Usage Practices and Proper Maintenance of Home Air Conditioners and Their Relationship to Symptoms of Sick Building Syndrome Among a Sample of Housing Units and Their Occupants in Alexandria City

ممارسات الإستخدام والعناية بأجهزة تكييف الهواء المنزلية وعلاقتها بأعراض متلازمة البناء المريض لدي عينة من الوحدات السكنية وقاطنيها بمدينة الإسكندرية

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ABSTRACT: Using air conditioner (AC) has recently increased all over the world, as it provides instant protection from high heat and humidity especially in summer, and its use has also been associated with disease control and protection from the effect of outdoor pollution. However, it has many harmful effects on individuals. This is due to hydro fluorocarbons (HFCs) product which is found in the indoor environment of the dwelling which flow to the outdoor environment, causing global climate change. In addition, many air conditioning systems consume a large amount of electrical energy and are a fertile habitat for the growth and reproduction of microorganisms such as Legionella bacteria that can cause lung diseases, and Corona virus, which causes respiratory failure which might lead to death. Also, AC is considered a source of noise for residents and their neighbors in many cases.

The main objective of this study was to determine the relationship between usage practices and proper maintenance of home air conditioners and their relationship to symptoms of sick building syndrome (SBS) among a sample of housing units and their occupants in Alexandria city.

The research data were collected: the first part was the field study, a questioner was used to collect data from an accidental purposeful sample of 60 housing units occupants in Alexandria city, data were statistically analyzed using SPSS program (ver.25). The second part of the study was lab study: samples of dust accumulated on the AC filter, and Air coming out directly from AC, were collected (30) to isolate, identify and study bacteria and fungi.

Results indicated significant differences (0.01) between the average of Orthopedic symptoms according to usage practices of AC, the healthy symptoms were among the fair usage category and the worst were among the bad usage categories. Results also indicated that isolated bacteria and fungi species cause human diseases.

Research results showed that the accumulated dust on air conditioning filters contained significant numbers of bacterial and fungal species which could cause various human diseases such as pneumonia and other respiratory tract infections, irritation and asthmatic reactions to allergic inflammation, respiratory health implications, resulted from the indications of Bacillus sp., Staphylococcus sp. and Micrococcus sp. bacterial species. Allergic diseases such as allergic rhinitis and asthma, respiratory inflammation, and asthmatic diseases and breathing-related problems, skin allergies, constant sneezing, and red/watery eyes are resulted from the infections of Alternaria sp., Mucor sp. and Penicillium sp. fungal species.

Keywords: *Home air conditioning, Indoor residential environment, Usage and Proper Maintenance of home air conditioners, Sick Building Syndrome, Indoor air quality.*

I.INTRODUC TION:

The concept of air conditioning was known in Ancient Rome, where aqueduct water was circulated through the walls of certain houses to cool them. Similar techniques in medieval Persia involved the use of cisterns and wind towers to cool buildings during the hot season. Modern air conditioning emerged from advances in chemistry during the 19th century, and the first large-scale electrical air conditioning was invented and used in 1902 by Willis Havilland Carrier[1], and it was confined to winter comfort; that is, to heating the home to a comfortable temperature in the winter by means of open fireplaces or stoves. Later, improvements were made in the heating equipment by the introduction of steam and hot water heating.[4]

Today air conditioning (AC) systems are found in the world because predicted increases in cooling high heat throughout the world running everywhere in the hot countries to get some relief from the heat: at work, at home, in the hotel, hospital, clinic, commercial centers, malls, airport, aircraft, vehicle and metro. Continued modernization of building stock, increased income, and a desire to reduce moisture in building materials continue to drive a sustained increase in

air conditioner occurrence and use in the developed and industrializing world.[2]

With the continuous raising of the standard of living, the air conditioning of buildings has become a necessity in many cases to ensure that their living conditions meet the comfort requirements of its occupants, which results in greater satisfaction.[3]

Air conditioners transfer heat from indoor to outdoor through a compression-expansion cycle involving a refrigerant or working fluid. This heat moves against the spontaneous heat flow direction (warm to cold). The refrigerant must be heated up by compressing it through an electric compressor to a temperature higher than the medium into which the heat is transferred, so that it can release heat to the energy carrier medium through a condenser. The refrigerant must be cooled through an expansion valve to a temperature lower than the interior temperature, so that it can absorb heat from the internal through an evaporator. Then the refrigerant vapor is routed back into the compressor.[5]

There is a great variety of designs and equipment for air conditioning, which, together with the fact that several systems share common characteristics[3].High voltage air conditioning (HVAC) systems are more used in different types of buildings such as industrial, commercial, residential, and institutional buildings. The main mission of HVAC system is to satisfy the thermal comfort of occupants by adjusting and changing the outdoor air conditions to the desired conditions of occupied buildings. Depending on outdoor conditions, the outdoor air is drawn into the buildings and heated or cooled before it is distributed into the occupied spaces, then it is exhausted to the ambient air or reused in the system. HVAC systems are all designed for the same purpose – to regulate the temperature of a building – but they're not all designed in the same way. There are several popular types of air conditioning systems, and each has its advantages and disadvantages. Different systems use different energy sources, while some offer more compact designs over others. The most common systems are **first**, Window Air Conditioner (AC). It is a very common choice for controlling the temperature in a small room. It contains different components such as compressors, condensers, coils, and the evaporator, all in one single unit. Window AC is designed to fit into the window of a room, so it generally does not need any significant home modifications to be installed. Wall units are very similar to window AC, except they need a hole made in the room's wall for them to be installed. **Second** Split or Multi Head Split Air Conditioners. These ductless systems are quite common in modern homes. They are referred to as split systems because they consist of two units, one kept inside your home and one outside. They can be used to cool or heat single areas, or multi-zone systems can be installed. These have one compressor outside, with several indoor units conditioning the air in various parts of your home. **Third**, Ducted Air Conditioning or central air conditioning can be the most efficient in many situations. A ducted system needs a large compressor on the outside of the building, an internal evaporative unit and ducts that bring conditioned air to the inside rooms through vents. Central AC system requires some significant modifications to your home and tends to have a high installation cost.[6]

ir conditioning is considered a double-edged sword, as it has many defects, including excessive consumption of electrical energy. Air conditioning has more harm to health such as it doesn't pump fresh air from outside, but it recirculates the same air. It removes negative ions and increases positive ions which increases the acidity causing inflammation in our bodies which is the main reason of most diseases. Air conditioning systems can lead to many health problems such as respiratory problems, wheeze, shortness of breath, cough, asthma, Ear Nose Throat (ENT) problems, flu, rhinitis, pharyngitis, sinusitis, sore throat, loss of voice, dry mouth, allergies, eyes dry and irritated, skin disorders, wrinkles, acne, aging Raynaud's disease, shoulder/knee/foot pain, as well as sleep disorders. negative effect on the absorption of nutrients as well as the elimination of waste material, constipation, gastroenteritis, high blood pressure, dehydration, migraine, nausea, heart palpitations, hot flashes with sweating or chills, tremor, dizziness, stress, anxiety, depression, chronic fatigue, and premature Menopause.[7]

Sick building syndrome (SBS) is one of the negative effects of air conditioning. World Health Organization (WHO) defined SBS as a group of non-specific symptoms occur to occupants which include eye, nose, and throat irritation, mental fatigue, headache, nausea, dizziness, and skin irritation, which appear to be related to certain workplace (WHO 1986 in [10]). Occupants experience acute health problems and discomfort which appear to be linked to time spent in the building, where no specific illness or causes can be identified.[8] The main source of SBS among several sources is ventilation which is influenced by the type of ventilation system. SBS is higher in buildings with mechanical ventilation system compared to natural ventilation.[9]

In addition to many problems resulting from the negative effects of air conditioning on operational efficiency and human health in buildings. Microbial biofilms on narrowly spaced heat-exchange surfaces impede airflow and heat transfer, thus increasing the energy required for

cooling and dehumidifying. Aided by high air velocity over the coils, emissions from biofilms—including whole cells, microbial fragments, and microbial volatile organic compounds (MVOCs)—could be delivered to occupants throughout the building. While the mechanisms are largely uncharacterized, **the presence of air conditioning and microbial growth on cooling coils has been linked to adverse health among building occupants.**[11]

The previous introduction makes it clear that as AC has some advantages, it has several disadvantages. The main purpose of this research was to determine the relationship between usage practices and proper maintenance of home air conditioners and their relationship to symptoms of sick building syndrome among a sample of housing units and their occupants in Alexandria city.

II.MATERIALS AND METHODS:

The study consisted of two parts, the first part was field study, and the second part was laboratory study.

Part one: Field study (survey):

objectives of this part were to study:

(a) Socio- economic characteristics of occupants.

(b) Housing characteristics.

(c) Usage practices, proper maintenance and problems resulting from home AC.

(d) Symptoms of sick building syndrome among the sample, they include respiratory system, neurological symptoms, orthopedic symptoms, and allergy which all result from AC.

(e) Testing hypotheses.

Research variables:

The research variables were represented in three types of variables:

1-Independent variables, which were represented in the socio-economic characteristics: marital status, number of family members, number of children, age, education and job of the husband and the wife, and family income. Housing characteristics include owning the home, floor number, number of rooms, number of AC.

2-Intermediate variables, they include: usage practices, proper maintenance, and problems resulting from home AC.

3-Dependent variables: symptoms of Sick building Syndrome among the occupants including respiratory system, neurological symptoms, orthopedic symptoms, and allergy.

Research hypotheses:

The study hypotheses were stated in the null hypotheses form as follows:

1-There is no significant correlation between each of socio-economic characteristics and housing characteristics of the occupants and each of usage practices, proper maintenance, and problems resulting from home AC.

2-There is no significant correlation between each of socio-economic characteristics and housing characteristics of the occupants and symptoms of sick building syndrome among the sample including respiratory symptoms, neurological symptoms, orthopedic symptom, and allergy.

3-There is no significant correlation between each of usage practices, proper maintenance, and problems resulting from home AC and symptoms of sick building syndrome among the sample including respiratory system, neurological symptoms, orthopedic symptom, and allergy.

4-There are no significant differences between the averages of symptoms of sick building syndrome occurring among occupants and the average of usage practices of the occupants.

Data collection:

The study was carried out on a sample consisted of 60 housing units and their occupants who own air conditioner in Alexandria city, Egypt. A questionnaire was developed to collect data from the sample. The questionnaire was pretested before collecting data through personal interviewing.

Developing the questionnaire:

A questionnaire was developed to collect data. It included:

1. Socio- economic characteristics of occupants, they included number of family members, number of children, age of husband and wife, family income. To process data several variables were set in categories using the mean ± standard deviation, table (1).

2. Housing characteristics included ownership of the home, floor number, number of rooms, number of air conditioners, table (2).

3. Usage practices, proper maintenance and problems resulting from home AC:

a. Usage included each of duration of using AC all over the year in addition to its/ their type and site in the housing unit, table (3, 4).

b. Proper maintenance included accumulation of dust in the filter was estimated table (7), number of cleaning the filter, who and how it was cleaned table (5,6). In addition to studying general problems resulting from home AC table (8). To process data items included in proper maintenance were given marks and set in categories using the mean ± standard deviation table (9).

4. Symptoms of sick building syndrome (SBS) among occupants, to study symptoms of SBS four main health items were included: respiratory system, neurological symptoms, orthopedic symptoms, and allergy. The study included frequency of occurrence among occupants. To process data marks were given to occurrence of symptoms and set in categories using the mean ± standard deviation table (10,11).

Statistical analysis:

Statistical analyses were performed using SPSS program (ver.25) to determine the percentages, frequency, arithmetic mean ±, standard deviation, Spearman, and Pearson's simple correlation coefficient, and multiple regression analysis.

Part two: Laboratory study:

Objectives of this part were to study the bacteria and fungi content of each of:

Dust accumulated on the AC filter :

Dust samples were obtained using non- woven fabric swatches (with dimension 15cm X 15 cm) from 30 AC in 30 housing units. The area of AC filter is 30 cm X 25 cm. All swatches have been sterilized before sampling .

Air coming out directly from AC :

Air samples were collected from 30 AC taken out from the housing units of the field study in order to study bacteria and fungi content of the air coming out from AC filter. Sampling has been performed during August and September 2021. All AC sampled units were Split AC type, which means the air conditioning system is made up of two separate units. The air-cooled condensing unit called the compressor unit is placed outside the air-conditioned area whereas the air-handling unit is inside the room where the AC is fixed.

The sample of the air was obtained via exposing two petri dishes filled with nutrient media. Two different medias were used, for bacteria Nutrient Agar M001: is used as a general purpose medium for the cultivation of less fastidious microorganisms, can be enriched with blood or other biological fluids, and it can be used for the cultivation and enumeration of bacteria which are not particularly fastidious, Cultural characteristics observed after an incubation at 35-37°C for 18-48 hours , for fungi, PDA media Potato Dextrose Agar MH096: recommended for the cultivation of yeasts and molds from pharmaceutical products in accordance with the microbial limit testing by harmonized methodology of USP/EP/BP/JP/IP, and growth was observed at 20-25°C for 2-7 days. Isolation and initially identification of microorganisms were carried out in the Microbiology Laboratory, Agricultural Botany Department, Faculty of Agriculture Saba Basha, Alexandria University, Egypt. The 16SrRNA gene was amplified from the DNA extracted from the isolated bacterial strains using primers P0 and P6, which was used in previous studies.18 The PCR product was then sent to a sequencing company (Macrogen Inc., Seoul, Korea), and the sequences were searched in the GenBank to be identified and then accessed using numbers generated by GenBank. For the fungi, the ITS region was used to identify the fungal strains from each other using ITS1 and ITS4 primers. (20,21) All the products were sequenced and applied to identify by the NCBI blast tool, and all the strains deposited in the GenBank under different accession numbers.

III.RESULTS AND DISCUSSION

Part one: Field study (survey):

(a) Socio- economic characteristics of occupants.

Results indicated that 70% of the sample were married, family size was 3-5 members among 78.3% and 66.6% had 2-3 children. Results showed that the age of 73.4% of husbands was 27-68 years and 70% of the wives age was 34-60 years. Both husbands (53.3%) and wives (56.6%) had bachelor's degrees. 40% and 51.6% of husbands and wives had governmental jobs respectively. The family income of the majority (76.6%) of the sample ranged from 12600- 3957 Egyptian pounds per month (table 1).

Table 1. Socio- economic characteristics of occupants

Socio- economic Characteristics item	Number n =60	%	Socio- economic characteristics item	Number n =60	%
1- Marital Status:			**6- Husband's Education:**		
Married	42	70	Pension / Divorced	7	11.7
Single	18	30	Reads and write.	1	1.7
			Middle Certification.	2	3.3
			Qualification above average	3	5
			bachelor's degree.	32	53.3
			Postgraduate qualification.	15	25
Total	**60**	**100**	**Total**	**60**	**100**
2- Number of family members:			**7- Wife's Education:**		
Less than 3	7	11.7	Middle Certification	4	6.7
From 3-5	47	78.3	Qualification above average	4	6.7
More than 5	6	10	bachelor's degree	34	56.6
			Postgraduate qualification.	18	30
Total	**60**	**100**	**Total**	**60**	**100**
3- Number of children:			**8- Husband's Job:**		
No children	4	6.7	Government	24	40
Less than 2	7	11.7	Non-governmental	17	28.3
From 2-3	40	66.6	pension / deceased	19	31.7
More than3	9	15			
Total	**60**	**100**	**Total**	**60**	**100**
4- Husband's Age: 47.8 ± 20.4			**9- Wife's Job:**		
Less than 27	8	13.3	Government	31	51.6
From 27-68	44	73.4	Non-governmental	7	11.7
More than 68	8	13.3	do not work.	19	31.7
			pension / deceased	3	5
Total	**60**	**100**	**Total**	**60**	**100**
5- Wife's Age: 47.1 ± 13.1			**10- Family income: 8303.3 ± 4346.1**		
Less than 34	8	13.3	Less than 3957	5	8.3
From 34- 60	42	70	From 3957 - 12600	46	76.7
More than 60	10	16.7	More than 126400	9	15
Total	**60**	**100**	**Total**	**60**	**100**

b) Housing characteristics:

Results indicated that the majority of the occupants (85%) rented their apartments, 46.7% of the sample lived on the first floor up to the fourth floor. Regarding the number of rooms, results indicated that 76.7% of the apartments consisted of 3-5 rooms and 48.3% had one AC and 41.7% had 2-3 AC (table 2).

Table 2. Housing Characteristics

Characteristics	Number n =60	%	Characteristics	Number n =60	%
1- Owner ship of the home:			**3- Number of rooms:**		
Owner	9	15	Less than3	8	13.3
Rent	51	85	From 3-5	46	76.7
			More than5	6	10
Total	**60**	**100**	**Total**	**60**	**100**
2- Floor Number:			**4- Number of air conditioners:**		
Less than 5	28	46.7	one	29	48.3
From 5-10	20	33.3	From 2-3	25	41.7
More than10	12	20	More than3	6	10
Total	**60**	**100**	**Total**	**60**	**100**

(C) Usage Practices and Proper Maintenance and problems resulting from home AC:

1- Usage practices of AC:

Results indicated that in general occupants used AC during summer season in the master bedroom (46.7%), children's bedroom (23.3%),

living room (45%), dining room (5%), reception (31.7%), and office room (1.7%). Only 1.7% of the sample used AC during the day in the living room in the autumn season. Most of the sample (55%) used AC during the night. Regarding the number of hours of usage, results showed that 16.7% and 6.7% of the sample used it in master bedroom and children's bedrooms respectively during sleeping time only. Also 13.3% of the occupants used the AC all night in the living room (table 3).

Table 3. Usage Practices of Ac, N = 60

Dwelling space / Air conditioner Distribution in the residential unit	Master bedroom		Children's bedroom		Living room		Dining room		Reception room		Office room	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
1- Air conditioner operating time:												
* Summer season	28	46.7	14	23.3	27	45	3	5	19	31.7	1	1.7
*Autumn season	0	0	0	0	1	1.7	0	0	0	0	0	0
*Winter season	0	0	0	0	0	0	0	0	0	0	0	0
*Spring season	0	0	0	0	0	0	0	0	0	0	0	0
2- Run time:												
* Night	33	55	12	20	5	8.3	5	8.3	3	5	1	1.7
* Day	0	0	1	1.7	11	18.3	10	16.7	1	1.7	0	0
* Night and day	5	8.3	4	6.7	14	23.3	9	15	1	1.7	0	0
3-The duration of operation of the air conditioner:												
*Sleep time only	10	16.7	4	6.7	1	1.7	0	0	0	0	0	0
*All day	2	3.3	2	3.3	0	0	1	1.7	0	0	0	0
* All night	8	13.3	3	5	8	13.3	1	1.7	0	0	0	0
* From 8-6 hours	8	13.3	3	5	8	13.3	2	3.3	0	0	0	0
* From 6-4 hours	3	5	0	0	3	5	3	5	0	0	0	0
* Less than 4 hours	7	11.7	4	6.7	7	11.7	14	23.3	4	6.7	1	1.7
* All the time	2	3.3	2	3.3	3	5	2	3.3	1	1.7	0	0

Research results showed (Table 4) that most of the sample used split-type air conditioning with an indoor unit fixed to the wall (68.3%), and 20% used window air-conditioning, while 11.7% used split air-conditioning with an indoor unit recessed in the ceiling. The percentage of the rooms that had an air conditioner opened on side street was 48.4%, and 28.3% of the rooms overlook on a main street.

A study showed that areas with a hot summer, the temperature in air-conditioned rooms is usually maintained around 25 C, this is a temperature that corresponds to the neutral region for the human body in a static environment and should therefore not cause any pathological problem. However, the use of air-conditioning often leads to an increase in the difference between indoor and outdoor temperatures. Such difference in the temperature intensifies the thermal stimulation of people who are subjected to the sudden change of temperature sensation when moving between indoors and outdoors. People who remain in air-conditioned environment for a long period of time will suffer from heat shock and heat stress when they leave the cool environment of airconditioned rooms[15].

Table 4. Type of air conditioning and views of the room that has air conditioning

Air conditioner type	Number n =60	%	Room views with air conditioning	Number n =60	%
▪ Central.	0	0	▪ Main street	17	28.3
▪ Window.	12	20	▪ side street	29	48.4
▪ Wall Hung Split.	41	68.3	▪ garden	2	3.3
▪ AC Divided into An Indoor Unit That Is Fixed to The Ground.	0	0	▪ Industrial area	3	5
▪ Segmented Indoor Unit That Attaches to The Ceiling.	7	11.7	▪ skylight	9	15
▪ Segmented indoor unit with ceiling recess.	0	0	▪ workshops	0	0
			▪ Next to the kitchen	0	0
			▪ cafe	0	0
Total	60	100	**Total**	60	100

2- proper maintenance and problems resulting from home AC:

Maintenance was done once a year (46.7%) by a maintenance company (90%) for occupants who used AC during the summer season. For those who used AC in autem season, only (10%) maintain it every 3 months by maintenance company (23.3%). Regarding using AC to warm the home/ unit in winter maintenance was done every three months (8.3%) and every four months (6.7%) by a maintenance company (21.7%). During spring season 8.3% of the sample maintain the AC every 3 months by a maintenance company (18.3%), (table 5). Occupants who maintain their AC by themselves, results showed that one third (33.4%) washed the filter with water only, (table 6).

Table.5 Proper maintenance and problems resulting from home AC

Season / Clean the air conditioner filter	cleaning times Number n =60	%	Season / Clean the air conditioner filter	cleaner Number n =60	%
*** Summer season**			***Summer season**		
• every 3 months	5	8.3	• maintenance company.	54	90
• every 4 months	2	3.3	•The head of the family or a family member.	2	3.3
• every 5 months	0	0	•No one (does not clean).	4	6.7
• every 6 months	7	11.7			
• once a year	28	46.7			
• On maintenance only	12	20			
• does not clean.	6	10			
Total	**60**	**100**	**Total**	**60**	**100**
***Autumn season**			***Autumn season**		
• every 3 months	6	10	• maintenance company.	14	23.3
• every 4 months	0	0	• The head of the family or a family member.	0	0
• every 5 months	0	0	• No one (does not clean).	46	76.7
• every 6 months	1	1.7			
• once a year	2	3.3			
• On maintenance only	5	8.3			
• does not clean/ does not work.	46	76.7			
Total	**60**	**100**	**Total**	**60**	**100**
***Winter season**			***Winter season**		
• every 3 months	5	8.3	• maintenance company.	13	21.7
• every 4 months	4	6.7	• The head of the family or a family member.	0	0
• every 5 months	0	0	• No one (does not clean).	47	78.3
• every 6 months	0	0			
• once a year	3	5			
• On maintenance only	4	6.7			
• does not clean/ does not work.	44	73.3			
Total	**60**	**100**	**Total**	**60**	**100**
***Spring season**			***Spring season**		
• every 3 months	5	8.3	• maintenance company.	11	18.3
• every 4 months	0	0	• The head of the family or a family member.	0	0
• every 5 months	0	0	• No one (does not clean).	49	81.7
• every 6 months	0	0			
• once a year	2	3.3			
• On maintenance only	4	6.7			
• does not clean/ does not work.	49	81.7			
Total	**60**	**100**	**Total**	**60**	**100**

Table 6. Clean the air-conditioning filter

How to clean the air conditioner filter	Number n =60	%
I don't know	18	30
Dust suction	2	3.3
Wash with water	20	33.4
Sterilization	2	3.3
At maintenance	18	30
Total	60	100

Research studies showed that there is relation between the building dust and sick building syndrome, where it indicated an association between micro dust and diseases symptoms. Most of investigated buildings were naturally ventilated, poor cleaning, overcrowding, and poor space management. It was also found associations between the Gram-negative bacterial content of the dust and symptoms, as well as between the dust particulates and mucous membrane symptoms. Relations between volatile organics desorbed from the dust and general symptoms was found, as well as between the content of the dust and general symptoms. [13,14]

Air conditioning dust problems:

Research results presented in Table (7) indicated that the majority of the respondents suffered from the accumulation of dust on AC filter in summer in big quantity (40%), while 38.3% stated that dust accumulates on AC filter was in medium quantity in the autumn season, and 33.4% %, 38.3%, stated that the quantity of dust accumulated on air-conditioning filter in winter and spring seasons was in a small quantities respectively.

Table 7. Air conditioning dust problems

Dust buildup on the air conditioner filter / Season	big quantity		medium		small quantity		nothing		Total	
	Number n =60	%	Number n =60	%	Number n =60	%	Number n =60	%	Number n =60	%
* Summer season	24	40	22	36.6	13	21.7	1	1.7	60	100
*Autumn season	10	16.7	23	38.3	19	31.7	8	13.3	60	100
*Winter season	14	23.3	17	28.3	20	33.4	9	15	60	100
*Spring season	13	21.7	16	26.7	23	38.3	8	13.3	60	100

Related problems resulted from AC usage:

Results indicated that 78.3% of the respondents suffered from high consumption of electricity while 20% stated that electricity consumption, noise, and health problems resulted from A.C. Results also showed that 8.3% suffered from unpleasant odors and had problems with neighbors (Table 8).

Table 8. Suffering from other problems caused by air conditioning

Degree of suffering / Air Conditioning problems	Large degree		medium		Few degree		Nothing		Total	
	Number n=60	%	Number n=60	%	Number n=60	%	Number n=60	%	Number n=60	%
Electricity consumption	47	78.3	12	20	0	0	1	1.7	60	100
the noise	5	8.3	12	20	20	33.4	23	38.3	60	100
Problems with the neighbors	1	1.7	5	8.3	14	23.3	40	66.7	60	100
Unpleasant odors	0	0	5	8.3	20	33.3	35	58.3	60	100
Health problems	6	10	12	20	20	33.4	22	36.6	60	100

Data were classified into categories using the averages and standard deviation, (Table 9).

Table 9. Mean ± standard deviation and categories of variables under study

Total practices		Number n= 60	%
1- usage: mean ± standard deviation (24.1±13.1)	Bad: Less than 11	3	5
	Medium: From 11- 37.2	50	83.3
	Good: Over 37.2	7	11.7
	Total	**60**	**100**
2- proper maintenance: mean ± standard deviation (19.8 ± 8.1)	bad: Below 11.7	3	5
	Medium: From 11.7- 27.9	50	83.3
	Good: Over 27.9	7	11.7
	Total	**60**	**100**
3- total practicing: mean ± standard deviation (54.6±16.5)	Bad: Less than 38.1	3	5
	Medium: From 38.1- 71.1	45	75
	Good: Over 71.1	12	20
	Total	**60**	**100**
4- problems: mean ± standard deviation (10.7±2.2)	Bad: Less than	7	11.7
	Medium: From	39	65
	Good: Over	14	23.3
	Total	**60**	**100**

(d) Symptoms of Sick Building Syndrome (SBS) Among the Sample resulted from AC usage.

Previous studies showed that causes of SBS fall into three main reasons: allergic and immunologic disease, infections, and exposure to chemicals and other substances, SBS symptoms can affect skin, respiratory, and neurological systems. You may mistakenly self-diagnose yourself with a cold or flu.[12]

Other studies added although objective physical abnormalities of SBS are not generally found except in a few specific diseases like Legionnaires' disease, the symptoms can be uncomfortable and even disabling. It is commonly accepted to represent eye, nose, and throat irritation; Neurotoxic symptoms like headaches, lethargy, difficulty concentrating, and sometimes have dizziness; nausea, chest tightness; and other symptom like Behavioral disorders chronic fatigue Genitourinary problems Learning disabilities, etc.[16]

1- Respiratory symptoms:

To identify health problems of the residents and SBS of the studied housing units under study, occupants were asked about some of the symptoms and diseases that they may complain of.

Results indicated that 23.3%, and 20% of the respondents suffered frequently from common cold and runny nose, respectively. Respondents who suffered from sneezing (41.6%), sore throat (38.3%), runny nose (30%), chest allergy (23.3%), and breathing problems (20%), stated that they fairly suffered (Table 10). The most common symptom was the sensation of a blocked or stuffy nose. True rhinitis with sneezing and running nose was much less common. The latter are the typical symptoms of allergic rhinitis due to an inhaled allergen. A feeling of dryness of the throat, perhaps associated.[13]

2- Neurological symptoms:

Results showed that 10% and 13.3% of the sample respectively frequently felt fatigue. While 13.3% and 36.7% suffered from migraine sleeping disturbance fairly and rarely respectively (Table 10).

3- Orthopedic symptoms:

Results indicated that 13.3% of the sample suffered from shoulder, knee, and neck pain frequently and osteitis. while 18.4% and 25% suffered from arthritis fairly and rarely respectively, (Table 10).

4- Symptoms of allergy:

31.7%, and 26.6% of the sample suffered from sinusitis frequently or fairly respectively, also 13.3% suffered from ophthalmia fairly, 31.7% rarely suffered from skin allergy, and 36% did not suffer from watery eyes (Table 10). Dry eyes are the least prevalent mucous membrane symptom, it can cause problems in those who wear contact lenses, who may not be able to use them throughout the day. Objective signs include reduced foam in the inner epicanthus and increases tear film break up time.[13]

Table 10. Symptoms of sick building syndrome resulted from AC usage

Degree of complaint / symptoms of SBS	frequently		fair		rare		There is no		Total	
	Number n = 60	%	Number n = 60	%	Number n = 60	%	Number n = 60	%	Number n = 60	%
1- Respiratory symptoms:										
▪ common cold	14	23.3	16	26.7	2	3.3	28	46.7	60	100
▪ sneezing	10	16.7	25	41.6	4	6.7	21	35	60	100
▪ runny nose	12	20	18	30	6	10	24	40	60	100
▪ Sore throat	6	10	23	38.3	9	15	22	36.7	60	100
▪ breathing problems	5	8.3	12	20	9	15	34	56.7	60	100
▪ Pneumonia	2	3.3	2	3.3	10	16.7	46	76.7	60	100
▪ asthma	1	1.6	3	5	10	16.7	46	76.7	60	100
▪ chest allergy	2	3.3	14	23.3	11	18.4	33	55	60	100
▪ frequent cold	10	16.7	19	31.7	5	8.3	26	43.3	60	100
2- Neurological symptoms:										
▪ general fatigue	6	10	8	13.3	13	21.7	33	55	60	100
▪ frequent migraines	2	3.3	8	13.3	17	28.4	33	55	60	100
▪ nerve inflammation	2	3.3	4	6.7	20	33.3	34	56.7	60	100
▪ sleeping disturbances	3	5	4	6.7	22	36.7	31	51.6	60	100
3- Orthopedic symptoms:										
▪ foot pain	5	8.3	8	13.3	10	16.7	37	61.7	60	100
▪ Shoulder, knee, and neck pain	8	13.3	12	20	9	15	31	51.7	60	100
▪ arthritis	7	11.6	11	18.4	15	25	27	45	60	100
▪ osteitis	8	13.3	8	13.3	11	18.4	33	55	60	100
4- Symptoms of allergy:										
▪ Sinusitis	19	31.7	16	26.6	6	10	19	31.7	60	100
▪ Skin problems /allergies	2	3.3	6	10	19	31.7	33	55	60	100
▪ ophthalmia	2	3.3	8	13.3	14	23.4	36	60	60	100
▪ watery eyes	4	6.7	7	11.6	13	21.7	36	60	60	100

Table 11. Mean ± standard deviation and categories of variables under study

Symptoms of SBS		Number n= 60	%
1- Respiratory symptoms: mean ± standard deviation (27.4±6.9)	Bad: Less than 20.5	10	16.7
	Medium: From 20.5-34.3	40	66.6
	Good: Over 34.3	10	16.7
	Total	60	100
2- Neurological symptoms: mean ± standard deviation (13.4± 2.5)	bad: Below 10.9	8	13.3
	Medium: From 10.9-15.9	29	48.4
	Good: Over 15.9	23	38.3
	Total	60	100
3- Orthopedic symptoms: mean ± standard deviation (12.5±3.3)	Bad: Less than 9.2	12	20
	Medium: From 9.2-15.8	31	51.7
	Good: Over 15.8	17	28.3
	Total	60	100
4- Symptoms of allergy: mean ± standard deviation (12.6± 3.1)	Bad: Less than 9.5	9	15
	Medium: From 9.5 to 15.7	34	56.7
	Good: Over 15.7	17	28.3
	Total	60	100
5-Overall health status: mean ± standard deviation (65.9±14.1)	Bad: less than 51.8	11	18.3
	Medium: from 51.8- 80	39	65
	Good: over 80	10	16.7
	Total	60	100

Data were classified into categories usage the averages and standard deviation, (Table 11).

(e): Statistical analysis (testing the hypotheses):

1-There is no significant correlation between each of socio-economic characteristics and housing characteristics of the occupants and each of usage practices, proper maintenance, and problems resulting from home AC.

Statistical analysis showed that there was a positive significant correlation (0.01) between usage practices and number of the dwelling rooms. The correlation between proper maintenance and each wife's and husband's age was significantly negative (0.01), while there was positive significant correlation between proper maintenance, and number of dwelling rooms (0.01) (Table 12).

Spearman test values showed that there was negative significant correlation between proper maintenance, and marital status (0.05), positive correlation between related problems and each of husband's job (0.05) and husband education (0.01), while there was negative significant between dwelling ownership and related problems (0.01) (Table 12).

Table 12. Values of the simple correlation coefficient and spearman test between some socio-economic characteristics & Residential characteristics and usage practices and proper maintenance, and problems resulting from home AC

usage practices / Socio-economic characteristics	Usage practices	proper maintenance	the problems	total practices
Simple correlation coefficient				
Wife's age	0.106	-0.324**	-0.45	-0.081
husband's age	0.137	-0.389**	0.198	-0.057
number of family members	-0.033	0.104	-0.043	0.020
Monthly income	0.203	0.001	-0.010	0.159
number of children	0.155	0.108	-0.003	0.175
Residential floor	-0 .157	-0.216	-0.119	-0.245
The number of dwelling rooms	0.557**	0.314**	0.046	0.598**
Spearman test				
husband's job	-0.143	-0.073	0.250*	-0.116
wife's job	0.051	0.033	-0.211	0.029
marital status	0.124	-0.275*	0.241	-0.006
Wife's education	0.245	0.216	-0.043	0.293*
Husband's education	0.087	-0.096	0.319**	0.069
dwelling ownership	-0.182	0.007	-0.304**	-0.179
room crowding	0.201	-0.030	0.023	0.147

*** 0.05** **** 0.01**

2-There is no significant correlation between each of socio-economic characteristics and housing characteristics of the occupants and symptoms of sick building syndrome among the sample including respiratory symptoms, neurological symptoms, orthopedic symptom, and allergy.

Spearman test values showed that there was positive significant correlation (0.05) between each of neurological symptoms and overall health status, and room crowding, negative significant correlation between neurological symptoms, and wife's job (0.05), negative correlation between Respiratory symptoms and dwelling ownership (0.01), negative correlation between Orthopedic symptoms and wife's job (0.01) (Table 13).

Table 13. values of the simple correlation coefficient and spearman test between some socio economic & residential characteristics and Symptoms of SBS resulted from AC usage

Socio-economic characteristics \ Symptoms of SBS	Respiratory symptoms	Neurological symptoms	Orthopedic symptoms	allergy	Overall health status
Simple correlation coefficient					
Wife's age	0.058	0.131	-0.102	0.120	0.054
Husband's age	0.175	0.164	0.095	0.226	0.187
Number of family members	-0.228	-0.224	-0.106	-0.090	-0.196
Monthly income	0.124	0.140	.086	0.128	0.135
Number of children	-0.113	0.062	-0.015	-0.047	-0.058
Residential floor	-0.078	-0.001	0.080	-0.121	-0.047
The number of dwelling rooms	0.086	0.084	-0.008	0.017	0.059
Spearman test					
husband's job	0.033	-0.014	0.104	0.073	0.054
wife's job	-0.177	-0.255*	-0.323**	-0.065	-0.222
marital status	0.127	0.036	0.217	0.209	0.166
Wife's education	-0.063	-0.097	-0.085	-0.138	-0.099
Husband's education	0.137	0.124	0.144	0.245	0.177
dwelling ownership	-0.309**	-0.094	0.007	-0.152	-0.200
room crowding	0.231	0.285*	0.192	0.180	0.249*

*** 0.05** **** 0.01**

3-There is no significant correlation between each of usage practices, proper maintenance, and problems resulting from home AC and symptoms of sick building syndrome among the sample including respiratory system, neurological symptoms, orthopedic symptom, and allergy.

Results showed that there was positive significant correlation (0.01) between health problems resulting from using AC, and each of respiratory symptoms, neurological symptoms, orthopedic symptoms, allergy, and overall health status (Table 14).

It was found that there was a negative significant correlation (0.05) between proper maintenance and neurological symptoms, (Table 14).

Table 14. The values of the simple correlation coefficient between each of home air conditioning usage practices, proper maintenance, and Symptoms of SBS resulted from AC usage

Symptoms of SBS \ Categories	Usage practices	proper maintenance	the problems	Total practices
Respiratory symptoms	0.062	-0.186	0.701**	0.050
Neurological symptoms	0.043	-0.249*	0.635**	-0.006
Orthopedic symptoms	-0.036	-0.169	0.554**	-0.039
allergy	0.043	-0.148	0.632**	0.044
Overall health status	0.039	-0.208	0.727**	0.024

*** 0.05** **** 0.01**

4- There are no significant differences between the averages of symptoms of sick building syndrome occurring among occupants and the average of usage practices of the occupants.

One way analysis of variance showed significant differences (0.05) between the average of respiratory symptoms according to usage practices of AC, the healthy symptoms were among the fair usage category and the worst was among the bad usage categories. Results also indicated significant differences (0.01) between the average of orthopedic symptoms according to usage practices of AC, the healthy symptoms were among the fair usage category and the worst was among bad usage categories (Table 15).

Table 15. significant differences between averages of symptoms of SBS of occupants, and the average of usage practices of the occupants

Categories of Symptoms	usage practices	the average level of	Direction of significant differences	t or q value and significance score
Respiratory symptoms	bad	18.67	B	
	fair	28	A	2.78*
	good	26.71	AB	
Neurological symptoms	bad	-	-	
	fair	-	-	1.035
	good	-	-	
Orthopedic symptoms	bad	7	B	
	fair	13.10	A	7.028**
	good	10.86	AB	
allergy	bad	-	-	
	fair	-	-	0.563
	good	-	-	
Overall health status	bad	48	B	
	fair	67.36	A	3.028*
	good	63	AB	

*** 0.05** **** 0.01**

Indoor environment is a crucial part of the design process; therefore, designers need to change their thinking about this physical environment and increase their awareness of health impact on occupants. Building factors that affect sick building syndrome are high indoor temperatures which enhances fungi, low fresh ventilation which enhances producing biological contaminants, poor individual control of temperatures, poor building service maintenance and poor cleaning or cleaning ability.[17]

Part two: Laboratory study:

Many fungi, bacteria, molds, pollen, and viruses are types of biological contaminants cases, a malfunction of some component of heating, ventilation, and air conditioning (HVAC) system allows the organisms to grow and be disseminated. Organisms can grow in spray-water air washers, air filters, poorly maintained cooling coils, and water leaking into air ducts humidifiers and drain pans, or where water has collected on ceiling tiles, carpeting, or insulation. Sometimes insects or bird droppings can be a source of biological contaminants. Physical symptoms related to biological contamination include cough, chest tightness, fever, chills, muscle aches, and allergic responses such as mucous membrane irritation and upper respiratory congestion. One indoor bacterium, Legionella, has caused both Legionnaire's Disease and Pontiac Fever.[8]

Data concerning isolated bacteria, fungi species and expected human diseases resulting from air condition usage in different places in Alexandria governorate, are presented in table 16 and 17. Results showed that bacteria isolated on the nutrient media were identified.

Identified bacteria were *Bacillus sp.*, *Rhodococcus sp.*, *Corynebacterium sp.*, *Micrococcus sp.*, *Staphylococcus sp.*, *Streptomyces sp.*, *Micrococcus sp.*

Identified fungi that were isolated on the PDA media, were *Alternaria sp.*, *Trichoderma sp*., *Fusarium sp.*, *Cladosporium sp.*, *Aspergillus sp.*, *Mucor sp.*, *Acremonium sp.*, *Cladosporium sp.*, *Penicillium sp.*, *Epicoccum sp.*, *Botrytis sp.*, *Rhizopus sp.*, *Phoma sp.*, *Acremonium sp.* It is obvious that the accumulated dust on the air conditioning filters contain significant numbers of bacterial and fungal species which could cause various human diseases. For instance, pneumonia, other respiratory tract irritation, asthmatic reactions to allergic inflammation. Respiratory health implications result from infection by *Bacillus sp*., *Staphylococcus sp.* and *Micrococcus sp*. bacterial species, respectively. (34,35,36)

On the other hand, allergic diseases such as allergic rhinitis and asthma, respiratory inflammation, asthmatic diseases, breathing-related problems, skin allergies, constant sneezing, and red/watery eyes result from infection by *Alternaria sp.*, *Mucor sp.* and *Penicillium sp.* fungal species, respectively. These results indicated that the accumulated dust in the air conditioning filters poses a threat for the buildings residents due to its microbial contents. (24,27,28)

Table 16. Isolated bacterial species and the expected human diseases resulted from Air Condition usage in different places in Alexandria governorate, n=30

Sample	Place	Bacteria	Accession number	diseases
1	Moharm beak /Central district	Bacillus subtilis	OM039403	pneumonia and other respiratory tract infections.[34]
2	Moharm beak/Central district	Bacillus pumilus	OM039405	pneumonia and other respiratory tract infections .[34]
3	Saba basha/Eastern district	Rhodococcus sp.	OM039410	pulmonary diseases.[22]
4	shods / Al Montazah District	----------		----------
5	Sidi gaber /Central district	Corynebacterium sp.	OM039407	pneumonia and other respiratory tract infections.[34]
6	Sidi gaber /Central district	Micrococcus luteus	OM039408	----------
7	Abo soliman / Al Montazah District	Rhodococcus sp.		pulmonary diseases.[22]
8	Moharm beak /Central district	Staphylococcus saprophyticus	OM039409	irritation and asthmatic reactions to allergic inflammation.[35]
9	Moharm beak /Central district	----------		----------
10	Ibrahimya /Eastern district	Staphylococcus sp.		irritation and asthmatic reactions to allergic inflammation.[35]
11	Ibrahimya /Eastern district	Streptomyces sp.		respiratory health implications.[36]
12	Abes/Eastern district	Corynebacterium sp.	OM039406	pneumonia and other respiratory tract infections.[34]
13	Elnasr street / Eastern district	Bacillus sp.		pneumonia and other respiratory tract infections.[34]
14	green plaza / Eastern district	Staphylococcus sp.		irritation and asthmatic reactions to allergic inflammation.[35]
15	Ibrahimya /Eastern district	Streptomyces sp.	OM039412	respiratory health implications.[36]
16	Ibrahimya /Eastern district	Bacillus sp.		pneumonia and other respiratory tract infections.[34]
17	Sba basha / Eastern district	Micrococcus sp.		respiratory health implications.[36]
18	Mostfa kamel /Eastern district	Rhodococcus sp.		pulmonary diseases.[22]
19	Roushdy / Central district	Staphylococcus sp.		irritation and asthmatic reactions to allergic inflammation.[35]
20	Aboyoussef /Al Agamy District	----------		----------
21	Moharm beak /Central district	Bacillus sp.		pneumonia and other respiratory tract infections.[34]
22	Asafra 45/Al Montazah District	----------		----------
23	elawayed/Al Montazah District	Micrococcus sp.		respiratory health implications.[36]
24	Asafra 45/Al Montazah District	Streptomyces sp.		respiratory health implications.[36]
25	Asafra 45/Al Montazah District	Staphylococcus sp.		irritation and asthmatic reactions to allergic inflammation.[35]
26	Moharm beak/Central district	Corynebacterium sp.		respiratory diseases.[23]
27	Wabor elmaya/ Eastern district	----------		----------
28	Wabor elmaya/ Eastern district	Streptomyces sp.		respiratory health implications.[36]
29	Sporting/Eastern district	----------		----------
30	Ibrahymia/ Eastern district	----------		----------

Table 17. Isolated fungal species and the expected human diseases resulted from Air Condition usage in different places in Alexandria governorate, n=30

Sample	Place	Fungi	Accession number	diseases
1	Moharm beak /Central district	Alternaria sp.	OM057639	allergic diseases such as allergic rhinitis and asthma.[24]
2	Moharm beak/Central district	Alternaria sp.		allergic diseases such as allergic rhinitis and asthma.[24]
3	Saba basha/Eastern district	Trichoderma sp.		invasive sinusitis diseases.[25]
	shods / Al Montazah District	Fusarium sp.		Sinusitis diseases and allergen.[24]
4	Sidi gaber /Central district	Aspergillus niger	OM057642	allergic diseases.[26]
5	Sidi gaber /Central district	Cladosporium sp.	OM057648	Phaeohyphomycosis respiratory inflammation, and asthmatic diseases.[27]
	Abo soliman / Al Montazah District	Alternaria sp.		allergic diseases such as allergic rhinitis and asthma.[24]
6	Moharm beak /Central district	Aspergillus fumigatus		allergic diseases.[26]
7	Moharm beak /Central district	Aspergillus sp.	OM057660	allergic diseases.[26]
8	Ibrahimya /Eastern district	Aspergillus sp.		allergic diseases.[26]
	Ibrahimya /Eastern district	Mucor sp.		respiratory inflammation, and asthmatic diseases.[27]
9	Abes/Eastern district	Acremonium sp.	OM057661	chronic subcutaneous infections and infections of the eyes.[31]
	Elnasr street / Eastern district	Fusarium sp.		Sinusitis diseases and allergen.[24]
10	green plaza / Eastern district	Penicillium chrysogenum	OM057658	breathing-related problems, skin allergies, constant sneezing, and red/watery eyes.[28]
11	Ibrahimya /Eastern district	Aspergillus flavus	OM057644	allergic diseases.[26]
12	Ibrahimya /Eastern district	Mucor sp.	OM057662	respiratory inflammation, and asthmatic diseases.[27]
	Sba basha / Eastern district	Aspergillus sp.		allergic diseases.[26]
13	Mostfa kamel /Eastern district	Aspergillus sp.		allergic diseases.[26]
14	Roushdy / Central district	Penicillium sp.		breathing-related problems, skin allergies, constant sneezing, and red/watery eyes.[28]
	Aboyoussef /Al Agamy District	Epicoccum sp.		upper and lower respiratory tract disease, rhinitis, sinusitis, and asthma.[29]
15	Moharm beak /Central district	Botrytis sp.	OM057646	allergies and other respiratory issues.[30]
	Asafra 45/Al Montazah District	Fusarium sp.		Sinusitis diseases and allergen.[24]
16	elawayed/Al Montazah District	Cladosporium sp.	OM057647	Phaeohyphomycosis, respiratory inflammation, and asthmatic diseases.[27]
	Asafra 45/Al Montazah District	Rhizopus sp.		Mucormycosis and allergies.[32]
17	Asafra 45/Al Montazah District	Aspergillus terreus	OM057659	allergic diseases.[26]
18	Moharm beak/Central district	Epicoccum sp.	OM057649	upper and lower respiratory tract disease, rhinitis, sinusitis, and asthma.[29]
	Wabor elmaya/ Eastern district	Penicillium sp.		breathing-related problems, skin allergies, constant sneezing, and red/watery eyes.[28]
19	Wabor elmaya/ Eastern district	Trichoderma sp.	OM057656	invasive sinusitis diseases.[25]
20	Sporting/Eastern district	Fusarium sp.	OM057650	Sinusitis diseases and allergen.[24]
		Aspergillus sp.		allergic diseases.[26]
21	Moharm beak /Central district	Rhizopus sp.		Mucormycosis and allergies.[32]
22	Moharm beak/Central district	Fusarium sp.		Sinusitis diseases and allergen.[24]
	Saba basha/Eastern district	Botrytis sp.		allergies and other respiratory issues.[30]
23	shods / Al Montazah District	Rhizopus stolonifer	OM057654	Mucormycosis and allergies.[32]
24	Sidi gaber /Central district	Aspergillus sydowii	OM057652	allergic diseases.[26]
25	Sidi gaber /Central district	Mucor sp.	OM057663	respiratory inflammation, and asthmatic diseases.[27]
	Abo soliman / Al Montazah District	Penicillium sp.		breathing-related problems, skin allergies, constant sneezing, and red/watery eyes.[28]
26	Moharm beak /Central district	Phoma sp.	OM057653	eye infections.[33]
	Moharm beak /Central district	Rhizopus sp.		Mucormycosis and allergies.[32]
27	Ibrahimya /Eastern district	Mucor sp.		respiratory inflammation, and asthmatic diseases.[27]
	Ibrahimya /Eastern district	Acremonium sp.		chronic subcutaneous infections and infections of the eyes.[31]
28	Abes/Eastern district	Aspergillus niger	OM057641	allergic diseases.[26]
29	Elnasr street / Eastern district	Fusarium sp.		Sinusitis diseases and allergen.[24]
	green plaza / Eastern district	Penicillium sp.		breathing-related problems, skin allergies, constant sneezing, and red/watery eyes.[28]
30	Ibrahimya /Eastern district	----------		----------

IV.CONCLUSION

The main objective of this study was to determine the relationship between usage practices and proper maintenance of home air conditioners and their relationship to symptoms of sick building syndrome (SBS) among a sample of housing units and their occupants in Alexandria city.

Results indicated significant differences (0.01) between the average of Orthopedic symptoms according to usage practices of AC, the healthy symptoms were among the fair usage category and the worst were among the bad usage categories. Results also indicated that isolated bacteria and fungi species cause human diseases.

Research results showed that the accumulated dust on air conditioning filters contained significant numbers of bacterial and fungal species which could cause various human diseases such as pneumonia and other respiratory tract infections, irritation and asthmatic reactions to allergic inflammation, respiratory health implications, resulted from the indications of Bacillus sp., Staphylococcus sp. and Micrococcus sp. bacterial species. Allergic diseases such as allergic rhinitis and asthma, respiratory inflammation, and asthmatic diseases and breathing-related problems, skin allergies, constant sneezing, and red/watery eyes are resulted from the infections of Alternaria sp., Mucor sp. and Penicillium sp. fungal species.

Through the previous results, which showed the direct and indirect impact of both the practices of usage and proper maintenance for home air conditioning systems and their relationship to the symptoms of sick building syndrome, and the general health of individuals residents of the residential units under this study. Therefore, the researchers recommend the necessity of periodic follow-up and care to clean the air conditioning filters in the proper manner, to limit the growth of fungi and pathogenic bacteria and thus maintain the quality of the indoor residential environment. This can be achieved by holding awareness seminars/lectures, guidance bulletins, and guidance programs directed to all family members and all segments of society. also, to conduct more future research regarding home air conditioning and its impact on various aspects of life quality for individuals.

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الملخص العربي

ممارسات الإستخدام والعناية بأجهزة تكييف الهواء المنزلية وعلاقتها بأعراض متلازمة البناء المريض لدي عينة من الوحدات السكنية وقاطنيها بمدينة الإسكندرية

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زاد إستخدام تكييف الهواء في الأونه الأخيرة في جميع أنحاء العالم، حيث يوفر حماية فورية من موجات الحرارة العالية والرطوبة خاصة في فصل الصيف، وقد إرتبط استخدامه أيضًا بمكافحة ناقلات الأمراض والحماية من آثار تلوث الهواء الطلق. وبالرغم من ذلك فله العديد من الاثار الضارة على الأفراد، ويرجع ذلك إلى مركبات الهيدروفلوروكربون (HFCs) التي يمكن أن تنبعث إلى البيئة الداخلية للمسكن ومنها إلى البيئة الخارجية مسببة التغيرات المناخية. بالإضافة إلى أن العديد من أنظمة تكييف الهواء تستهلك قدراً كبيراً من الطاقة الكهربائية، وتعد موطناً خصباً لنمو وتكاثر الكائنات الحية الدقيقة مثل الليجيونيلا التي يمكن أن تسبب أمراض الرئة، وفيروس كورونا الذي يتسبب في فشل الجهاز التنفسي ومن ثم الوفاة، كما يعد مصدر للضوضاء لقاطني الوحدات السكنية وجيرانهم في أحياناً كثيرة.

أستهدف البحث بصفة رئيسية دراسة ممارسات الإستخدام والعناية بأجهزة تكييف الهواء المنزلية وعلاقتها بأعراض متلازمة البناء المريض لدي عينة من الوحدات السكنية وقاطنيها بمدينة الإسكندرية، ولتحقيق هدف البحث تضمنت الدراسة شقين، الشق الأول الدراسة الميدانية والتي تمثلت عينتها في عينة صدفية قوامها 60 وحدة سكنية وقاطنيها بمدينة الإسكندرية وقد تم تجميع بياناتها البحثية عن طريق إستمارة الإستبيان بالمقابلة الشخصية، ثم تحليل البيانات إحصائياً بإستخدام برنامج Spss (25)، والشق الثاني الدراسة المعملية وتهدف إلي عزل وتعريف الفطريات والبكتريا الناتجة عن إستخدام أجهزة تكييف الهواء المنزلي في بعض أحياء مدينة الإسكندرية.

وقد كانت أبرز النتائج البحثية تشير إلى وجود فروق معنوية (0.01) بين متوسطات مستوي ممارسات العناية والإستخدام للتكييف المنزلي لقاطني الوحدات السكنية موضع الدراسة، حيث إن الأعراض الصحية للعظام كانت لدي الفئة ذات الدرجات الوسطي في إستخدام التكييف، والأعراض غير الصحية كانت لدي الفئة ذات الدرجات المنخفضة في إستخدام التكييف.

كما أوضحت النتائج البحثية المتصلة بالدراسة المعملية إلى أنه قد تم عزل أعداد كبيرة من بعض الأجناس البكتيرية والفطرية من الغبار المتواجد في فلتر التكييف المنزلي، والتي تؤثر على صحة قاطني الوحدات السكنية موضع الدراسة والمتعلقة بالأعراض المرضية لمتلازمة البناء المرض ومنها بعض الاجناس البكتيرية مثل *Micrococcus sp*، *Bacillus sp.*، *Staphylococcus sp* المسبب للألتهاب الرئوي والتهابات الجهاز التنفسي الأخرى، والتهيج والربو وحساسية الصدر، وإلتهابات الجهاز التنفسي. وكذلك بعض الأجناس الفطرية مثل *Alternaria sp.*, *Mucor sp. and Penicillium sp* والمسببة لأمراض الحساسية مثل التهاب الأنف التحسسي والربو، والتهاب الجهاز التنفسي، وأمراض الربو والمشاكل المتعلقة بالتنفس، وحساسية الجلد، والعطس المستمر، والعيون الحمراء / الدامعة.

الكلمات المفتاحية: أجهزة تكييف الهواء المنزلية، البيئة السكنية الداخلية، ممارسات الإستخدام والعناية بأجهزة تكييف الهواء المنزلية، متلازمة البناء المريض، جودة الهواء الداخلي.