Health Aspects Related to Indoor Air Pollution

In the last two decades an increasing interest can be observed for health effects related to pollution of both the atmosphere and the air at workplaces. The knowledge about sources and distribution of air pollution, about its adverse effects and about methods of improving air quality has steadily increased. Epidemiology has contributed importantly to a better knowledge of such health effects. In fact epidemiological investigations and experimental studies are the two pillars on which standards for the quality of the air in the macro- and meso climate must be established. One of the important conclusions from various epidemiological studies is that pollution of the atmosphere, and exposure to dangerous chemicals or materials during work, and smoking of tobacco, act synergistically in causing lung function impairments and respiratory symptoms.

Although man spends up to 70% of his time in his home, very few studies have been carried out about the quality and health effects of hazardous pollutants indoors. Biersteker, et al\(^1\) came to the conclusion that SO\(_2\) concentrations indoors usually were lower than outdoors, but could be higher under particular circumstances, e.g., if indoor sources were active. Yocom, et al\(^2\) pointed out that use of coal for heating can lead to high levels of SO\(_2\) and that heavy use of a gas stove can increase the indoor concentrations of CO and NO\(_X\) considerably. Similar conclusions about NO\(_2\) concentrations were drawn by Benarie, et al\(^3-5\) Derouane, et al\(^6-8\) and other authors. The observation that certain types of outdoor pollution can reach high concentrations indoors and the possibility of synergistic effects with other pollutants indoors are of special importance for the estimation of health effects of outdoor pollution. On the one hand the exposure indoors could lead to an overestimation of the health effects of outdoor pollution. On the other hand, if one wants to predict the possible damage to the airways on the basis of given levels of outdoor air pollution, it is advisable to add the possible effects of the pollution indoors.

It has been a praiseworthy initiative of the Regional Office for Europe of the World Health Organization (WHO) to invite a number of experts for a Working Group which convened in Bilthoven (the Netherlands) from 3–6 April 1979. This Working Group wrote a report entitled 'Health Aspects Related to Indoor Air Quality'.\(^9\)

The report describes in extenso various circumstances in which dangerous levels of particular pollutants could be generated indoors. A division is made between: a) pollutants primarily generated outdoors, such as smoke and other particulates, SO\(_2\), NO\(_X\), etc., and b) pollutants generated or released indoors. These last pollutants can be either released from building materials (formaldehydes, asbestos, radon, etc.) or be related to human activity or presence (for instance, hobby activities, smoking, nutrition, domestic cleaning, household products, domestic plants and pets, heating, cooking, etc).

The WHO report underlines the fact that the present tendency to limit ventilation in order to conserve energy, will have the disadvantage of increasing the levels of certain pollutants indoors. The use of cosmetics and domestic cleaning products in the form of aerosols, administered by propellants, is adding to the risks. If pollutants from specific sources are exhausted in the large volume of the atmospheric air, they will be heavily diluted. Such dilution will be far less indoors, because of the relative small volume of the indoor air. Therefore, particular domestic activities can generate high levels of dangerous substances or chemicals. For instance, hobby or craft activities can be carried out indoors without the protective measures required by regulations governing the industrial workplace.

In fact there is little knowledge about specific health effects of pollutants indoors. Very few
epidemiological studies have been carried out with the special purpose to study the effects of indoor pollution. To these few belong the investigations on effects of NO\textsubscript{2}, generated by gas cooking. Some results of these studies have been published in the December issue of this Journal. For instance, Melia, et al,\textsuperscript{10,11} in an epidemiological survey, observed a higher prevalence of respiratory symptoms among schoolchildren living in houses with gas used for cooking, than among children from houses with electric cooking. In another investigation among schoolchildren the same team of investigators tested the hypothesis whether the higher prevalence of respiratory symptoms actually could be related to an increased NO\textsubscript{2} level in the houses where gas cooking took place.\textsuperscript{13}

The mean NO\textsubscript{2} concentration in kitchens with gas cookers indeed was around 6 times higher than in kitchens with electric cookers.\textsuperscript{13} This study also showed a higher prevalence of respiratory symptoms among children from the homes with gas cookers. However, no association was found between the NO\textsubscript{2} levels in the kitchens and the prevalence of respiratory symptoms. On the other hand, an association was observed between prevalence of respiratory symptoms and NO\textsubscript{2} levels in the bedrooms. Lung function, measured with a dry spirometer, was not related to the NO\textsubscript{2} levels, neither in the kitchens, nor in the bedrooms.\textsuperscript{12}

Speizer, et al,\textsuperscript{14} showed a greater history of respiratory illness before age 2, among children in homes with gas cookers. They also measured slight but significantly lower levels of forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV\textsubscript{1}) among children who were exposed to higher indoor levels of NO\textsubscript{2}.

In contrast to the results of the above mentioned studies, which were carried out among large numbers of children, are the results of 2 studies in the United States, which showed no relationship between an increased NO\textsubscript{2} level indoors, and prevalence of respiratory symptoms.\textsuperscript{15-17} These investigations were carried out in adults and children, however, the number of children studied was small. The negative results could be explained by these small numbers of children, supposing that NO\textsubscript{2} effects could be better measured among children than adults, for instance because the airways of young children might be particularly sensitive to NO\textsubscript{2} exposure. Florey, et al\textsuperscript{12} offer other explanations, i.e.: a) NO\textsubscript{2} could be a proxy for another factor which promotes respiratory illness, for instance an increased humidity in the homes with gas cookers. Such increased humidity indeed was observed during their studies.

b) The indoor measurements of NO\textsubscript{2} levels might have been made at the wrong places to estimate general exposure, or might even have been the wrong measurements — peak exposures may be more important than exposure to average levels. The American investigation showed that peak values of more than 1100 \(\mu g/m^3\) could be observed.

Whatever may be the truth, the subject deserves further investigation. Therefore, the aforementioned WHO Working Group very rightly recommended new studies to confirm the results. If it were true that large numbers of children would suffer from respiratory symptoms and would have a limitation in the development of their lung function because of cooking on gas stoves, this information would be important in view of prevention of respiratory diseases.

As mentioned before, an important aspect of the indoor presence of chemicals such as SO\textsubscript{2}, O\textsubscript{3}, etc. is the possible overestimation of the health effects of outdoor air pollution, because of ignoring the high proportion of time spent indoors, even if the exposure there would be to lower concentrations than outdoors. Data on health effects of pollutants generated outdoors, have been reviewed extensively, e.g., in air quality criteria documents of WHO. The main acute adverse health effects of formaldehyde (from building materials) are irritation of the eyes and the respiratory tract.\textsuperscript{18} Odour annoyance has also been reported. From various investigations it is well known that sometimes high levels of formaldehyde can be measured indoors, in some houses even up to 2.8 mg/m\textsuperscript{3} although most values remain under 0.5 mg/m\textsuperscript{3}. Epidemiological investigations on the health effects of chronic exposure to such levels, however, have not been conducted. The conclusion of the Working Group in the abovementioned report, therefore, was that there is insufficient knowledge about chronic effects of formaldehyde.

The possible health effects of radon and asbestos can be estimated on the basis of studies in workplaces (e.g. radon in uranium mines, or asbestos in the shipbuilding industry). As regards the risk of exposure to asbestos, the Working Group considered the formation of national tumour registries giving emphasis to mesothelioma and bronchogenic carcinoma and containing detailed occupational, residential and smoking histories, as an important step to identification of these risks.

Furthermore, effects of sidestream smoking were considered. The passive smoker is subject to effects of high CO-levels and respirable particulates in the sidestream smoke, which could have consequences
for cardiorespiratory invalids. It was felt that investigation of the long-term health effects of passive smoking, e.g., by inclusion of this aspect in epidemiological studies, should be encouraged. Little is known about the damage which is caused by chemical materials, which increasingly contaminate the indoor air, such as cosmetics, cleaning materials and other products for domestic use. Propellants with such products contain, for instance, chlorinated fluorocarbons, a chemical which has been banned in several countries, and chemicals like methylene chloride, vinyl chloride, etc. Various components of polishes, waxes, bleaching agents, and detergents could have a carcinogenic effect. It was impossible for the WHO Working Group to make an estimation of the size of the risks to health, but the Group’s opinion was that preventive activity, for instance, by prohibition of toxic chemicals in consumer products and by appropriate product labelling would deserve high priority. Among the recommendations of the report, studies on health effects were mentioned several times.

The need for epidemiological and clinical studies on effects of unvented combustion products was particularly emphasised. Furthermore, it was considered important to investigate which indoor allergic factors could play a role in the development of diseases of the airways. Such allergens could be: moulds, mites, and allergens from plants and domestic animals. Where possible, epidemiological studies of health effects of other pollutants (for instance, passive smoking, chronic exposure to formaldehyds, etc.) should be encouraged.

Hopefully the WHO recommendations will encourage investigators to design and conduct such studies, in order to improve our knowledge in this important field.

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REFERENCES


