a high level of protection of human health and the environment in the European Community. The averaging time for the air quality measurements varies with the pollutant, depending on the targeted health effect, and is typically 1 hour, 24 hours or the calendar year. Health effects, however, are caused by pollutants in air that people actually breathe. CONCAWE has long argued that knowledge of personal exposures to airborne pollutants is essential to understand the associations of health effects and ambient air quality. Personal exposures are the result of all polluting sources of breathing air, of which ambient air is only one. Internationally, researchers have started to act on this acknowledged shortcoming in the epidemiological database. Several studies have now been published on this subject, with more likely to follow, especially in the USA but also in Europe. Some of these studies are looking at subgroups of the population, such as young children, or elderly people living at retirement homes, both considered to be particularly sensitive to some of the air pollutants.

The picture emerging from the exposure studies is that of increased complexity when compared with the concentration patterns of regulated ambient air pollutants. In many cases the personal exposures are higher and much more variable than the corresponding ambient air measurement

results. A variety of factors can be responsible for that. Climatic conditions contribute because they determine the general standard of housing, especially the degree to which ambient air is allowed to penetrate. Personal preferences contribute, e.g. the degree to which a house is ventilated. Pollutant characteristics contribute, such as for ozone which, due to its high reactivity, decays rapidly in the indoor environment. Social factors contribute, especially being exposed to environmental tobacco smoke which has been estimated to contribute 3.5 $\mu g/m^3$ to a person's daily exposure to benzene (Commission proposal for ambient air: 5 $\mu g/m^3$) and 20–30 $\mu g/m^3$ for particulate matter (Council directive: 40 $\mu g/m^3$ as an annual limit value).

People's time spent in traffic and public transport are significant for PM exposures. Also for PM, a so-called personal cloud has been detected which has not yet been fully explained, although it is now thought to be caused at least in part by clothing. Use of consumer products may contribute to exposure to volatile compounds. Wood fires and barbecues are other, potentially significant, sources of personal exposures to toxic air pollutants.

Several exposure studies have been conducted recently in Europe, with the support of the European Commission. Personal exposure to benzene was studied in the project Monitoring of Atmospheric Concentrations of Benzene in European Towns and Homes or MACBETH. Cities involved were Copenhagen, Antwerp, Rouen, Padova, Murcia and Athens. Ambient levels of benzene, as well as personal exposures were generally found to increase from north to south. Personal exposures of study participants, as well as indoor levels, were higher than outdoor levels in four of the cities, pointing to contributing sources in the indoor environment.

A similar exposure study was conducted under the name of EXPOLIS, for adult urban populations. The cities included Helsinki, Basel, Prague, Grenoble, Milan and Athens. Personal exposures to fine particulates, carbon monoxide and 30 volatile organic compounds including benzene were assessed, in combination with stationary measurements of outdoor air for the same pollutants. Again the personal exposures to benzene were higher than the concentrations in outdoor air, this time in all cities, indicating the contribution from personal or indoor sources. A similar geographic spread of personal exposures to fine particulate matter was found, with indications of contributions from non-outdoor sources. EXPOLIS researchers also looked at time-activity patterns of European adult population. On average, people were found to spend more than 20 hours per day in indoor situations (home, work, commute).

The general picture that emerges from these studies, and similar studies conducted elsewhere in the world, is that of increased complexity of personal exposures when compared with ambient concentrations. This is not surprising in view of the many sources and factors that may contribute to, or modify, personal exposures. It confirms the notion that benefits from improvement of outdoor air quality should not be assessed in isolation from people's real exposures. Any claims made about proportional health benefits from reduction of pollutants in ambient air simply cannot tell the whole story. The costs of implementing stringent air quality limit values should be balanced against their predicted real benefits.