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No Difference in Rates of Absenteeism between Workers in Air-Conditioned Offices and Naturally Ventilated Ones: A Data Base Study

Key Words
Air-conditioning
Absenteeism
Respiratory diseases

Abstract
The present study was carried out to determine if continuous exposure to air-conditioning during working hours has an observable effect on health. Absenteeism from ill health recorded by company doctors was compared in two groups of employees of the French National Electric and Gas Company in western France, working in similar jobs and spending most of their time in either air-conditioned offices or a natural atmosphere. No difference between the two groups was observed during the two years studied with respect to the incidence, duration or frequency of medically-related absences. A similar investigation of absences due only to respiratory diseases resulted in the same conclusion. This study showed that air-conditioning has no major effects on health.

Introduction

Air-conditioning systems are increasingly used in companies and offices, as new technology, in particular computers, requires an atmosphere with stable temperature and humidity. New office architecture with windowless rooms, strict security requirements and energy-saving features have also contributed to the increased use of air-conditioning.

Air-conditioning helps fight air pollution of human, industrial or external origin by (1) readjusting the oxygen, carbon dioxide and water contents of the air; (2) absorbing toxic dust, polluting gases or excess heat, and (3) eliminating suspended particles, such as soot, smoke, plants and pollen. Its use should therefore provide a feeling of comfort and have positive effects on health. However, as the use of air-conditioning units and humidifiers has increased, they have been suspected of causing a certain number of disorders, symptoms and diseases which may be classed into three groups [1–3]:

(1) Infectious diseases, especially Legionnaires' disease, which first occurred in 1976 during a meeting of US army veterans [4]. A causal relationship with air-conditioning was clearly established as the disease was shown to be due the diffusion of a bacterium *Legionella pneumophila*, which was present in stagnant water of the humidification systems. Other infectious diseases may arise in the same way.

(2) Allergic respiratory diseases, such as 'humidifier fever', which are due to the escape from filters of dust and particles carrying a variety of specific antigens [5].

(3) A very wide range of other disorders and complaints that have been reported during various surveys: these include drowsiness, headaches, nuchal pain, sore throat, pharyngitis, sinusitis, rhinitis, cough, dryness of the mucosa, conjunctivitis, dryness of the eyes, and psy-

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chological symptoms. These heterogeneous symptoms are grouped together under the term 'sick building syndrome' [6, 7]. In view of the literature describing the suspected or demonstrated pathological effects of air-conditioning, it was decided to assess the value of the daily use of air-conditioning in the workplace by asking the following questions: 'Does exposure to air-conditioning have any significant pathological effects? Does it have a positive or negative effect on health?'

In order to answer these questions, a study was performed on staff working for the French National Electric and Gas Company by comparing absenteeism for medical reasons (i.e. authenticated by a medical certificate) in two groups of employees with similar jobs, one working in an air-conditioned atmosphere, and the other in naturally ventilated premises.

Material and Methods

The French National Electric and Gas Company is responsible for the production, transport and distribution of energy. This involves a wide range of jobs, from the primary to the tertiary sectors. During 1984 and 1985, when this study was performed, the company employed about 156,000 people throughout France, 80% of whom were men.

This study was carried out on a subgroup of employees in Nantes and Saint-Brieuc in the west of France. The selected subjects had sedentary jobs, spent most of their working hours in an office and belonged to the administration and finance departments of different divisions (distribution, production and transport, and disablement and pensions). Employees working in an office fitted with an airtight air-conditioning system for at least 1 year were considered as working in an air-conditioned atmosphere. The different systems were determined after interviewing the building managers. The three buildings studied were all equipped with central heating, ventilating and air-conditioning systems. Two buildings contained a humidifying system with streaming water, while the other had a water spray system. The main differences between the three systems involved the percentage of recycled air (respectively, 0%, 50%, and the other, a varying percentage) and the relative humidity (respectively, 50%, 50%, and an unknown but very low value in the building with the spray humidifier).

Employees of the French National Electric and Gas Company have a special social security system. They are seen by consulting physicians when they have a health problem, which would include: short absences from work for illness, chronic disease, work-related injury and disablement. The information about these events and any deaths at work have been recorded since 1978 and are entered in a computerized data base [8].

According to staff regulations, any employee absent for medical reasons must be seen by a consulting physician. In practice and, in particular, when the absence is of a very short duration, a physician is not always consulted, and the diagnosis of the disease causing the absence may then be missing from the data base. Two types of comparison were performed: the first on absence due to sickness, whatever its cause, and the second on absence due to certain types of

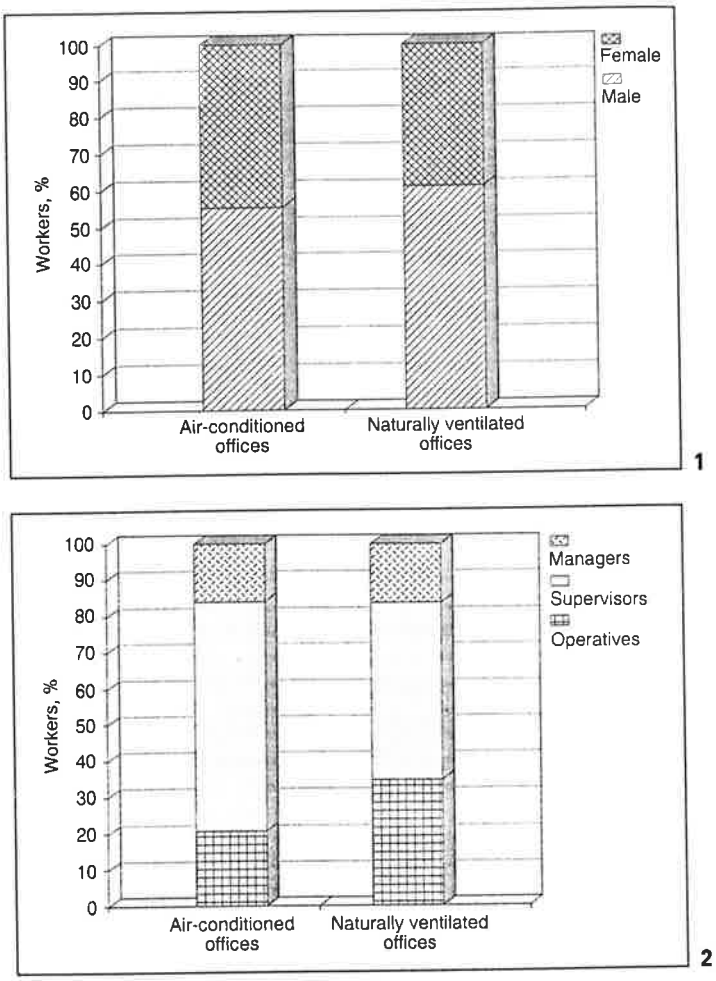

Fig. 1. Sex distribution according to ventilation system.
Fig. 2. Salary level distribution according to ventilation system.

infectious diseases, i.e. sore-throat, acute bronchitis, other acute upper respiratory tract disorders and influenza.

Although numerous social, occupational, economic and psychological factors have an effect, absence from work for all medical causes combined provides an indicator of health, particularly when its 'duration' component is taken into account [9] it was used in the present study to measure psycho-physiological 'ill-being'. The specific diagnoses of disorders of the ears, nose and throat (ENT) and the upper respiratory tract were analyzed specifically because they are frequently mentioned in the literature on the pathological effects of air-conditioning. To overcome any inaccuracies due to the lack of medical control, which may lead to an underestimation of sickness absence due to these disorders, we used the results of a survey of noncontrolled absences, which was carried out in 1980 to determine precisely the medical causes of absences. The following parameters were used to study absences: (1) the percentage of staff absent at least once during the year; (2) the mean duration of absence per absentee per year) and (3) the mean number of absences per year per absentee.

Absenteeism rates during 1984 and 1985 were analyzed separately, as there was an influenza epidemic in 1985.

A previous study [9] showed that the occurrence, duration and frequency of absence from work varied considerably according to a staff member's sex, age and salary level. These variables were therefore taken into account in the analyses in order to avoid attributing to the air-conditioning effects actually due to differences in the demographic and professional structure of the groups studied.

Statistical Analyses

Incidences of absenteeism for all medical reasons combined, or for specific diagnoses of ENT, were compared between workers in air-conditioned offices and naturally ventilated ones by means of χ^2 and logistic regression models. The latter technique provides a method to take into account potential confounding variables (in this case, sex and salary level). The quantitative variables describing absence from work (annual duration and number of absences per year) were compared between the two groups with t tests.

For every test, the differences were accepted as statistically significant when $p < 0.05$.

Results

Description of the Sample (December 1984)

1,634 subjects were included in the study. In view of the selection criterion for sedentary work, it is not surprising that there was a higher percentage of managerial staff (16%) and women (42%) as compared with the overall staff of the French National Electric and Gas Company, where the percentages of managers and women are 13.8 and 18.7%, respectively. Absenteeism among these employees was similar to the national average [9].

These subjects were distributed as follows: 827 employees worked in air-conditioned offices and 809 in naturally ventilated offices. The distribution of the two groups, with respect to sex and salary level (operatives, supervisors and managers), showed a higher percentage of women and managers in the naturally ventilated offices (fig. 1, 2), whereas the age distribution was the same.

Absenteeism for Medical Reasons

Absenteeism for All Medical Reasons Combined. There was no difference in the incidence of absence due to sickness in the two groups either in 1984 or 1985 (table 1). A logistic regression model was used to determine the probability of an employee having at least one period of absence during the year using three variables: sex (male, female), salary level (operatives, supervisors or managers) and air-conditioning (yes, no). Both in 1984 and in 1985, for the same sex and salary category, the probability of being absent from work at least once during the year was the same whether work was performed in an air-conditioned environment or not (table 2).

Table 1. Incidence of absence according to exposure to air-conditioning

Study year	Ventilation system		p
	air-conditioned (n = 827)	natural (n = 809)	
1984			
Absentees, n	370	344	> 0.05
Absentees, %	44.7	42.5	
1985			
Absentees, n	405	389	> 0.05
Absentees, %	48.9	48.1	

Table 2. Logistic regression analysis of the 1984 sickness absences from all causes combined

Model variables (indicators)	Coefficients	SD	p
Constant	−1.1129	0.149	< 0.001
Female	0.403	0.107	< 0.001
Operative	1.04	0.176	< 0.001
Supervisor	0.56	0.159	< 0.001
Exposure to air-conditioning	0.137	0.104	> 0.05

Test of model: χ^2 (4 d.f.) = 71.39, $p < 0.001$.

The absence frequency and duration for all employees taking sick leave were tested next. No variations according to exposure to air-conditioning were observed (table 3).

Specific Diagnoses. The data grouped together in table 4 show that there was no difference in the incidence of absences due to sore throat, sinusitis, acute bronchitis, other upper respiratory tract infections or influenza between employees working in air-conditioned offices or not. The 1985 influenza epidemic affected both groups in the same way.

A logistic regression analysis was performed for each of the 2 years to control the effect of the variables sex and staff category, which were distributed differently in the two groups. The model determined the probability of stopping work at least once, for at least one of the specific diseases mentioned above (except influenza). For a fixed sex and staff category, there was a significant 'air-conditioning effect' (table 5), and employees who worked in an air-conditioned atmosphere stopped work more often for these medical causes than others. One possible explanation for this finding is that subjects in air-conditioned

Table 3. Absence profile (duration and frequency) according to ventilation system

Year	Duration of absence/year/absentee, days			Number of absences/absentee/year		
	air-conditioned	natural air	p	air-conditioned	natural air	p
1984						
n	370	344		370	344	
Mean	30.8	26.9	> 0.05	1.66	1.65	> 0.05
SD	50.8	41.6		1.01	1.09	
1985						
n	405	389		405	389	
Mean	28.9	27.9	> 0.05	1.74	1.74	> 0.05
SD	46.9	40.2		1.13	1.09	

Table 4. Incidence of absence for specific causes according to ventilation system

Cause of absence	1984		1985	
	natural air	air-conditioned	natural air	air-conditioned
Sore throat	27 (3.3)	43 (5.2)	33 (4.6)	46 (5.5)
Sinusitis	9 (1.1)	11 (1.3)	8 (0.9)	12 (1.4)
Acute bronchitis	14 (1.7)	13 (1.5)	20 (2.4)	21 (2.5)
Other URT disorders	20 (2.4)	34 (4.1)	18 (2.2)	29 (3.5)
Influenza	26 (3.2)	36 (4.3)	78 (9.6)	70 (8.5)

Numbers in parentheses are percentages. There was no significant difference in absences for any cause between ventilation systems. URT = Upper respiratory tract.

offices underwent a medical examination more often in the case of an absence (89%) than employees not working in an air-conditioned office (75%).

The number of absences really due to these diagnoses were evaluated from the results of a survey of nonmedically controlled absences. On the hypothesis that the proportion of ENT cases in the noncontrolled absences was the same in these two groups as in the national survey, it was possible to add an estimated number of cases to those directly diagnosed. After this adjustment, the differences in the percentages of absences disappeared.

As far as the duration and frequency of absences due to these specific diseases are concerned, there were no significant differences between the two groups (table 6).

Seasonal Absenteeism. The absenteeism rates of the two groups measured globally for the whole year were therefore almost similar. Also, there were no seasonal differences. Figure 3 shows the mean number of monthly absences per employee, for all medical causes combined, during the 2 study years. Apart from April 1984, there was no statistically significant difference. The peak at the start of 1985 corresponds to the influenza outbreak.

Table 5. Logistic regression on specific absenteeism in 1984

Model variables (indicators)	Coefficients	SD	p
Constant	−3.569	0.34	< 0.001
Female	0.62	0.17	< 0.001
Operative	1.189	0.36	< 0.001
Supervisor	0.74	0.34	< 0.05
Exposure to air-conditioning	0.46	0.17	< 0.01

Test of model: χ^2 (4 d.f.) = 42.27, $p < 0.001$.

Discussion

The results of this study, which was carried out to evaluate if continuous exposure to air-conditioning at work has positive or negative effects on health, showed that the frequency and severity of disorders causing absenteeism were not affected by office air-conditioning. The same was true for upper respiratory tract and ENT disorders.

Table 6. Absence profile (duration and frequency) for each cause according to air-ventilation system

Symptom or illness		Duration of absence/year/absentee, days			Number of absences/year		
		natural air	air-conditioned	p	natural air	air-conditioned	p
Sore throat							
1984	n	27	43		27	43	
	Mean	7.3	8.06	> 0.05	1.03	1.11	> 0.05
	SD	4.2	4.7		1.19	0.32	
1985	n	33	46		33	46	
	Mean	7.6	11.4	> 0.05	1.09	1.08	> 0.05
	SD	8.7	14.7		0.39	0.28	
Sinusitis							
1984	n	9	11		9	11	
	Mean	9.1	9.45	> 0.05	1.11	1	> 0.05
	SD	6.13	6.9		0.33	0	
1985	n	8	12		8	12	
	Mean	10.6	5.4	> 0.05	1.12	1	> 0.05
	SD	7.3	2.1		0.22	0	
Acute bronchitis							
1984	n	14	13		14	13	
	Mean	9.6	7.5	> 0.05	1.0	1.07	> 0.05
	SD	4.5	3.5		0.3	0	
1985	n	20	21		20	21	
	Mean	10.2	8.04	> 0.05	1.05	1.04	> 0.05
	SD	55.2	3.8		0.22	0.22	
Other URT disorders							
1984	n	20	34		20	34	
	Mean	6.5	10.6	> 0.05	1.05	1.03	> 0.05
	SD	3.8	12		0.22	0.17	
1985	n	18	29		20	34	
	Mean	9.9	13.5	> 0.05	1.11	1.13	> 0.05
	SD	8.7	22.13		0.5	0.35	
Influenza							
1984	n	26	36		26	36	
	Mean	8.03	7.5	> 0.05	1.15	1.02	> 0.05
	SD	4.7	3.6		0.36	0.17	
1985	n	78	70		78	70	
	Mean	7.5	9.4	> 0.05	1.07	1.12	> 0.05
	SD	4.4	6.5		0.27	0.34	

URT = Upper respiratory tract.

Air-conditioning was not found to have any preventive effect during an influenza epidemic.

Our study shows that the pathological consequences of air-conditioning are very slight, and like other studies [5, 10, 11], it shows that air-conditioning has no major repercussions on health.

The findings in the present paper do not contradict those obtained by interviewing employees. Although comparative studies of the complaints of subjects working in air-conditioned or natural atmospheres did show an increased incidence of subjective disorders, such as dryness of the mouth, rhinitis, headaches, visual discomfort, postprandial drowsiness and constipation, in air-conditioned environments [3, 5, 10, 12, 13], these disorders rarely caused staff absenteeism. The ill-being that they reveal, which seems to be associated with work in high-

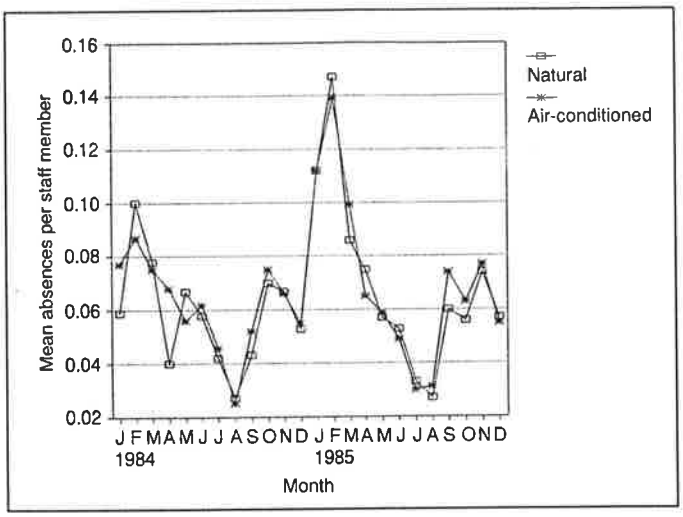

Fig. 3. Monthly curves of the mean number of absences per staff member for all medical causes combined in subjects exposed or not exposed to air-conditioning.

rise buildings, may be due to factors other than air-conditioning. The following factors have been proposed: artificial light in windowless rooms [13, 14], claustrophobia caused by sealed windows and office architecture [5], exposure to computer visual display units [15], adaptation to a new working organization often associated with the move to high-rise office buildings [15], exposure to formaldehyde [1] and an excess of positive ions [3].

As far as climate is concerned, as this study compared employees subjected to the same climatic and sociocultural environments, the 'climate' effect should, in principle, be eliminated. However, special geographical features did exist. Hence, respiratory and ENT disorders are perhaps more frequent in western France than elsewhere. This analysis should therefore be repeated in one or several other regions.

The absence of any individual or even collective data on tobacco smoking is a more important drawback. It is an important office pollutant [16], and cigarette smoke may explain the respiratory disorders observed in certain insufficiently ventilated buildings. However, most studies on sick building syndrome [e.g. ref. 6] do not conclude that smoking is a causative factor. In France, smoking is prohibited in public places, but in offices where there is no contact with the general population, workers are at liberty to smoke if they desire to do so. In some companies, there is a no-smoking policy; workers included in this survey are not so restricted. So our hypothesis was that smoking and working in an air-conditioned atmosphere might be considered as two independent factors and the distribution of smokers to be identical in the two groups as shown in other studies [10].

A similar survey with the additional air collection of relative humidity and physicochemical data on the ambient of the offices and personal information from the staff, such as any history of allergy and respiratory diseases, smoking, and the distances traveled to work, should make it possible to assess precisely all aspects of air-conditioning and its effects on health. The present study already shows that the health consequences of air-conditioning are limited.

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