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Research Article

Some Effects of HVAC System in a Specific Working Environment - A Case Study

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Abstract

Most of the work people perform in closed rooms. However, proper attention previously has not been directed to the problem of people working in offices without natural ventilation. The subject of this study is the influence of the HVAC system on health, working ability, absenteeism and the satisfaction of people working in an office without natural ventilation. There is no known ergonomic research that previously dealt with this topic, taking into account the above-mentioned specificity. A case study was conducted, which included fifteen employees of a branch of a company engaged in the provision of telecommunication services. Employees in the branch office of this company perform tasks in several rooms where no natural ventilation is applied. In view of this, special attention is paid to the practice of maintaining the HVAC system. An original questionnaire specially formulated for this purpose was used, which was answered by the staff of the company that maintains the HVAC system for the mentioned company. In addition, an adapted general health questionnaire was used, which also included issues related to the impact of the work environment on working ability and the satisfaction with the existing air quality. The results of the conducted research show what are the most pronounced health problems of the workers. It is concluded that in order to maintain the health of workers in offices without natural ventilation, a comprehensive approach is required, which involves more strict air control that involves additional measurement of certain parameters of the air quality in regular intervals, as well as additional education of staff of firms who maintain HVAC systems.

Keywords: HVAC; Closed Space; Ventilation; Health; Air Quality

Introduction

Most people work indoors. However, the attention of ergonomic researchers, especially in Europe, has not previously been directed at the problem of people working in offices without natural ventilation. The subject of this study is the influence of the HVAC system on health, working ability, absence from work and the satisfaction of people working in offices without natural ventilation.

Indoor air quality has a major impact on human health. This impact is often left unnoticed, and people are surprised to learn that the closed environment is in some cases doubly polluted, according to the EPA. Pollutants include gases, dust, toxic chemicals, molds, dirt, mites, and volatile organic compounds (VOCs) and many others. Air quality can affect productivity, personal comfort, building maintenance costs, and health and safety. Therefore, air pollution is a cause for considerable concern [1].

Numerous studies examined the effect of air conditioning on the health of employees and the quality of the interior air, but from the point of view of the filters used, the particles that purify, the thermal factors and the very reactions of the human organism. It is difficult to find any work in the field of ergonomics that was primarily focused on the study of air quality in indoor areas where there is no possibility of natural ventilation. A number of studies have been carried out in which different approaches have been applied in relation to the assessment of air quality in indoor areas, in particular the impact of certain factors on the health of workers as well as prevention measures. However, by inspecting the found works that dealt with this problem, it could also be noticed that previously there was no elaborate topic where the method of maintaining the HVAC system was considered a factor that could have an impact on the health and comfort of employees. In this regard, it is of particular importance that complex air quality studies in indoor

environments include, in the considerations, the way and organization of the maintenance of the HVAC system, including companies that are externally engaged in the provision of the prescribed air quality [1-27].

The aim of the research

Considering the above, the aim of the paper is to examine the influence of the HVAC system in rooms where there is no possibility of opening the window to the health of workers, absenteeism and job satisfaction.

In addition, the aim of the paper is to investigate the influence of HVAC systems on the health of workers.

Method

In order to examine the impact of closed rooms on health, a general health questionnaire was used. The questionnaire has been modified to some extent in order to further investigate the effect of HVAC system maintenance and examine the impact of air quality on employees' satisfaction.

In order to examine how to maintain and organize the maintenance of the HVAC system, two questionnaires were additionally formed. One questionnaire was designed for the management structure of the company, in order to establish their competencies, practices related to the maintenance of the HVAC system, as well as the care of employees' health. The second questionnaire was intended for service providers who maintain a HVAC system in the company. The aim of this questionnaire was to collect information on the practice of maintaining the HVAC system.

The survey was conducted in the company providing telecommunication services. A branch of this company that fulfills the conditions of research has been selected. The premises of this branch had windows that could not be opened. Ventilation was based on the usage of the installed air conditioning system.

The research involved 15 respondents (8 males and 7 females). The average age of the subjects was 28 years.

The respondents were promoters, agents and sales advisers. The questionnaires on how to maintain the HVAC system were filled out by people from the company's management, including a person in the company in charge of safety and health at work.

Discussion section

Based on the analysis of 15 respondents, we have come up with the following results:

In accordance with the arithmetic mean, we calculated a standard deviation whose results are shown in the table.

In the third question, respondents answered questions related to health problems that lasted longer than 2 days.

Problems	YES	NO	YES%	NO%
Headache	9	6	60	40
Nausea	7	8	46.67	53.33
Dizziness	6	9	40	60
Fatigue	10	5	66.67	33.33
Irritation of eyes, throat and nose	10	5	66.67	33.33
Breathing problems	5	10	33.33	66.67
Cough	11	4	73.33	26.67
Bowling	9	6	60	40
Dyspnoea	4	11	26.67	73.33
Blurred vision	6	9	40	60
Acute inhalation	4	11	26.67	73.33
Sinus congestion	8	7	53.33	64.67
Pain and / or discomfort in:				
spine	14	1	93.33	6.67
neck	12	3	80	20
hands	5	10	33.33	66.67
shoulders	9	6	60	40
Wrists	3	12	20	80
Legs	5	10	33.33	66.67
abdomen	4	11	26.67	73.33

Table 1

From what we can conclude that the majority of respondents feel pain in the spine, and then in the neck and shoulders, then there is cough, irritation, feeling fatigue and headache and problems with sneezing.

In the 4th question, we answered the existence of unusual or unpleasant smells in the building.

YES	NO	YES%	NO%
11	4	73.33	26.67

Table 2

What we can conclude that most have noticed unpleasant smells.

In the fifth question, we were interested in whether at work, the aforementioned health problems, pain or discomfort are smaller, same or higher.

SMALLER	SAME	LARGGER	SMALLER %	SAME %	LARGGER %
0	7	8	0	46.67	53.33

Table 3

What it can be seen that the pain was mostly the same or greater.

In the sixth question, we were interested in whether, after work, the aforementioned health problems, pain or discomfort were smaller, same or higher.

SMALLER	SAME	LARGGER	SMALLER %	SAME %	LARGGER %
6	7	2	40	46.67	13.33

Table 4

What it can be seen that most pain is the same or smaller.

In the 7th question, we were interested in whether, after a week out of work, the aforementioned health problems, pain or discomfort were smaller, same or greater.

SMALLER	SAME	LARGGER	SMALLER %	SAME %	LARGGER %
13	2	0	86.67	13.33	0

Table 5

What we can conclude that the pain is much smaller.

In Question 8, it was determined whether the employees were taking days off because of health problems, pain or discomfort.

YES	NO	YES%	NO%
9	6	60	40

Table 6

What we can conclude that they mostly took days off.

In question 9, respondents answered questions about the presence of pollutants.

Pollutants	YES	NO	YES%	NO%
Ammonia	2	13	13.13	86.67
Asbestos	1	14	6.67	93.33
Carbon dioxide	1	14	6.67	93.33
Carbon monoxide	0	15	0	100
Glass wool	0	15	15	100
Formaldehyde	0	15	0	100
Methyl Ifhol	2	13	13.133	86.67
Microorganisms	11	4	73.33	26.67
Live	0	15	0	100
Exhaust gas	4	11	26.67	73.33
Azotine oxide	0	0	0	0
Ozon	0	15	0	100
Color vapors	1	14	6.67	93.33
Pesticides	3	12	20	80
PCB	0	15	0	100
Radon and his postings	0	15	0	100
Sterilized gases	0	15	0	100
Sulfur oxides	1	14	6.67	93.33
Perfumes, hair sprays	12	3	80	20
Cigarette smoke	9	6	60	40

Table 7

What we can see the greatest presence of asbestos, carbon dioxide, vapor and sulfur oxide, then ammonia and methyl alcohol as well as pesticides.

In the 10th issue, the influence of the above-mentioned pollutants on health during work, after work and during sleep, was examined. The graph shows the first number of respondents who answered questions ranging from 0 to 10, where 10 indicates intense influence while 0 marks invisible influence.

a)	
0	2
1	0
2	2
3	1
4	1
5	3
6	0
7	2
8	3
9	0
10	1
%	
0	13.33
1	0
2	13.33
3	6.67
4	6.67
5	20
6	0
7	13.33
8	20
9	0
10	6.67
b)	
0	2
1	0
2	2
3	1
4	1
5	2
6	1
7	4
8	1
9	0
10	1
%	
0	13.33

1	0
2	13.33
3	6.67
4	6.67
5	13.33
6	6.67
7	26.67
8	6.67
9	0
10	6.67
c)	
0	2
1	1
2	2
3	1
4	1
5	2
6	4
7	0
8	1
9	0
10	1
%	
0	13.33
1	6.67
2	13.33
3	6.67
4	6.67
5	13.33
6	26.67
7	0
8	6.67
9	0
10	6.67

What we can see not so significant impacts of polluters on the life of employees.

In the 13th question, samples of air quality problems were examined.

Cause	YES	NO	YES%	NO%
Inadequate air flow rate	9	6	60	40
Humidity	3	12	20	80
Air conditioning	11	4	73.33	26.67
Temperature	7	8	46.67	53.33
Noise	9	6	60	40
Lighting	8	7	53.33	46.67
Unpleasant odors	7	8	46.67	53.33
Air circulation stops at weekends	3	12	20	80
Irritants in the air	6	9	40	60
External pollutants	4	11	26.67	73.33
Machines / equipment	1	14	6.67	93.33
Smoking	0	15	0	100
Too big crowd in the room	10	5	6.67	93.33
Bulkheads	1	14	6.67	93.33
Renovation	0	15	0	100
Spraying with pesticides	3	12	20	80
New furniture / carpet furniture	1	14	6.67	93.33
I do not know	1	14	6.67	93.33

Table 9

What we conclude that the most common patterns are air conditioning, inadequate air flow velocity and lighting.

In the 14th question, it was determined in which parts of the year the difficulties were most common.

Age	YES	NO	YES%	NO%
Winter	5	10	33.33	66.67
Spring	1	14	6.67	93.33
Summer	1	14	6.67	93.33
Autumn	4	11	26.67	73.33
Equal	6	9	40	60

Table 10

What it was determined that winter was the most dangerous, followed by autumn, spring and summer.

In the 15th question the severity of pain was examined at weekends.

SMALLER	SAME	LARGGER	SMALLER %	SAME %	LARGGER %
12	3	0	80	20	0

Table 11

From what it can be seen that the pain is much weaker over the weekend.

In question 16, the level of problems after the climate service was tested

SMALLER	SAME	LARGGER	SMALLER %	SAME %	LARGGER %
2	11	2	13.33	73.33	13.33

Table 12

From what it can be seen that it is not.

Conclusion

The results of the study have shown that, in order to protect the health of workers in offices without natural ventilation, a comprehensive approach requiring more stringent air control is required, based on periodic measurement of parameters that affect air quality. Namely, this study found that health problems in workplaces where there is no possibility of natural ventilation are in place, among which the most common are headaches and coughs, and they increase during prolonged exposure to air conditioning itself. The recovery effect occurs both after a weekend and after a sick leave. The most common problems occur in spring and summer.

As the problems themselves do not increase or reoccur, and become chronic, it is best to reactively prevent them. In this regard, companies and organizations must maintain the air conditioning systems in due time and in the right way, as well as maintenance companies must monitor market trends, and laws related to this area, including standards. It is especially important to adapt the existing HVAC system or certain segments to the new environment. An example is, an increase in the degree of filtration in case of an increase in air pollution, instead of strictly incorporating filters according to the manufacturer's specifications, which were made more than a decade ago. Such an approach can provide for the preservation of the health of employees and their working ability.

Generally, do not try to add or subtract anything. Hold on to this text and do not depart from it for a millimeter if you exhibit it

Bibliography

1. Elena Traistaru., *et al*. "A comparative study on the quality of air in offices and homes". *Journal of Environmental Science and Health, Part A* 48 (2013).
2. GJ Holst., *et al*. "Allergy and respiratory health effects of dampness and dampness-related agents in schools and homes: a cross-sectional study in Danish pupils". *Indoor Air* 26 (2016): 880-891.
3. L Allermann., *et al*. "Building-related symptoms and inflammatory potency of dust from office buildings". *Indoor Air* 17 (2007): 458-467.
4. A Hoisington., *et al*. "Characterizing the bacterial communities in retail stores in the United States". *Indoor Air* 26 (2016): 857-868.
5. FC Tsai and JM Macher. "Concentrations of airborne culturable bacteria in 100 large US office buildings from the BASE study". *Indoor Air* 15 (2005): 71-81.
6. S Liu., *et al*. "Contribution of human-related sources to indoor volatile organic compounds in a university classroom". *Indoor Air* (2015).
7. B. Herbig. "Does office space occupation matter? The role of the number of persons per enclosed office space, psychosocial work characteristics, and environmental satisfaction in the physical and mental health of employees". *Indoor Air* 26 (2016): 755-767.
8. K Azuma., *et al*. "Prevalence and risk factors associated with nonspecific building-related symptoms in office employees in Japan: relationships between work environment, Indoor Air Quality, and occupational stress". *Indoor Air* 25 (2015): 499-511.
9. WJ Fisk and WR Chan. "Health benefits and costs of filtration interventions that reduce indoor exposure to PM2.5 during wildfires". *Indoor Air* 27 (2017): 191-204.
10. X Zhang., *et al*. "Physiological responses during exposure to carbon dioxide and bioeffluents at levels typically occurring indoors". *Indoor Air* 27 (2017): 65-77.
11. M Verriele., *et al*. "The MERMAID study: indoor and outdoor average pollutant concentrations in 10 low-energy school buildings in France". *Indoor Air* 26 (2016): 702-13.
12. AM. Johnson., *et al*. "Real-time transformation of outdoor aerosol components upon transport indoors measured with aerosol mass spectrometry". *Indoor Air* (2016).
13. Seppnen., *et al*. "Ventilation and performance in office work". *Indoor Air* 16 (2006): 28-36.
14. Oluwole., *et al*. "Indoor mold levels and current asthma among school-aged children in Saskatchewan, Canada". *Indoor Air* 27 (2017): 311-319.

15. Jianbang Xiang., *et al*. "Ozone, Electrostatic Precipitators, and Particle Number Concentrations: Correlations Observed in a Real Office during Working Hours". *Environment Science and Technology* 50 (2016): 10236-10244.

16. KS Lam., *et al*. "Achieving 'excellent' indoor air quality in commercial offices equipped with air-handling unit – respirable suspended particulate". *Indoor Air* (2006).

17. X Zhang., *et al*. "Effects of exposure to carbon dioxide and bioeffluents on perceived air quality, self-assessed acute health symptoms, and cognitive performance". *Indoor Air* 27 (2017): 47-64.

18. T Salthammer., *et al*. "Human sensory response to acetone/air mixtures". *Indoor Air* 26 (2016): 796-805.

19. N Hodas., *et al*. "Indoor inhalation intake fractions of fine particulate matter: review of influencing factors". *Indoor Air* 26 (2016): 836-856.

20. WR Chan., *et al*. "Estimated effect of ventilation and filtration on chronic health risks in U.S. offices, schools, and retail stores". *Indoor Air* 26 (2016): 331-43.

21. G Mallach. "Exhaust ventilation in attached garages improves residential indoor air quality". *Indoor Air* 27 (2017): 487-499.

22. P Wolkoff. "External eye symptoms in indoor environments". *Indoor Air* 27 (2017): 246-260.

23. Bradman., *et al*. "Formaldehyde and acetaldehyde exposure and risk characterization in California early childhood education environments". *Indoor Air* 27 (2017): 104-113.

24. M Mendez., *et al*. "Identification of the major HOx radical pathways in an indoor air environment". *Indoor Air* (2016).

25. J Pejtersen., *et al*. "Indoor climate, psychosocial work environment and symptoms in open-plan offices". *Indoor Air* 16 (2006): 392-401.

26. MJ Mendell and AG Mirer. "Indoor thermal factors and symptoms in office workers: findings from the US EPA BASE study". *Indoor Air 19* (2009): 291-302.

27. L Mølhave. "Inflammatory and allergic responses to airborne office dust in five human provocation experiments". *Indoor Air* 18 (2008): 261-70.

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