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Passive Smoking in Aircraft—A Current WHO Project

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Only few measurements of levels of pollution by tobacco smoke in aircraft have been made. The results suggest that levels are quite moderate, but studies of actual reactions by passengers and cabin crew indicate rather strong, objective effects. These consist of irritation of the mucous membranes of eye, nose and throat as well as perception of bad odours. Evidently, environmental tobacco smoke causes distress in aircraft already at lower concentrations than under ground conditions, probably because of special climatic conditions such as ultra-low air humidity, elevated levels of ozone, subnormal air pressure and, eventually, disturbance of the concentration of light air ions. None of these abnormalities can easily be eliminated. Ventilation, however effective in terms of rate of air changes, can not effectively curb local peak concentrations, and, close to a smoker the concentration of smoke may be 100 times as high as the room average. Therefore, aircraft must provide separate smoking resp non-smoking areas. Area division along an aisle is unacceptable since the ventilation system makes the aisle and adjacent seats on both sides be located in one whirl of common air. WHO will try to stimulate improvements of airline practices and aircraft design.

(key Words: passive smoking, environmental tobacco smoke, indoor air quality, aircraft ventilation)

INTRODUCTION

The WHO programme on smoking and health has kept a general interest in passive smoking problems for many years. During the most recent years there has been an increasing number of questions put forward to WHO by airline passengers who have felt unduly distressed by exposure to tobacco smoke in aircraft. These complaints have focused particular attention to the specific problems about smoking in aircraft, and in 1983 a separate project was started to look into these matters. For the work within this project collaboration was established with the International Civil Aviation Organization (ICAO) and the International Air Traffic Association (IATA). In order to establish baseline data a meeting was held in Geneva in December 1983, attended by representatives of the above mentioned organizations and some other experts in various related fields.

MEASUREMENTS OF TABACCO SMOKE CONSTITUENTS IN ARICRAFT

The litterature contains rather little information about actual concentrations of different tobacco smoke components in aircraft cabins. Most of the data that are available come from an American study that was performed in 1971 by the US Department of Transportation jointly with the Department of Health Education and Welfare (7). Measurements were made on 18 intercontinental flights with a duration of 7–11 hours and on 14 domestic flights with a duration of about one hour. Air sampling devices were installed in the front, middle and aft part of the cabin of the aircraft at each flight. For practical reasons the sampling devices were located above the baggage racks, whereby the measured concentrations probably were lower than those actually present in the passengers' breathing zone.

The concentrations of carbon monoxide were generally 2–3 ppm and the maximum value was 5 ppm. Concentrations of particulate matters were generally 20–50 $\mu g/m^3$ and the maximum 120 $\mu g/m^3$. All these values indicate such moderate levels that have been found to cause minor effects only under ground level conditions (8).

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ACTUAL REACTIONS TO TABACCO SMOKE IN AIRCRAFT

The above mentioned American study did also include questions to the passengers about their reactions to tobacco smoke in the cabin air. Some major data from these questionnaire studies are shown in Tables 1 and 2. The actual passenger reactions reflected by these tables are, as a matter of fact, quite strong in spite of the rather modest concentrations of pollutants that had been measured.

Another group that is exposed to environmental tobacco smoke in aircraft is of course airline cabin crew. In a large study of cabin attendants' working environment performed in 1981 by Scandinavian Airlines (10), cabin attendants were asked to indicate to what degree they were bothered by each one of various negative factors in the cabin work. The result is shown in Table 3.

There is no other work environment factor that does bother the cabin attendants so much as smoky air. The figures in Table 3 represent an average of male and female cabin attendants and of cabin attendats from different types of flight and aircraft. In Table 4 we find a breakdown according to sex of cabin attendant and type of flight/aircraft.

Among the female cabin attendants, especially on the longer flights, virtually everyone is bothered, most often even to a great extent, by smoky air in the cabin working environment.

In the discussion following the publication of the American study it was questioned if the passenger reactions were "real" or mayby rather emotional. The pertinent American authority, the Civil Aeronautics Board, stated however that "...there can no longer be any doubts that smoking aboard aircraft causes real discomfort to passengers...furthermore, it is clear that this annoyance is rooted in a perceived physical discomfort, rather than on moralistic Judgements" (4). By nature, the discomfort may consist of irritation of the mucous membranes of eye, nose and throat and/or annoyance by perception of bad odour. The major cause of the irritating effects seems to be found in the particulate phase of the smoke while gas compounds of the smoke are primarily responsible for the annoying effects (8).

All the above mentioned reactions, both from passengers and airline crew, give a unanimous, clear impression that exposure to tobacco smoke in aircraft is a much larger problem than it would be expected from the measurements of smoke pollutants in the American 1971 study. Even if those figures might, as suggested above, be to low to be representative of actual conditions in passenger breathing zone, the total picture indicates the presence of other factors contributing to more severe reactions than would have been expected under ordinary ground conditions. These potentiating factors would most probably be related to the climate conditions in aircraft.

AIRCRAFT-SPECIFIC CLIMATE FACTORS

The climate in an aircraft at cruising altitude differs in several respects from such ground conditions to which human beings are normally adapted.

One specific climate factor is the ultra-low humidity in aircraft. The relative humidity of air at earth surface is normally between 60 and 95 per cent, while the cabin air at cruising altitudes will be extremely dry, with a relative humidity between 10 and 20 per cent. It has been shown in laboratory experiments that irritation of the mucous membranes of eye, nose and throat as well as annoyance by perception of bad odour begins at lower concentrations of the pertinent pollutants when the air is dry as compared to normal humidity conditions (6). This does most probably contribute to the severeness of irritation and annoyance perceived by aircraft passengers and cabin attendants.

Another factor is the low air-pressure. Even if modern aircraft are pressurized, they are not pressurized to sea-level pressure but to a pressure corresponding to an altitude of around 2000 meters, which represents around 80 per cent of sea-level air-pressure. The level of hypoxia immediately arising from this reduction of air-pressure would generally not be important. On the other hand it may well make the human body extra susceptible to any further reduction of tissue oxygene supply for example such as caused by exposure to the CO component of environmental tobacco smoke.

A third factor consists of the elevated levels of ozone that may be encountered at high altitudes, especially at certain intineraries as for example the North Atlantic routes. This has been confirmed by actual measurements onboard aircraft (3). Since the physiological effects of exposure to ozone are partly similar to those of exposure to environmental tobacco smoke, a combination of ozone and environmental tobacco smoke will cause discomfort already at lower smoke concentrations than those that would by themselves have caused the same effects.

A fourth possible, although unsufficiently investigated factor is related to the light air ions. The presence of tobacco smoke does quite substantially change the level of light air ions (5). There are some data that indicate that human wellbeing may be disturbed by unnormal levels of air ions (2). If such data can be confirmed, these matters might constitute another climate factor, worsening the effects of environmental tobacco smoke in aircraft.

With regard to their aggravating role in relation to tobacco smoke it would be desirable if the above mentioned, abnormal climate conditions in aircraft could be eliminated. In theory it could be possible to humidify cabin air. However, this requires an extra water supply at take-off that for a 747 aircraft would amount to around 1000 kg already when the degree of humidification were kept at a modest level of 35 per cent. This constitutes a too heavy extra load to let the idea be feasible (9).

Pressurizing aircraft to sea-level would also be possible in the theory, but that would require stronger build-up of the body of the aircraft, which would increase the weight of the aircraft making it more expensive to build at same time as operation costs would increase. All this makes 100 per cent pressurization unfeasible from cost/effectiveness point of view.

Similar aspects are prevailing in the case of eliminating ozone. There are actually certain technical devices to achieve a reduction of ozone levels, but these devices are energy consuming to an extent that makes their use unrealistic.

VENTILATION

Good ventilation is obviously an important means of reducing the irritation and annoyance caused by environmental tobacco smoke in an aircraft. The current ventilation systems in aircraft seem to be quite efficient to the extent that they usually achieve around 20 air changes per hour if the ventilation system is operated at full capacity. In modern aircraft there is, however, most often a re-circulation of part of the air, sometimes up to 45 per cent of the total air flow is being re-circulated. This is specifically unfortunate in the sense that smoke-filled air that goes in to the re-circulation system from the smoking zone will be distributed all over the cabin, including the non-smoking zone, in the process of re-circulation. Even if this smoke-polluted air is diluted by fresh air, the re-circulation system itself constitutes a direct emission of smoke-pollution into the non-smoking section. It should also be kept in mind that tobacco smoking in a space where people are so closely packed as in an aircraft entails specific ventilation problems. It has been measured that the concentration of smoke constituents at points close to a smoker can be up to 100 times as high as the average of the room (8). In a close packed aircraft people sitting close to smokers will therefore, at least temporarily, be exposed to local peak levels of smoke that cannot be effectively curbed by any feasible kind of ventilation system.

SEATING ARRANGEMENTS

Since ventilation alone is incapable of protecting non-smokers well enough from exposure to environmental tobacco smoke in aircraft, it is urgent to find good seating arrangements to separate smokers and non-smokers. IATA has issued recommencations to airlines about seating arrangements and specific procedures with regard to smoking in aircraft (1). Some airlines do adopt a system where, in small aircraft with one aisle only, this aisle is separting the smoking and the non-smoking section of the aircraft. As perceived by passengers this is a definitely unsatisfactory system. A review of the technicalities of ventilation reveals that the aisle and adjacent seats on both sides are part of the same big whirls of air inside which smoke constituents are distributed from all parts of this whirl to all other parts of it.

RESTRICTIONS ON SMOKING

Both ventilation and separted seating aims at preventing smoke from reaching target individuals at too high concentrations. The most effective remedy for passive smoking problems in aircraft would, however, consist in the prevention of any emission of smoke, i e a total ban on smoking. On some airlines this is the actual rule on flights of short duration. At the same time it has been pointed out that on flights of longer duration, there might be serious side-effects of a total ban on smoking. Such a ban might result in some smokers violating the prohibition to smoke in the toilets, which would then severly increase risks for fire onboard the aircraft.

Even if, on long flights, a total ban of smoking would not be feasible, it would still be possible to reduce emission by some restrictions on smoking. An example of such a restriction is the ban on pipe and cigar smoking that is issued by a number of airlines. Since these kinds of smoking material produce larger amounts of smoke than cigarettes do, this rule can already achieve a worthwhile reduction of emission.

PROSPECTS FOR THE FUTURE

Most airlines can improve the cabin air situation by revising their rules and practices. A most important feature would then be the procedures for enforcing the rules. This might require additional standard recommendations. Airlines and aircraft manufacturers should further give increased attention to possible improvements of ventilation systems specifically with regard to hypersensitive persons for example those with allergic or asthmatic disorders. There is also a need for specific research to establish such air quality criteria that would be appropriate ones under the aircraft-specific climate conditions. WHO will try to draw attention to all these aspects in collaboration with related parties such as IATA, individual airlines and research institutes.

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Table 1

	Percent passengers bothered by smoke	
	Smokers	Non-smokers
With respiratory history	26	71
Without respiratory history	18	54

Source: US Dept of Transp (7)

Table 2

	Percent passengers recommending remedial action	
	Smokers	Non-smokers
Intercontinental passengers	27	62
Domestic passengers	39	73

Source: US Dept of Transp (7)

Table 3

Are you bothered in your work by any of the factors listed below?

	Not at all	To a certain extent	To a great extent
Noise	13%	53%	34%
Cold	29%	56%	15%
Temperature variation in the cabin	32%	55%	13%
Heat	43%	49%	8%
Variation in cabin pressure	36%	51%	13%
Draughts	27%	47%	26%
Static electricity	44%	45%	11%
Dry air	10%	31%	59%
Turbulence	22%	60%	17%
Dust	62%	31%	7%
Smoky air	4%	26%	69%
Odours	26%	61%	13%
Pungent smells	59%	34%	7%

Source: Östberg (10)

Table 4

Extent to which bothered by smoky air in working environment; breakdown according to type of flight/aircraft and sex

		Not at all	To a certain extent	To a great extent
Total		4%	26%	69%
Short-haul flights (DC9)	female cabin attendants	3%	25%	72%
	male	18%	33%	48%
Medium range flights (DC8 or DC10)	female	1%	25%	74%
	male	11%	35%	54%
Long-haul flights (DC10 or 747)	female	1%	15%	84%
	male	7%	40%	53%

Source: Östberg (10)