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1.2. Investigations on the effect of regulating smoking on levels of indoor pollution and on the perception of health and comfort of office workers

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INTRODUCTION

Since the mid-1970s many investigations of building-associated epidemics of complaints and illnesses have been undertaken in North America and Europe in response to occupants' health complaints. The majority of these investigations coincide in time with a concerted effort to minimize building energy use by reducing fresh air ventilation rates and increasing the operational comfort ranges for acceptable temperature and humidity in air conditioned, mechanically ventilated buildings (1). Health complaints have ranged from headache and eye irritation to reproductive systems and pregnancy problems. Almost all these instances have involved new or refurnished buildings in which conditions of ambient air are completely mechanically controlled and lighting supplied by fluorescent lamps. Only in a few instances were complaints or illnesses traced back to specific causes such as carpet shampoo residues, fiberglass from ducting systems, rock wool, and excessive levels of formaldehyde. But, specific causes for symptoms were not determined for most investigations.

The term "Building Illness" has been used to refer to these epidemics of complaints from building occupants about symptoms and discomforts including headaches, burning eyes, irritation of the respiratory system, drowsiness, fatigue and general malaise experienced over an extended period of time with the cause remaining undetermined but suspected to be related to components of the building or air supply system (2,3). In modern, energy-efficient office buildings tobacco smoke, perhaps because of its visibility, is frequently regarded as an important source of airborne particulates and gases. It is thus only natural that a great deal of attention has been concentrated on smoking as a source of indoor airborne substances and as a possible cause for Building Illness. However, modern buildings tend to generate a large variety of pollutants as well as to entrap large numbers of them penetrating from the outside. Evidence from many studies has now demonstrated that buildings indeed entrap and concentrate a large variety of pol-

lutants found both outside and generated inside and that, in fact, for many pollutants the levels of concentrations inside buildings, under normal working conditions, exceed those found on the outside (4, 5, 6).

It is the purpose of our review to compare the levels of possible cigarette smoke-related aerosols with the prevalence of health-related complaints in offices with different rules and regulations about permissions, restrictions or prohibitions of smoke. Our information will come from different sources:

First from a review of pollutant levels reported for 111 buildings selected for study because of persistent building-related complaints and from 32 buildings selected for study because of absence of complaints. The data from these buildings also make possible a comparison of pollutant levels in buildings with and without rules restricting or prohibiting smoking.

Second, from a study done in collaboration with the Office Professional Employees International Union, Local 153, in New York City. This study was based on nine buildings in which approximately 1100 members of Local 153 responded to a detailed health and environment questionnaire which made it possible to compare the prevalence of complaints of discomfort or of symptoms related to Building Illness in offices where smoking was permitted, restricted or prohibited.

POLLUTANT LEVELS, BUILDING ILLNESS COMPLAINTS AND SMOKING RESTRICTIONS

Since 1977, there has been a large increase of Health Hazard Evaluations initiated by occupants of sealed, air conditioned buildings who believe their office (or work environment) to be hazardous and their symptoms to be building-related. Most of these evaluations were done by the US National Institute for Occupational Safety and Health (NIOSH), the US Center for Disease Control (CDC), by State Departments of Health and Labor in the US, and by a number of privately sponsored investigations of sealed buildings. A large number of the reports from such investigations are now available in Canada and the United States (in addition to similarly motivated European studies).

Many of the studies report results of industrial hygiene investigations of indoor conditions including information on a variety of pollutants carefully and repeatedly measured. Also available for most of these studies are detailed health surveys of symptoms and complaints, which typically include information on personal habits and on some of the relevant history of respondents.

Reports of 111 buildings studied in response to Building Illness complaints were obtained. Seventeen of these buildings restricted smoking. Also, reports of 32 other buildings were obtained of which 11 restricted smoking. (A list of these reports and information on where they may be obtained will be furnished on request.) Information on smoking restrictions came from individual reports and was further clarified as needed by discussion with investigators. If smoking was restricted at some periods but measurements were taken when smokers could have been present, the obtained values were grouped with other measures from buildings without smoking restrictions.

POLLUTION IN BUILDINGS WITH AND WITHOUT COMPLAINTS

Most studies of Building Illness complaints measured background levels of pollutants. The types of pollutant selected for measurement depended as much on the investigators' hunch of what might possibly cause problems in the building as on the measuring and testing facil-

ities at their disposal. Thus, our review of 143 investigations in buildings reveals measured levels of a large number of substances. Measured levels of approximately 156 different chemicals and 12 other miscellaneous factors (such as noise or bacteria) are cited at least once. An adequate number of measurements was available for subsequent analyses of 12 suspected indoor pollutants, which might be related to smoking. These measures provide information in the pattern of pollutant levels found in modern, sealed, so-called energy-efficient buildings in which health-related complaints have been recorded.

Not all studies reported results in comparable units. Levels were expressed in counts, ppm, ppb, mg/m³ or µg/m³. Conversion of the units to a common scale was accomplished for specific chemicals. In many instances measurements were taken but *no detectable level* (ND) was found or the results were reported as "trace amounts". Where a range of values was reported for repeated measurements in a building, the average value assigned to that building was the statistical median. By this method, bias was avoided due to too many ND findings or due to isolated unusually high values. The choice of medians also makes the estimate of a typical pollution burden somewhat independent of the sensitivity of the measuring procedure as it is possible the pollutant was present but in levels below that of the sensitivity of the test procedure.

Table 1 gives the averages (median) of the 12

TABLE 1. *Median levels of pollutants measured most frequently in buildings investigated for health complaints*

Pollutant	Buildings without smoking restrictions	Number of Reports	Buildings with smoking restrictions	Number of Reports	All buildings
Aldehydes[a]	ND	5	—	0	ND
Amines	ND	10	—	0	ND
Aromatic Hydrocarbons	Trace	39	56.07 mg/m³	2[b]	Trace
Carbon Dioxide	354.5 ppm	20	476.5 ppm	2	354.5 ppm
Carbon Monoxide	2 ppm	44	4.12 ppm	7	2.25 ppm
Formaldehyde	Trace	35	ND	3	Trace
Hydrocarbons	ND	47	ND	2	ND
Nitrogen Oxides	ND	21	ND	1	ND
Nitrogen Dioxide	ND	9	—	0	ND
Ozone	ND	22	0.001 ppm	2	ND
Particulates	0.028 mg/m³	13	0.015 mg/m³	1	0.021 mg/m³
Sulphur Dioxide	ND	15	ND	1	ND
Temperature	72° F	17	73° F	6	72° F
Relative Humidity	38%	20	23.5%	5	35.1%

a: Not including Formaldehyde
b: Two values are 8.14 mg/m³ and 104.0 mg/m³
ND: Tested but no detectable levels found
—: No data

most frequently measured pollutants obtained from the 111 buildings with Building Illness reports and Table 2 gives the same information for the 32 buildings studied specifically for pollutant levels. Each table gives the number of buildings from which each pollutant level was obtained. Buildings were divided also by whether smoking was or was not restricted in the location where measurements were obtained.

Because of differences in the way buildings were selected for measurements, we present the data separately in Tables 1 and 2.

In most studies, methods for measuring pollutant levels were of no greater sensitivity than were necessary to detect Threshold Limit Values (TLVs) or other industrial standards. Thus there was a large number of reports in Table 1 with N.D. readings. Values in Table 2 usually were obtained as part of investigations using sensitive state of the art procedure.

For the two values thought most relevant to evaluate the contribution of smoking, carbon monoxide (CO) and particulates, values in Tables 1 and 2 do not substantially differ from each other nor do measurements of CO and particulates from smoking-restricted areas differ from those of workplaces without such restrictions. Values in both tables can be compared also with those available in the literature. Reported values were no higher and often lower than those reviewed in a number of publications (3, 4, 5, 6). For instance, a number of studies compared outdoor levels of CO with levels in offices where there was smoking. One by Chappell and Parker (7), of 10 offices,

TABLE 2. *Median levels of pollutants measured most frequently in buildings investigated for reasons other than health complaints.*

Pollutants	Buildings without smoking restrictions	Number of Reports	Buildings with smoking restrictions	Number of Reports	All Buildings
Aldehydes[a]	0.09 mg/m³	5	0.025 mg/m³	4	0.087 mg/m³
Amines	—	0	—	0	—
Aromatic Hydrocarbons	0.09 mg/m³	11	4.5 mg/m³	3	0.11 mg/m³
Carbon Dioxide	729.3 ppm	2	900 ppm	1	900 ppm
Carbon Monoxide	3.5 ppm	10	3.4 ppm	3	3.4 ppm
Formaldehyde	0.26 ppm	2	0.024 ppm	2	0.027 ppm
Hydrocarbons	0.0275 mg/m³	22	0.18 mg/m³	2	0.0295 mg/m³
Nitrogen Oxides	41.6 ppb	7	26 ppb	1	38.8 ppb
Nitrogen Dioxide	33.9 ppb	4	—	0	33.9 ppb
Ozone	0.005 ppm	1	0.0145 ppm	2	0.012 ppm
Particulates	0.037 mg/m³	9	0.036 mg/m³	1	0.036 mg/m³
Sulphur Dioxide	0.09 ppm	2	0.012 ppm	2	0.012 ppm
Temperature	71 °F	3	—	0	71 °F
Relative Humidity	39%	3	—	0	39%

a: Not including Formaldehyde
—: No data

reports average indoor (and outdoor) levels to be 2.5 ppm. A study of Szadkowski (8) of 25 offices found indoor CO concentrations of 2.78 ppm and outside concentrations of 2.59 ppm. These figures agree with the average (median) CO level of 2.25 ppm based on 51 buildings with Building Illness included in Table 1 and 3.4 ppm based on 13 buildings in Table 2. In neither table is there any noteworthy difference in CO levels between premises where smoking was and was not restricted.

Regarding suspended particulates, the average (median) for 13 studies is 0.028 mg/m^3 for Table 1 and 0.037 mg/m^3 for 9 buildings in Table 2, all of them without smoking restrictions. There were too few buildings to estimate what the average difference might be between these buildings and those with smoking restrictions.

These values are considerably smaller than the average of 0.17 mg/m^3 reported by Weber and Fischer (9) using a Piezoelectric balance to measure particulates in 44 offices selected apparently at random. They are even lower than the average of 0.251 mg/m^3, also measured with a Piezoelectric balance, reported by Repace and Lowrey (10) for buildings in which smoking was permitted.

Part of the reason for lower particulate values in 24 buildings in Tables 1 and 2 is that the buildings monitored by Repace and Lowrey were public facilities such as eating establishments, sports arenas and halls, while the values in the reviewed studies mostly apply to the white-collar workplace.

Another reason for the difference in results may be related to technique. The measurements taken by Weber and Fischer (9) and by Repace and Lowrey (10) used a Piezobalance Respirable Aerosol Analyzer. Measures taken in studies reviewed here with one exception used gravimetric methods or techniques involving air pumps and filters. When first introduced, the electrostatic technique for counting particulates was thought to offer a superior method for the measurement of particulates. However, there may be some procedural problems which need to be worked out before data from that instrument will have the validity and reliability comparable to that of standard, older methods. We have reported that questions concerning the reliability and accuracy of the instrument had been raised by a number of investigators (5). For instance, fluctuations of counts of some aerosols seem to vary with temperature and humidity when the Piezoelectric balance is used. This is especially true for the "sticky" tobacco aerosol. In some Piezoelectric monitoring devices, matched reference crystals are used to compensate for fluctuation due to changes in temperature and humidity. However, they cannot fully compensate. The reference crystals are not exposed to the same airstream. In addition, one of the humidity effects only occurs on a loaded crystal which limits the usefulness of an unloaded reference crystal. The reference crystal in the TSI 3500 (the instrument used by both Repace and Lowrey and by Weber and Fischer) is not exposed to the sample airstream and does not (and was not intended to) compensate even partially for temperature and humidity fluctuations.

Sticky aerosols may congregate on the crystal and result in spuriously high readings. If humidity changes at the rate of 1 % per minute, the associated error could be as high as 100 μg/m^3 for a moderately hygroscopic aerosol (11, 12). For highly hygroscopic aerosols, such as one gets from tobacco smoke, or with more rapid humidity changes, the errors might even be larger. The spurious increase in the estimate of tobacco aerosols by increasing humidity is easily verified.

There are other problems relating to the length of sampling time and the number of

samples taken before cleaning the crystal. Weber and Fischer (9), for instance, took an extraordinarily large number of samples and so did Repace and Lowrey (10). The one exception in our series also using a Piezoelectric balance (13) again reports a very large value (2-4 mg/m^3) but offers no details of sampling. In contrast, the highest value in our series reported through other than the Piezoelectric method is 0.224 - 0.62 mg/m^3 (14). Thus in the final analysis the estimates obtained by the Piezobalance of aerosol particulates in the presence of tobacco smoke may be seriously overestimated. Until these questions are answered, results from the use of Piezoelectric balance need to be interpreted with caution. Also interpreted with caution need to be any comparison between measurements of particulates obtained through filtering and electrostatic methods because of the different sizes of particles measured by each method.

In short, this whole issue of how to sample particulates needs clarification.

The one large difference between values in areas with and without smoking restrictions is that of aromatic hydrocarbons. The measurements of aromatic hydrocarbons in smoking restricted environments were made in hospitals where hydrocarbons are normally present in the air. Aromatic hydrocarbons measured in workplaces without smoking restrictions did not include hospitals. Nevertheless aromatic hydrocarbons were measured in a large number of offices (and are included in Tables 1 and 2 for this reason) where they were found in "trace amounts".

It appears, then, that there are no differences on the average values of the kind of pollutants measured in these studies in buildings with and without smoking restrictions. Also, the levels of pollutants that were measured in buildings with health-related complaints were no larger than those reported in the literature from buildings without such complaints. The cause of complaints probably does not lie in the levels of individual pollutants measured in the studies evaluated here. Nevertheless, Building Illness might still be related to other substances in the indoor air or combinations that have not been measured directly (15).

Health and comfort in nine office buildings

A computer-readable, self-administered work environment questionnaire was given to members of the Office Professional Employees International Union, Local 153, New York City. The questionnaire was constructed so as to document perceived environmental conditions, symptoms and complaints related to Building Illness among occupants of nine such buildings. The buildings chosen had no prior histories of complaints.

Among others, the Health and Work Environment Survey questionnaire contained detailed information about:

1. Environmental conditions (such as air movement, lighting, odors, etc.).
2. Lighting conditions (ranging from questions on fluorescent lighting to window lighting).
3. Health-related symptoms (such as headaches, dizziness, fatigue, sleepiness, and others which have been very often reported in buildings with health and comfort complaints).
4. Life-style factors and personal factors (including smoking).
5. Stress factors (such as job security).

There were other questions as well about equipment use, employment history, types of appliances used at home, and others not reported here.

Answers on health, environmental and other conditions were scored on a three-point scale: *1* for "Never or Rarely"; *2* for "Sometimes"; *3* for "Often or Always". Questions were phrased so that "Never or Rarely" or a *1* indicated a favorable and "Often or Always" or a *3* an unfavorable response. For example, "Is there too little air movement?" or "Have you ever experienced headaches while at work?". Using this scoring scheme it is possible to construct *indices* based on related questions, and assign a subject a *score* corresponding to his or her average rating or the individual item included in each index. These indices could then be related to various sets of conditions, including those relating to smoking. The indices of interest here and the questions that define them are given in Table 3.

Each respondent was classified according to how he or she felt that the overall environmental or stress conditions or health-related symptoms (as measured by each environmental, stress and health index) were "good", "average" or "poor" (and "low", "average" and "high" for each stress index). In order to better separate "good" ("low") and "poor" ("high") conditions, a "good" ("low"), that is a favorable condition was assumed to exist only when all questions making up any one index were answered as favorable (i.e. "1"). Any response that was unfavorable to any question making up the index (i.e "3") classified the subjects rating as "poor" ("high"). Thus a "good" (or "low") classification required an average of "1", a "poor" (or "high") classification an average of greater than "2". All other average scores classified a subject as "average" on a particular environment, stress or health index.

The major findings in this study, which is published in detail elsewhere (15), were a statistically significant association between all indices of health and disease and conditions of ventilation, lighting, Video Display Terminals (VDTs) or Cathode Ray Tubes (CRTs) use and stress (possibly in that order). Analyses of environment, health and stress indices in relation to smoking were made. There were different types of smoking restrictions. In one set of buildings, smoking was prohibited. Usually a special area was set aside for smokers. In another, smoking was prohibited during specific usually busy time periods, for instance between 10 am and 9 pm, but permitted during others (16). Apparently smokers comply generally with regulations. Also, compliance tends to be reinforced by non-smokers' insistence of adherence to regulations.

Regarding smokers and smoking restrictions, the following groups were identified:

- Non-smokers working in places where smoking was permitted.
- Non-smokers working in places where smoking was restricted.
- Non-smokers working in places where smoking was prohibited.
- Smokers working in places where smoking was permitted.
- Smokers working in places where smoking was restricted.
- Smokers working in places where smoking was prohibited.

As responses to questions were almost identical for places where smoking was restricted and where it was prohibited, we also combined the workplaces where smoking was restricted or prohibited into a single category.

The next series of tables show these relationships for non-smokers (Tables for smokers, not shown here, are similar).

Rather than giving individual cell frequencies, we elect to present the outcome of the cross tabulations as percentages in such a way that direct comparisons can be examined. Each column gives the proportion of individuals

TABLE 3. *Groups of responses used to construct "health" and "stress" related indices.*

Health Related

Building Illness
- headache
- fatigue
- nose irritation
- eye irritation
- sore throat or cold symptoms

Cardiorespiratory
- nose irritation
- breathing difficulty
- chest pain or tightness
- racing heart

Musculoskeletal
- neck ache
- sore arms, hands or wrists
- backache

Neurophysiological
- headache
- dizziness
- fatigue
- sleepiness
- moodiness
- depression
- lightheadedness
- confusion

Somatic
- nausea
- skin rashes
- ringing in ears
- sore throat or cold symptoms
- frequent urination

Visual
- blurred vision
- eye irritation
- split or double vision
- trouble focusing eyes

Stress Related

Decision Making
- In your job are you able to make decisions on your own?
- are you free to determine how you do your job?
- Can you set the speed at which you work?
- Are you able to influence company policies that affect your job?

Job security
- Is your job security good? During the past year, were you faced with possible job loss or layoff? (exclude actual job loss or layoff)

Physical
- Does your job require you to work very fast?
- Does your job require you to exert a lot of physical effort?
- Are you required to use awkward work motions?

Relationships
- Are co-workers helpful in getting your job done?
- Is your supervisor helpful in getting your job done?
- Are you faced with abuse or hostility from: customers or clients, supervisors or co-workers?

who rate their environment, health or stress conditions as *good, average,* or *poor.* Thus Table 4 shows that of the 128 non-smokers working in places where smoking was permitted, 11.7 % rated their ventilation conditions (as measured by the Ventilation Index) as *good,* while 11.4 %, 10.0 % and 10.8 % of non-smokers working in places where smoking was restricted, prohibited, and either restricted or prohibited, did so. Of the 128 non-smokers working where smoking was permitted, 32.0 % rated their building ventilation (as measured by the Ventilation Index) as *poor,* while 28.6 %, 23.3 % and 26.2 % of non-smokers did so who worked where smoking was restricted, prohibited, and either restricted or prohibited.

The hypothesis of statistical independence between the frequencies was computed using Chi Square statistics for non-smokers and smokers separately. For instance, Chi Square for Table 4 is 1.1718 which, for 4 degrees of freedom, falls far short of statistical significance. (For d.f. = 4, Chi Square would have to be 9.488 or larger for a one-tailed test and equal to or larger than 7.779 for a two-tailed test for rejection of the null hypothesis with $p < 0.05$). It should be noted that d.f. = 4 for all tables in this series. We draw attention to the fact that the column labelled "PROHIBITED OR RESTRICTED" is not included in the calculation of Chi Square values. That column serves as a summary, combining frequencies observed in workplaces where smoking was "RESTRICTED" with where it was "PROHIBITED".

The distribution of responses to questions assessing the quality of environmental conditions of Ventilation (Table 4), Temperature (Table 5), Humidity (Table 6), Lighting (Table 7), and Odor (Table 8) do not differ statistically

TABLE 4. *Percentage distribution for responses to "Ventilation Index" for non-smokers working where smoking was permitted, restricted, prohibited, and restricted or prohibited.*

Non-smokers working where smoking is:

Ventilation Index	Permitted	Restricted	Prohibited	Prohibited or Restricted
Good	11.7	11.4	10.0	10.8
Average	56.3	60.0	66.7	63.1
Poor	32.0	28.6	23.3	26.2
	100.0	100.0	100.0	100.0
No of cases	128	35	30	65

$\chi 2 = 1.1718$ $p \leq .88$

TABLE 5. *Percentage distribution for responses to "Temperature Index" for non-smokers working where smoking was permitted, restricted, prohibited and restricted or prohibited.*

Non-smokers working where smoking is:

Temperature Index	Permitted	Restricted	Prohibited	Prohibited or Restricted
Good	13.1	5.9	3.4	4.8
Average	69.2	79.4	93.1	85.7
Poor	17.7	14.7	3.4	9.5
	100.0	100.0	100.0*	100.0
No of cases	130	34	29	63

$\chi 2 = 8.0637$ $p \leq .09$

*Ignoring rounding errors

TABLE 10. *Percentage distribution for responses to "Visual Health" for non-smokers working where smoking was permitted, restricted, prohibited, and restricted or prohibited.*

Non-smokers working where smoking is:

Visual Health Index	Permitted	Restricted	Prohibited	Prohibited or Restricted
Good	68.6	62.9	71.0	66.7
Average	16.1	31.4	16.1	24.2
Poor	15.3	5.7	12.9	9.1
	100.0	100.0	100.0	100.0
No of cases	137	35	31	66

$\chi 2 = 5.7750$ p $\leqslant .22$

TABLE 11. *Percentage distribution for responses to "Absenteeism Index" for non-smokers working where smoking was permitted, restricted, prohibited, and restricted or prohibited.*

Non-smokers working where smoking is:

Absenteeism Index	Permitted	Restricted	Prohibited	Prohibited or Restricted
Good	88.8	84.8	80.6	82.8
Average	10.4	15.2	19.4	17.2
Poor	0.7	0.0	0.0	0.0
	100.0*	100.0	100.0	100.0
No of cases	134	33	31	64

$\chi 2 = 2.4711$ p $\leqslant .65$

*Ignoring rounding errors

in smoking restricted or prohibited workplaces. It is likely that this relationship simply reflects a more permissive and tolerant attitude by the employers. This can be seen also from the relative lack of relationship between smoking status and stress in employee to employee relationships (Table 15), which falls short of statistical significance (although showing the same trends as do the other stress/smoking relationships).

Finally we return to the review of buildings with Building Illness complaints which made up the first part of our discussion.

The analysis also explored the possibility that Building Illness complaints were related to the absence of smoking regulations. Table 16 shows the relative frequency of symptoms of "eye strain and irritation", "nose and throat irritation", and "fatigue" and "headache" reported as major problems in buildings with

TABLE 12. *Percentage distribution for responses to "Job Security Index" for non-smokers working where smoking was permitted, restricted, prohibited, and restricted or prohibited.*

Non-smokers working where smoking is:

Job Security Index	Permitted	Restricted	Prohibited	Prohibited or Restricted
Good	66.4	44.1	26.7	35.9
Average	32.8	47.1	60.0	53.1
Poor	0.7	8.8	13.3	10.9
	100.0*	100.0	100.0	100.0*
No of cases	134	34	30	64

$\chi 2 = 25.1117$ $p \leq .001$

* Ignoring rounding errors

TABLE 13. *Percentage distribution for responses to "Physical Stress Index" for non-smokers working where smoking was permitted, restricted, prohibited, and restricted or prohibited.*

Non-smokers working where smoking is:

Physical Stress Index	Permitted	Restricted	Prohibited	Prohibited or Restricted
Good	9.6	8.8	0.0	4.6
Average	80.1	70.6	67.7	69.2
Poor	10.3	20.6	32.3	26.2
	100.0	100.0	100.0	100.0
No of cases	136	34	31	65

$\chi 2 = 12.2418$ $p \leq .02$

and without smoking restrictions. There is a trend here of fewer reports of eye, nose and throat irritation as a major complaint when smoking is restricted than when it is not. However, these differences fall far short of statistical significance and, anyway, the largest difference is for headaches, for which 50 % more studies in smoking-restricted than smoking not restricted environments report as a major symptom.

DISCUSSION

The available data do not support a conclusion that increased reports of Building Illness symptoms are associated with smoking. Pollution levels in buildings without smoking restrictions are no greater than those observed in buildings with smoking restrictions or in buildings that were not studied for illness complaints. In other words, neither pollution levels

TABLE 14. *Percentage distribution for responses to "Stress Decision Index" for non-smokers working where smoking was permitted, restricted, prohibited, and restricted or prohibited.*

Non-smokers working where smoking is:

Stress Decision Index	Permitted	Restricted	Prohibited	Prohibited or Restricted
Good	0.7	0.0	3.3	1.6
Average	66.2	46.9	43.3	452
Poor	33.1	53.1	53.3	53.2
	100.0	100.0	100.0*	100.0
No of cases	136	32	30	62

$\chi 2 = 9.6003 \leqslant p\ .05$
* Ignoring rounding errors

TABLE 15. *Percentage distribution for responses to "Interpersonal Stress Index" for non-smokers working where smoking was permitted, restricted, prohibited, and restricted or prohibited.*

Non-smokers working where smoking is:

Interpersonal Stress Index	Permitted	Restricted	Prohibited	Prohibited or Restricted
Good	16.3	13.3	3.7	8.8
Average	71.5	80.0	88.9	84.2
Poor	12.3	6.7	7.4	7.0
	100.0*	100.0	100.0	100.0
No of cases	123	30	27	57

$\chi 2 = 4.4935\ p \leqslant .34$
* Ignoring rounding errors

TABLE 16. *Percentage of incidents of most prominent Building Illness-Related symptoms in 95 buildings without, and 16 buildings with smoking restrictions.*

Symptoms

Smoking	Fatigue	Eye Irritation	Nose/Throat Irritation	Headache
Not restricted	31.9	55.8	56.8	51.6
Restricted	37.5	50.0	43.8	75.0

nor patterns of symptoms differ between buildings with or without smoking restrictions. While almost all investigations reviewed here inquired about the smoking habits of the surveyed population, only eight suggested that smoking might be the cause of the problem. (None of these eight studies supports its claims with actual data.) On the other hand, some of the investigations did a careful review of the possible effects smoking might have on health-related complaints. For instance, one study by Salisbury compared smoking density by floors in a building to frequency of health complaints (17). No association was found. We have reported elsewhere that complaints of white-collar workers in these buildings may be due to the interaction of low ventilation and ultraviolet emitting fluorescent lamps which lead to the production of photochemical oxidants. When high ultraviolet emitting lamps are replaced or when ventilation rates are increased, reports of symptoms decline significantly and do so dramatically when both ventilation and lighting conditions are changed (18). Reports of eye irritation alone decreased by 31 %.

The review of available studies does not provide any objective evidence that either pollution levels or patterns of health-related complaints differ in some remarkable way between locations with or without smoking restrictions. Modern buildings tend to generate and entrap pollutants from numerous sources. Under inadequate ventilation, conditions may be created where discomfort and illness result irrespective of whether or not smoking is permitted.

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