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Canan Demir Yildiz

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## **A Management Factor at Sick Building Syndrome: Are Old or New School Buildings Sick?**

**Canan DEMİR YILDIZ<sup>1</sup>**

Muş Alparslan University

### **Abstract**

The training and learning activities for students are primarily conducted in closed environments. The symptoms resulting from living environments in occupied buildings are referred to as “sick building syndrome (SBS).” The aim of this study is to evaluate the SBS associated with the age of a school building. In this research, grounded research design, which is a type of mixed-method approach, was preferred because qualitative and quantitative methods were used to support each other. Four different schools were selected based on the ages of the school buildings by criterion sampling method. These schools were identified to be 1-, 5-, 10-, and 40-year old buildings. Thus, the research sample comprised a total of 423 students. The students were provided with a questionnaire and the data obtained were analyzed with IBM SPSS 25 software. At the end of the research, it was observed that 329 students experience symptoms in the school, and the most commonly experienced physical symptoms are headache (188 students), physical and mental fatigue (175 students), and concentration disorder (142 students). Moreover, a significant relationship was observed between the symptoms experienced by the students during their time in the school and the symptoms they experienced after school. It was revealed that the most uncomfortable places are corridors and washrooms. In general, it can be concluded that the SBS symptoms are observed in four different buildings, and they vary depending on comfort conditions such as hygiene, ventilation, and heating instead of the age of the school building. Furthermore, it was noted that school principals responsible for the administration of school buildings have an important role in the improving or deteriorating of SBS symptoms.

**Keywords:** Sick Building Syndrome, School Building, Sick Building Symptoms, Students.

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<sup>1</sup> Assist. Prof. Dr., Faculty of education, Muş Alparslan University, Turkey, ORCID: 0000-0002-5905-9344

**Correspondence:** canan.yildiz@alparslan.edu.tr

## Introduction

Generally, the causes of symptoms related to indoor spaces in schools are subjectively evaluated, and it is difficult to concretize these symptoms in a clinical environment. Although sick building syndrome (SBS) is a widely used term, it is defined in diverse ways in the literature and among researchers. Moreover, there are continued discussions regarding chemical, physical, and psychological conditions associated with the health of individuals in indoor spaces and ways in which these conditions interact. The pollutant concentrations can be low in non-industrial closed environments and thus, require versatile and expensive observation methods for the measurement. The level of sensitivity of an individual, when exposed to low-concentration, plays a crucial role in getting ill. Although psychological parameters are also considered to affect the illness symptoms, existing methods used to evaluate the psychological parameters are very limited. Hence, the symptoms of illnesses experienced in such environments are a complex issue because various unknown factors affecting are the health and their intensities and even the results of the most advanced research are still questionable (Brightman and Moss, 2000). Despite these complexities, researchers have identified the symptoms associated with buildings to characterize SBS and then examine SBS, which is more complex.

Most researchers assert that SBS includes a set of symptoms that does not possess a clear cause and are associated with exposure to certain building environments. In addition to this uncertainty, researchers have tried to elucidate the SBS using various definitions or certain terms like “building-related illness,” “office eye syndrome,” and “tight-building syndrome” as additional information was gathered. Although objective measures have been developed, the diagnosis of SBS is primarily based on personal reports (Brightman and Moss, 2000).

“Sick building syndrome” is a term commonly used when occupiers of a building are affected by illnesses caused because of the building itself. Diseases are generally transmitted by natural respiration. Patients usually feel well or display no symptoms outside of the building (Boards SIAoS, 1996; Awbi, 2003). SBS comprises a set of symptoms observed among indoor occupants. Runny eyes and nose and sore throat, headache and dizziness, nausea, fatigue and weakness, concentration disorder, and skin irritation and redness are the frequently observed symptoms (Takigawa, 2012). These symptoms start appearing after a certain period of time is spent inside a building and tend to alleviate outside the indoor environment. When the causes of SBS were investigated, it was observed that this is a highly complex issue and associated with physical environmental conditions, chemical and biological indoor environmental contaminants, and personal factors (Redlich et al, 1997; Salvaggio, 1996). In a two-year prospective study by Zhang, et al. (2014) they investigated associations between environmental parameters such as room temperature, relative air humidity (RH), carbon dioxide (CO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), sulphur dioxide (SO<sub>2</sub>), ozone (O<sub>3</sub>), particulate matter (PM<sub>10</sub>), and health outcomes including prevalence, incidence and remission of SBS symptoms in

junior high schools in Taiyuan, China and found that the environmental pollution, including PM10, SO2 and NO2, could increase the prevalence and incidence of SBS and decrease the remission rate.

Because the insulation in school buildings is increasingly enhanced, toxicants from cigarette smoke, chalk powder, and art rooms and facilities cannot be discharged and thus, are being continuously circulated indoors via the ventilation system. Moreover, inlet of an air duct system usually contains dust or mold, thereby spreading germs throughout the building. Piping systems of school buildings are rarely cleaned and hence, the germs generated from these systems cause several diseases (Lunenburg and Ornstein, 2008). Excessive humidity in locked rooms, indoor pool areas, and basement of school building can cause mold and fungi growth, which can propagate to dangerous levels (typically, school managements are not aware of this situation) (Baechler et al. 1991). Besides the several indoor air pollutants, outdoor air pollution also significantly affects the indoor environment (Çobanoğlu and Kiper, 2006).

Administrators usually assume that the ventilation quality in their school is good unless any symptom of illness appears. However, several air pollutants, such as radon gas, carbon monoxide, asbestos particles, and dust, cannot be detected by smell or observation. Other pollutants are perceptible only at higher concentrations. For example, formaldehyde, paint, liquid cleaning detergents, mold, and fungi have an odor at harmful levels (Lunenburg and Ornstein, 2008; Baechler et al. 1991). SBS symptoms are mainly triggered by one or combination of more than one factors, like flammable materials, damp, airborne epidemic disease agents, formaldehyde, in new carpets and building furniture along with the presence of dust particles, insecticides, rat poisons, and pesticides (Bosher, 2004; Environmental Protection Agency [EPA]).

However, in the 1971 Clean Air Act, established in the USA, six common air pollutant criteria, i.e., ozone, particle matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, lead as well as 189 toxic or hazardous air pollutants were identified (Suh et al. 2000). These air pollutants cause acute illnesses, such as vomiting, and chronic diseases, such as cancer, as well as immunological, neurological, reproductive, developmental, and respiratory diseases. In general, the factors affecting SBS can be summarized as follows (Redlich et al, 1997; Burge, 2004, Norbäck, 2009): Air contaminants, ventilation, school organization (job satisfaction, stress, social structures), host factors (sex, atopy and allergy, airway hyper-reactivity, pre-existing disease), poor building service maintenance. It can be summarized the common contaminants in indoor air as such: Volatile organic compounds (formaldehyde, solvents, printer and photocopier emission, paints and resins, printed materials), dust/fibres (asbestos, man-made mineral fibres (fibreglass), dirt, construction, and paper dust), Bioaerosols (bacteria, moulds, viruses, pollen, fungi, dust mites, animal dander and excreta), Entrapped outdoor sources (vehicle exhaust, industrial exhaust), physical factors (temperature, noise, humidity, lighting), contaminants generated by human activity (carbon dioxide, perfume) and others

(fuel combustion products, environmental tobacco smoke, pesticides, radon, cleaning agents, building materials).

In a study, it was revealed that installations of twenty- or thirty-year-old school buildings need to be replaced. It was reported that a school building begins to rapidly deteriorate after forty years, and most of the school buildings are abandoned after sixty years. School buildings over thirty years of age are considered old. However, today, many schools pose an environmental threat, and certain building renovation products, substances, and procedures may harm the environment. Cleaning agents, floor covering, radon and asbestos, classroom illuminations, electromagnetic fields, insecticides, poisons, molds, formaldehyde, and several other substances, as well as environmental conditions, may negatively affect the health and behavior of building occupants. In addition to their effect on learning, it is considered that most of these factors cause illnesses in susceptible students and personnel (Bluestein, 2001).

Therefore, the reconsideration of school buildings from the health perspective becomes crucial because children spend most of their time inside school buildings for education and training activities. Hence, the necessity of investigation of school buildings for SBS arises. It was observed that many previous studies on SBS were conducted in offices, while the studies for school buildings were conducted in pre-school institutions or primary schools with the participation of parents. Moreover, it was observed that many studies were performed with quantitative methods. With this research, it is believed that quantitative analyses of school building environments will provide a significant contribution to the literature, in association with the students' views along with the determination of symptoms that alleviate after leaving the school premises or the symptoms that worsen inside the building. As stated in the literature, evaluation of the age of a school building will be a significant contribution of this study to determine whether the age of a school building is an important determinant of SBS. However, it is also expected that the identification of the conditions that cause unhealthy environments and the most uncomfortable physical areas inside the school building based on the views of the students will fill an important research gap.

### **Aim of the Research**

This study aims to investigate school buildings for SBS. For this purpose, answers to the following questions were sought:

1. Do students have any symptoms in schools? If so, which symptoms do they have?
2. How do experienced symptoms in schools differ in terms of gender and age?
3. Do the experienced symptoms alleviate after school? If so, which symptoms alleviate?
4. Which of the experienced symptoms in question worsen further at school?

5. Do experienced symptoms differ in terms of the age of the school building? In other words, is there any difference in SBS among various schools?
6. Do students think that there are unhealthy places in the school building? What are they?

### **Methods**

While determining the research model, efforts were made to use different methods for different components of the research and to extend the scope of the research; hence, the aim of the study was to determine the relation between the results obtained from different methods and designs or to evaluate the cases from different perspectives and thereby obtain extensive and detailed results. This approach is referred to as the mixed-method approach that provides a holistic process for exhibiting the different aspects of the investigated event. Creswell (2017) defines the mixed-method approach as the combination of qualitative and quantitative methods and approaches and concepts in research or subsequent researches.

In this research, grounded research design, which is a type of mixed-method approach, was preferred because qualitative and quantitative methods were used to support each other. In grounded design, quantitative and qualitative data are simultaneously or subsequently collected. Herein, quantitative and qualitative data were simultaneously obtained.

The quantitative side of the research was realized by a descriptive survey model. The presence of any differentiation by gender, age, and age of the school building was investigated. The views of the students obtained constituted the qualitative aspect of the research.

Herein, the study group comprises students who were selected by criterion sampling from a high school located in the center of the Muş Province. In the selection of the study group, the age of the school building was defined as the criterion, and the school buildings were selected accordingly. As the criterion of the research, third-grade high school students studying in 1-, 5-, 10-, and 40-year-old school buildings constituted the study group of the research. The schools were randomly selected based on this criterion. There were no reports of health complaints or environmental problems from any of the schools before the investigation. Available students were approached for the efficient performance of the questionnaire. However, to conform to the aim of the research, students who have spent at least 1 year inside the school building were voluntarily included in the research. Hence, a total of 423 students participated in the research. The questionnaire comprising qualitative and quantitative questions was applied to the entire study group (N = 423).

A questionnaire form was prepared by the researcher at the end of a literature review. This questionnaire form consisted of two parts. The first part includes demographic information, while the second part includes structured and semi-structured questions. The experienced symptoms associated with SBS obtained by literature review were listed, and the participants were asked to state the illness symptoms experienced by them except the listed symptoms.

The symptoms experienced as a result of SBS constituting the subject of the research were listed. The students were asked to select the options applicable to them to determine the illnesses that alleviate after leaving the building and the illnesses that worsen inside the building. The students were also asked to list the areas that they assume to be unhealthy along with their reasons. Hence, the research data were obtained by the application of the questionnaire form previously prepared by the researcher.

The data obtained from the qualitative side of the research were analyzed with the descriptive analysis technique. The obtained data were summarized in the table with frequency and percentages and direct quotations were included. The selected students were coded as follows from each school: First female student (F1) and male student (M1).

### **Statistical Method**

Research data were uploaded in a computer environment and evaluated with IBM SPSS 25 (IBM Statistical Package for Social Sciences) software. The descriptive statistics for categorical variables (gender, school ages, symptoms, etc.) were numerically presented and as a percentage. The comparisons of the symptoms with respect to the categorical variables were analyzed using the “Pearson Chi-Square,” “Yates’s correction for continuity,” and “Fisher exact” tests. The results were compared based on confidence levels of 95% and 99%, and the significance levels were assumed as  $p < 0.001$  and  $p < 0.05$ . Ratio tests were performed for significant results when comparing the symptoms by school ages. In addition, the symptoms stated were compared with alleviating and worsening illnesses using the “Mc Nemar” test. The descriptive statistics of the age variable were given as the mean ( $\pm$ ) standard deviation. Because it was found that the age variable did not comply with the normality assumption when comparing the individuals who have or do not have symptoms using “Kolmogorov–Smirnov/Shapiro–Wilk tests,” analysis was performed in comparisons with “Mann–Whitney U” test. The significance level was considered as  $p < 0.005$  and  $p < 0.001$ .

### **Results**

Of the 423 participated students in the research, 266 (62.9%) were female and 157 (37%) were male. The ages of the students varied between 14–19-years range, and the average age of the students was  $16.13 \pm 1.05$  years. The ages of the female students varied between 14–18-years range, and the average age of female students was  $16.20 \pm 0.94$  years, while the ages of the male students varied between 14–19-years range, and the average age of male students was  $16.03 \pm 1.22$  years.

Students from four different schools were included in the research. 128 (30.3%) of the students studied in the forty-year-old school building, 105 (24.8%) were in the one-year-old school building, 92 (21.5%) were in the five-year-old school building, and 98 (23.2%) were in the ten-years-old school building.

329 (77.8%) of the students stated that they have symptoms, 93 (22%) stated that they do not experience any symptoms, and 1 student (2%) did not provide any answer.

The distribution of 422 students who stated whether they experienced any symptoms is given in Table 1. The symptoms frequently experienced by the students were found to be headache (188 students), physical and mental fatigue (175 students), and concentration disorder (142 students), while the least common symptoms were included in the other group and they were (insomnia (n = 3), psychological (n = 5), stress (n = 1), acne (n = 1), fainting (n = 2), diabetes (n = 2), abdominal pain (n = 1), chest pain (n = 1), heart ache (n = 1), stomach ache (n = 1), distraction (n = 1)), and nasal bleeding (experienced by 10 students).

**Table 1.** Distribution of the students by experienced symptoms

Experienced symptoms	Yes*	No*
Nausea	56 (13,3)	366 (86,7)
Concentration disorder	142 (33,6)	288 (66,4)
Odor sensitivity	72 (17,1)	350 (82,9)
Headache	188 (44,5)	234 (55,5)
Eye discomfort	92 (21,8)	330 (78,2)
Runny nose	62 (14,7)	360 (85,3)
Throat ache	50 (11,8)	372 (88,2)
Cough	90 (21,3)	332 (78,7)
Dry and itchy skin	40 (9,5)	382 (90,5)
Dizziness	67 (15,9)	355 (84,1)
Nosebleeds	10 (2,4)	412 (97,6)
Physical and mental fatigue	175 (41,5)	247 (58,5)
Loss of memory	19 (4,5)	403 (95,5)
Erythema	12 (2,8)	410 (97,2)
Eye watering	72 (17,1)	350 (82,9)
Nasal congestion	54 (12,8)	368 (87,2)
Shortness of breath	49 (11,6)	373 (88,4)
Eye itching	44 (10,4)	378 (89,6)
Cold	71 (16,8)	351 (83,2)
Shivering	53 (12,6)	369 (87,4)
Palpitation	53 (12,6)	369 (87,4)
Fever	30 (7,1)	392 (92,3)
Other**		

The results of the comparison of the symptoms experienced by the students by gender are given in Table 2.

Firstly, it was tested whether each type of symptoms was related to gender, and it was found that females experience more headaches ( $p < 0.001$ ), eye problems ( $p < 0.05$ ), and physical and mental fatigue conditions ( $p < 0.001$ ) than males. Also, a significant relationship ( $p < 0.05$ ) was found between gender and nasal congestion, although the number of females and males having nasal congestion was equal, and it was observed that the reason of this relationship is that the number of the females who do not have any symptoms is very high (238 students).

**Table 2.** Comparison of symptoms by gender variable

Experienced Symptoms	Experienced symptoms by gender variable
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	Female*	Male*	p value
Nausea	38 (67,9)	18 (32,1)	,400
Concentration disorder	90 (63,4)	52 (36,6)	,860
Odor sensitivity	50 (69,4)	22 (30,6)	,200
Headache	137 (72,9)	51 (27,1)	<,001**
Eye discomfort	71 (77,2)	21 (22,8)	,001***
Runny nose	34 (54,8)	28 (45,2)	,160
Throat ache	33 (66,0)	17 (34,0)	,618
Cough	61 (67,8)	29 (32,2)	,270
Dry and itchy skin	26 (65,0)	14 (35,0)	,896
Dizziness	46 (68,7)	21 (31,3)	,345
Nosebleeds	7 (70,0)	3 (30,0)	,453
Physical and mental fatigue	127 (72,6)	48 (27,4)	<,001**
Loss of memory	14 (73,7)	5 (26,3)	,446
Erythema	9 (75,0)	3 (25,0)	,286
Eye watering	49 (68,1)	23 (31,9)	,311
Nasal congestion	27 (50)	27 (50)	,037***
Shortness of breath	36 (73,5)	13 (26,5)	,137
Eye itching	33 (75,0)	11 (25,0)	,109
Cold	44 (62,0)	27 (38,0)	,875
Shivering	39 (73,6)	14 (26,4)	,113
Palpitation	38 (71,7)	15 (28,3)	,200
Fever	21 (70,0)	9 (30,0)	,515

\* The data are represented numerically (column percentage) and the comparisons are calculated based on the column. \*\*p < 0.001 \*\*\*p < 0.05

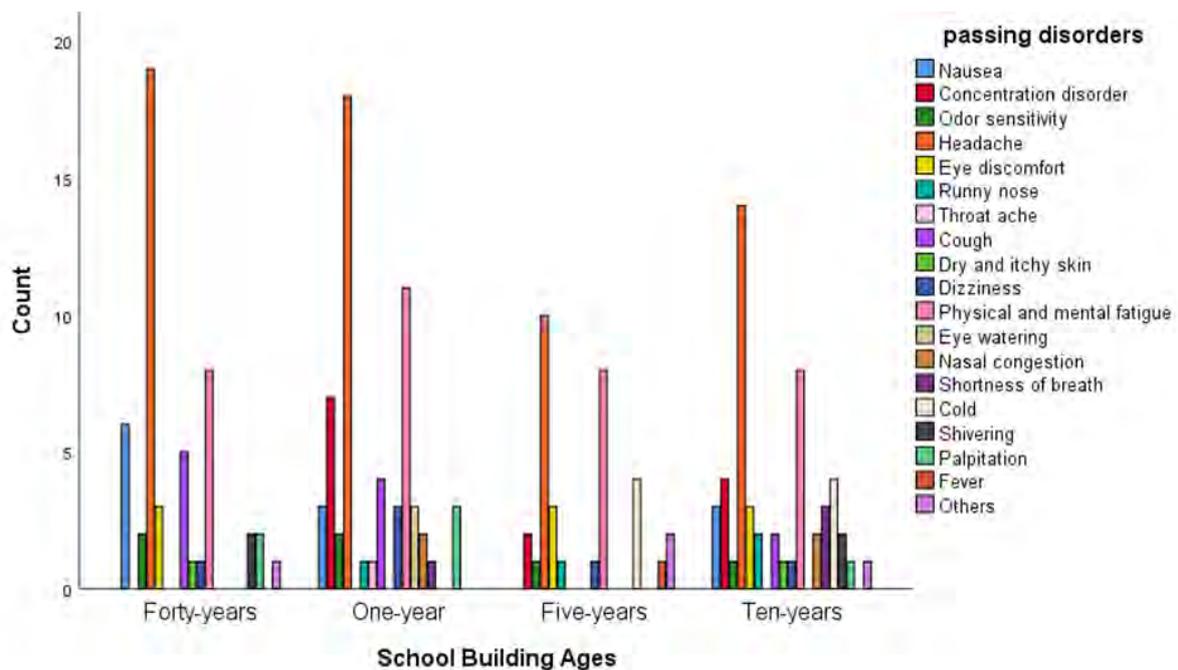
When it was tested whether there is a difference between the median ages of the individuals who have/do not have symptoms by age, a significant difference was observed only between the median ages of the students who have/do not have concentration disorder condition ( $p = 0.018$ ), and it was found that this difference is because the mean rank of the ages of the students who have concentration disorder condition is higher than the mean rank of the ages of the students who do not have concentration disorder condition. A significant difference was not observed by age for other symptoms ( $p < 0.05$ ).

The answers provided by the students to the question “Do your symptoms alleviate after school or on holidays?” demonstrated that the symptoms of 89.8% (379 students) of the students and 55.4% (210 students) of the students experienced alleviation. 194 of 210 students, whose symptoms were alleviated, stated the symptoms which were alleviated, and the distribution of the relieving symptoms is given in Table 3. The mostly alleviating symptoms of the students were headaches (61 students) and physical and mental fatigue (35 students).

**Table 3.** Distribution of symptoms of the students that relieve after school or on holiday

Alleviating symptoms	Frequency (n)	Percent (n)
Nausea	12	6,2
Concentration disorder	13	6,7
Odor sensitivity	6	3,1
Headache	61	31,4
Eye discomfort	9	4,6
Runny nose	4	2,1
Throat ache	1	,5
Cough	11	5,7
Dry and itchy skin	2	1,0
Dizziness	6	3,1
Physical and mental fatigue	35	18,0
Eye watering	3	1,5
Nasal congestion	4	2,1
Shortness of breath	4	2,1
Cold	8	4,1
Shivering	4	2,1
Palpitation	6	3,1
Fever	1	,5
Other	4	2,1
<b>Total</b>	<b>194</b>	<b>100</b>

In Figure 1, the alleviating symptoms of the students are shown by the age of the school building. The results indicate that headaches and physical and mental fatigue have high rates in all the school buildings. Headache was observed to occur at the highest rate in the forty-year-old school building, while mental and physical fatigue had a higher rate in the one-year-old school building. Given the alleviating symptoms, although it is expected that SBS symptoms will be experienced at a lower ratio in the one-year-old school building, it can be seen that SBS symptoms were observed at a higher rate than the five- and ten-year-old school buildings.

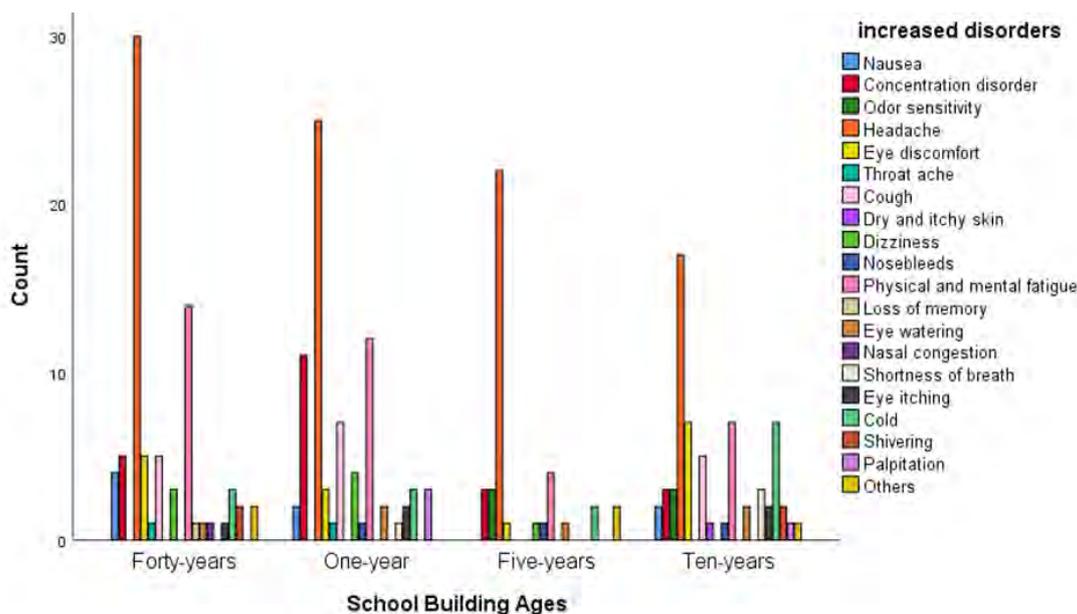


The answers provided by the students to the question “Which of the symptoms worsens at the school?” was examined; it was seen that 61.2% (259) of the students answered this question, and the distribution of the worsening symptoms is given in Table 4. It was observed that headache (94 students) and physical and mental fatigue (37 students) worsened.

**Table 4.** Distribution of the symptoms of the students that worsen at school

<b>Worsening symptoms</b>	<b>Frequency (n)</b>	<b>Percent (n)</b>
Nausea	8	3,1
Concentration disorder	22	8,5
Odor sensitivity	6	2,3
Headache	94	36,3
Eye discomfort	16	6,2
Throat ache	2	,8
Cough	17	6,6
Dry and itchy skin	1	,4
Dizziness	8	3,1
Physical and mental fatigue	37	14,3
Loss of memory	1	,4
Eye watering	6	2,3
Nasal congestion	1	,4
Shortness of breath	4	1,5
Eye itching	5	1,9
Cold	15	5,8
Shivering	4	1,5
Palpitation	4	1,5
Other	5	1,9
<b>Total</b>	<b>259</b>	<b>100</b>

The comparison of the worsening symptoms of the students by age of school buildings is shown in Figure 2. Considering the worsening symptoms by age of school buildings, it can be seen that headaches and physical fatigue are experienced at the highest rate in the forty-year-old school building but it is believed that this result was obtained due to the high number of participants. Accordingly, it is understood that the mostly worsening symptoms of the students in four-year-old school buildings are associated with headaches and physical fatigue. However, it was highlighted that none of the symptoms such as throat ache, cough, dry and itchy skin, loss of memory, nasal congestion, shortness of breath, eye itching, shivering, and palpitation was observed in the five-year-old school building.



A significant relation was found ( $p < 0.001$ ) when it was tested whether the symptoms of the students and the symptoms that alleviate are related. However, a significant relation was not found ( $p = 0.848$ ) when the relation between the symptoms of the students and the symptoms that worsen in the school were examined.

When the symptoms of the students were examined by schools, it was found out that 27.4% of the students experiencing symptoms were from the forty-year-old school building, 28.6% (94 students) were from the one-year-old school building, 19.1% (63 students) were from the five-year-old school building, and 24.9% (82 students) were from the ten-year-old school building. The students experiencing most symptoms were from the one- and forty-year-old school buildings. It was concluded that the symptoms state of the students (sick or not sick) varied based on school ages ( $p < 0.001$ ), and the distribution of the students experiencing symptoms by school ages is given in Table 5. The statistical difference with a confidence level of 95% was found between the physical and mental fatigue, skin redness, and shivering conditions and the school ages ( $p < 0.05$ ). The students experiencing physical and mental fatigue are from the ten- and forty-year-old school buildings, and each school has different percentages. The students who have redness on the skin are mostly from the forty- and ten-year-old school buildings but considering the percentages, it was found that the percentage of the skin redness in the forty-year-old school building differs from other buildings. The percentages of shivering are also higher in the ten- and forty-year-old school buildings, and the ratios are close to each other and differ from the other two schools.

**Table 5.** Comparison of the symptoms by school ages

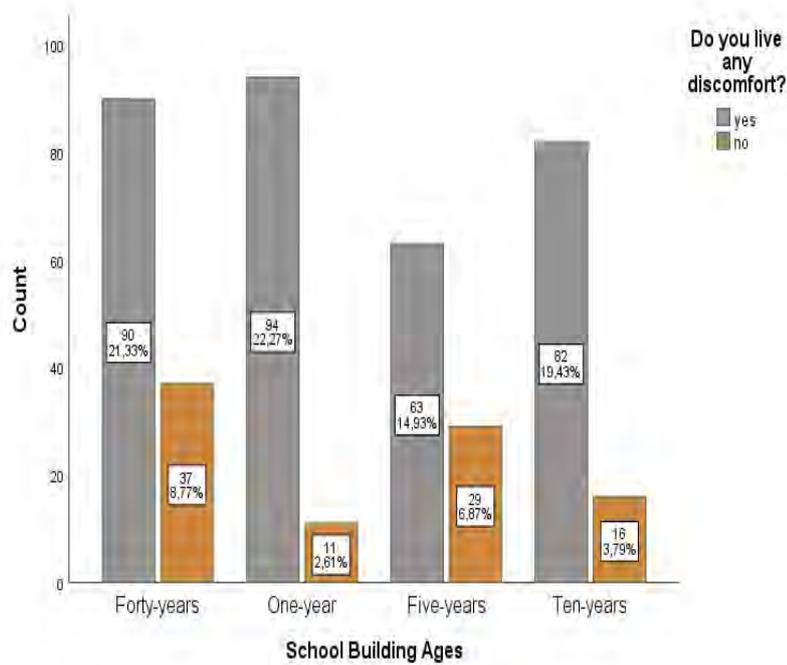
SBS Symptoms	School Building Ages				p değeri
	Forty-years*	One-year *	Five-years*	Ten-years*	
Nausea	21 (37,5)	13 (23,2)	10 (17,9)	12 (21,4)	0,615
Concentration disorder	39 (27,5)	46 (32,4)	28 (19,7)	29 (20,4)	0,090
Odor sensitivity	25 (34,7)	13 (18,1)	17 (23,6)	17 (23,6)	0,497
Headache	64 (34,0)	46 (24,5)	39 (20,7)	39 (20,7)	0,415
Eye discomfort	35 (38,0)	20 (21,7)	15 (16,3)	22 (23,9)	0,204
Runny nose	19 (30,6)	14 (22,6)	12 (19,4)	17 (27,4)	0,822
Throat ache	15 (30,0)	12 (24,0)	9 (18,0)	14 (28,0)	0,813
Cough	33 (36,7)	21 (23,3)	15 (16,7)	21 (23,3)	0,371
Dry and itchy skin	11 (27,5)	8 (20,0)	10 (25,0)	11 (27,5)	0,782
Dizziness	22 (32,8)	15 (22,4)	17 (25,4)	13 (19,4)	0,715
Nosebleeds	4 (40,0)	0 (0)	4 (40,0)	2 (20,0)	0,214
Physical and mental fatigue	46 (26,3)	51 (29,1)	29 (16,6)	49 (28,0)	0,016**
Loss of memory	6 (31,6)	5 (26,3)	2 (10,5)	6 (31,6)	0,617
Erythema	7 (58,3)	1 (8,3)	0 (0)	4 (33,3)	0,049**
Eye watering	25 (35,7)	19 (26,4)	13 (18,1)	15 (20,8)	0,689
Nasal congestion	12 (22,2)	13 (24,1)	15 (27,8)	14 (25,9)	0,475
Shortness of breath	12 (24,5)	10 (20,4)	12 (24,5)	15 (30,6)	0,473
Eye itching	21 (47,7)	9 (20,5)	6 (13,6)	8 (18,2)	0,058
Cold	23 (32,4)	13 (18,3)	18 (25,4)	17 (23,9)	0,543
Shivering	18 (34,0)	5 (9,4)	11 (20,8)	19 (35,8)	0,016**
Palpitation	16 (30,2)	12 (22,6)	9 (17,0)	16 (30,2)	0,627
Fever	13 (43,3)	5 (16,7)	6 (20,0)	6 (20,0)	0,400

\* The data are represented numerically (column percentage) and the comparisons are calculated based on the column. \*\*p < 0.05

The distributions of the symptoms by school building ages are listed in Table 6. When it was tested whether the symptoms of the students that worsen at the school differ by school building age, no significant difference was found (p = 0.124). When it was tested whether the symptoms of the students that relieve after the school show difference by school building ages, no significant difference was found (p = 0.075).

However, from the answers provided by the students to the question “Do you have any symptoms you experience in the school?”, it is seen that the highest percentage of the students who have symptoms is in the one-year-old school building (Figure 3). Although the oldest school building was expected to have the highest percentage of SBS, it can be seen that the new school building has a higher (22.27%) sickness percentage.

Considering the distribution of the SBS symptoms by school age, skin redness has never been experienced in any school building.



**Table 6.** Distribution of symptoms by school building ages

Symptoms	School Ages			
	Forty-years*	One-year *	Five-years*	Ten-years*
Nausea	4 (50)- 6(50)	2 (25)-3 (25)	0 (0)-0 (0)	2 (25)-3 (25)
Concentration disorder	5 (22,7)-0 (0)	11 (50)-7 (53,8)	3 (13,6)-2 (15,4)	3 (13,6)-4 (30,8)
Odor sensitivity	0 (0)- 2 (33,3)	0 (0)-2 (33,3)	3 (50)-1 (16,7)	3 (50)-1 (16,7)
Headache	30 (31,9)-19 (31,1)	25 (26,6)-18 (29,5)	22 (23,4)-10 (16,4)	17 (18,1)-14 (23)
Eye discomfort	5 (31,3)-3 (33,3)	3 (18,8)- 0(0)	1 (6,3)-3 (33,3)	7 (43,8)-3 (33,3)
Runny nose	0 (0)-0 (0)	0 (0)-1 (25)	0 (0)-1 (25)	0 (0)-2 (50)
Throat ache	1 (50)-0 (0)	1 (50)-1(100)	0 (0)-0(0)	0 (0)-0(0)
Cough	5 (29,4)-5 (45,5)	7 (41,2)-4 (36,4)	0 (0)-0 (0)	5 (29,4)-2 (18,2)
Dry and itchy skin	0 (0)-1 (50)	0(0)- 0(0)	0(0)- 0(0)	1 (100)-1 (50)
Dizziness	3 (37,5)-1 (16,7)	4 (50)-3 (50)	1 (12,5)-1 (16,7)	0 (0)-1 (16,7)
Nosebleeds	0 (0)-0 (0)	1 (33,3)-0(0)	1 (33,3)-0(0)	1 (33,3)-0(0)
Physical and mental fatigue	14 (37,8)-8 (22,9)	12 (32,4)-11 (31,4)	4 (10,8)-8 (22,9)	7 (18,9)-8 (22,9)
Loss of memory	1 (100)- 0 (0)	0 (0)- 0 (0)	0 (0)- 0 (0)	0 (0)- 0 (0)
Erythema	0 (0)- 0 (0)	0 (0)- 0 (0)	0 (0)- 0 (0)	0 (0)- 0 (0)
Eye watering	1 (16,7)- 0 (0)	2 (33,3)- 3 (100)	1 (16,7)- 0 (0)	2 (33,3)- 0 (0)
Nasal congestion	1 (100)- 0 (0)	0 (0)-2 (50)	0 (0)- 0 (0)	0 (0)-2 (50)
Shortness of breath	0 (0)- 0 (0)	1 (25)-1 (25)	0 (0)- 0 (0)	3 (75)- 3(75)
Eye itching	1 (20)- 0 (0)	2 (40)- 0 (0)	0 (0)- 0 (0)	2 (40)- 0 (0)
Cold	3 (20)- 0 (0)	3 (20)- 0 (0)	2 (13,3)-4 (50)	7 (46,7)-4 (50)
Shivering	2 (50)-2 (50)	0 (0)- 0 (0)	0 (0)- 0 (0)	2 (50)-2 (50)
Palpitation	0 (0)-2 (33,3)	3 (75)-3 (50)	0 (0)- 0 (0)	1 (25)-1 (16,7)
Fever	0 (0)- 0 (0)	0 (0)- 0 (0)	0 (0)-1 (100)	0 (0)- 0 (0)
Other**	2 (40)-1 (25)	0 (0)-0 (0)	2 (40)-2 (50)	1 (20)-1 (25)

\* The data are represented numerically (column percentage) as worsening at school-relieving after school.

When the students were asked the question “Is there any unhealthy environment at the school?”, of the 405 students who answered the question, 175 (43.2%) stated that there was an unhealthy environment, while 230 students (56.8%) stated otherwise. The distribution of the students

regarding the uncomfortable places in the schools is given in Table 7. Accordingly, the students most feel uncomfortable in the corridors (188 students) and washrooms (130 students). It was understood that furniture, school garden, sports hall, basement, and cafeteria are usually the places where the students do not feel uncomfortable.

**Table 7.** Distribution of the places in the school building that are found uncomfortable by the students

Areas where students feel discomfort	Yes*	No*
Washrooms/toilets	130 (30,7)	293 (69,3)
Class	25 (5,9)	398 (94,1)
Dining hall	17 (4,0)	406 (96,0)
Corridors	188 (44,5)	234 (55,5)
Sports Hall	11 (2,6)	412 (97,4)
Schoolyard	5 (1,2)	418 (98,8)
Furniture	3 (,7)	420 (99,3)
Cafeteria	4 (,9)	419 (99,1)
Basement	6 (1,4)	417 (98,6)

\* The data are represented numerically (percentage).

The comparison of the places found uncomfortable by the students by school types is given in Table 8. Accordingly, the number of students who found washrooms uncomfortable was the highest in the ten-year-old school building and lowest in the five-year-old school building; almost all of the students who found the cafeteria uncomfortable were from the one-year-old school building; almost all of the students who found the sports hall uncomfortable were from the forty-year-old school building, and it was found that there was a difference in ratios of the uncomfortable places by schools ( $p < 0.05$ ).

**Table 8.** Comparison of the places found uncomfortable by the students by school building age

Uncomfortable places found by students	Forty-years*	One-year*	Five-years*	Ten-years*	p değeri
Washrooms/toilets	39 (30,0)	29 (22,3)	13 (10,0)	49 (37,7)	<0,001**
Class	6 (24,0)	10 (40,0)	3 (12,0)	6 (24,0)	,264
Dining hall	2 (11,8)	14 (82,4)	1 (5,9)	0 (0)	<0,001**
Corridors	4 (50,0)	1 (12,5)	1 (12,5)	2 (25,0)	,597
Sports Hall	9 (81,8)	2 (18,2)	0 (0)	0 (0)	,002***
Schoolyard	4 (80,0)	0 (0)	1 (20,0)	0 (0)	,087
Furniture	1 (33,3)	1 (33,3)	1 (33,3)	0 (0)	,805
Cafeteria	2 (50,0)	0 (0)	1 (25,0)	1 (25,0)	,671
Basement	2 (33,3)	0 (0)	3 (50,0)	1 (16,7)	,275

\* The data are represented numerically (column percentage) and the comparisons are calculated based on the column. \*\* $p < 0.001$  \*\*\* $p < 0.05$

The students were asked to state the uncomfortable places in the school building that they found was also unhealthy (shown in Table 7) and their reasons. Accordingly, considerable answers from the students are provided below by school types:

**The views of the students from the forty-year-old school building:** “Students do not use the toilets hygienically” (F5). “The toilets need to be renewed, cleaned, and enlarged. Make our school a very clean place. The students should not litter the classrooms. If the students continue to litter the school grounds, our school will remain dirty all the time no matter how much it is cleaned. This may

*cause illnesses around us. Food should be prepared more meticulously” (F28). “I have no idea whether the sports hall is cleaned or not but I see dust everywhere. I am a clean person and so I think that it will be better for health if cleanliness is maintained” (F42). “The toilets are unhealthy because they are dirty and narrow. We also want the students to keep them clean” (F46). “The sports hall is very cold and dusty” (F51). “Toilets smell very bad and the classrooms are stuffy” (F55). “People smoke in here” (F58). “There is only one smoking area in the cafeteria and it is for teachers. It is disturbing” (F62). “There are stains on the walls of the school building because it is not clean” (F63). “The corridors and the sports hall are not well cleaned; additionally, the students in the physical education class cause more pollution and this worsens our health” (F75). “The cafeteria itself and the supplies (forks, knives, plates, etc.) are not clean; contamination in the food, which threatens our health and increase of these contaminants, is extremely unhealthy for us” (F83). “Washroom is unhealthy. The management prioritizes the disciplinary issues and fails to impress when it comes to the assessment of unhealthy conditions” (F90). “Toilets are cleaned well but girls do not leave them clean so a hygienic environment cannot be maintained” (F91). “Toilets are cleaned properly but the students do not leave them clean. For this reason, the toilets smell very bad so we cannot enter and it is very disturbing” (F96). “The toilets are very dirty. I feel uncomfortable. I cannot use the washrooms. It smells very bad and this makes me sick” (F97). “The school toilets are not hygienic and none of the doors are intact” (F99, F100).*

Accordingly, it is understood that most of the 39 students found the toilets unhealthy due to lack of hygiene and cleanliness. Considering the answers of the students, it can be seen that the toilets are cleaned but the students fail to use them hygienically and properly. Hence, it can be concluded that the education of the students on maintaining the environment clean is insufficient, and environmental awareness has not been sufficiently created. However, a group of students mentioned the disturbance due to the dust in the sports hall. In such places, the children breathe more frequently as a result of intense exercise and hence, inhale more dust particles, and the possibility of development of illnesses, such as asthma, cough and nasal discharge, increases. Similarly, care should be taken to clean the classrooms and school corridors, and necessary measures are essential to address the dust and provide appropriate ventilation for such places.

However, a lack of cleanliness of the cafeteria and supplies causes some illnesses. The priority of the schools should be to consider the health of the children entrusted to them and take the necessary precautions pertaining to this. Therefore, they are responsible for keeping all the places in the school clean and hygienic. It can be concluded from the fact that the illnesses appeared in some students at a young age, while other students are susceptible to them. Because students spend most of their time in school environments, it is vital to keep these environments hygienic and well-ventilated and to use healthy supplies. The establishment of healthy schools is a necessity for a healthy generation.

**The views of the students from the one-year-old school building:** *“I think that the unhealthy places are the classrooms because the diseases spread more quickly due to the crowd”* (M17). *“The poor lighting in the school cafeteria strains the eyes”* (M18). *“The toilets smell very bad and are very dirty”* (F6). *“The classrooms are unhealthy because they are stuffy. Oxygen remains insufficient because the classrooms are very crowded. The environment would be healthier if the number of the students decreased”* (F17). *“The toilets are very dirty and places like counters are not well cleaned. I feel uncomfortable while using them. I feel bad and the classrooms are also very dirty”* (F19). *“The classrooms are much polluted, poorly ventilated. I feel uncomfortable because of the smell”* (F26). *“Cafeteria is not clean and hygienic and the food is not tasty”* (F31). *“The cafeteria is unhealthy because it is not hygienic. The plates and spoons are mostly dirty”* (F43). *“We can catch infections because the smoking areas and toilets are very dirty”* (F45). *“The toilets are unhealthy because there is neither paper towel nor liquid soap and the door handles and tables are also dirty”* (M77). *“The toilets are not hygienic and we have difficulties when performing ablution”* (M86). *“There are cracks on the walls and water leaks in the winter although it is a new building and I think this is unhealthy. Particularly the cafeteria section smells very bad. I think that a place for dining should not be as bad as this!”* (Female97).

It can be concluded that the students complain about dusty environments in the classrooms, lack of cleanliness, and hygiene in the toilets and cafeteria. Other remarkable responses were regarding the smoking areas. It can be understood that there is either a smoking area in the school or the students use toilets for smoking. However, the presence of a smoking area in the school causes intoxication among the students. Hence, it can be concluded that the presence of such environments at schools leads to SBS. Most of the children expressed that there were no unhealthy environments at the school and they were satisfied with their schools. Some of the answers of the students are as follows:

*“There is no unhealthy environment”* (F7). *“I would be very glad if the points I have stated are considered”* (F67). *“There is not (an unhealthy environment)”* (M36).

**The views of students from the five-years-old school building:** *“Almost everywhere it is unhealthy”* (M16). *“Gloves are not used when preparing toasts. The toilet and cafeteria are unhealthy because of poor ventilation”* (Female18). *“The classrooms are unhealthy because our mates are fighting all the time and damaging all the desks and chairs, and there is so much dust in the classroom”* (F21). *“The basement smells damp”* (F33). *“The toilets are dirty and the plates are not cleaned well in the cafeteria”* (F52).

Considering the statements of the students, it can be said that they found the environments unhealthy mostly due to the dust. The students also stated that the damp and mold smell are disturbing. It should be considered that the damp is a health threatening factor for students and necessary actions should be taken to prevent the damp.

**The views of the students from the ten-years-old school building:** *“The classrooms and toilets are stuffy and cause illnesses”* (F1). *“The toilets are unhealthy places in the school because the doors are broken and don’t close. There is no liquid soap. Sometimes there is a little amount of soap. The windows in the toilets cannot be opened and the indoor is very stuffy”* (M3). *“The toilets and the backyard of the dormitory are unhealthy because the toilets are not cleaned, and the backyard of the dormitory is very dirty and full of garbage”* (M5). *“Students smoke in men’s room and there is a very bad smell”* (M9). *“The smell of the toilets is very strong and can be smelled near the corridors”* (M18). *“The toilets and classes are very unhealthy. The toilets are not cleaned and students smoke in the toilets and we have difficulty in breathing”* (M24). *“The toilets are extremely dirty and not hygienic. These places could be cleaner and more hygienic or soap could be supplied near the wash basins. We cannot use soap to wash our hands because soaps are not provided”* (M33). *“The toilets are very dirty. No matter how much they clean, there are still things that we do not like to see”* (F39). *“The toilets smell like cigarette smoke so much and this makes us passive smokers”* (F62). *“The toilets are not very clean and the smell does not go away even a little when we open the windows. My friends and I feel uncomfortable about this”* (F71). *“The toilets are unhealthy because there is a heavy smell when passing by the toilets in corridors and I really do not like this situation and believe that it is not good for my health”* (F75). *“The corridors are unhealthy because they are very crowded; the toilets are very dirty and smell like cigarette smoke, it smells so bad that you can’t enter”* (F79). *“The classrooms are not clean; the classrooms are cold and the painting of the school should be renewed because it looks very old”* (F86).

Considering the statements of the students, the students who complained about the washroom areas (37.7%) at the highest ratio by school building age were from the ten-year-old school building, and according to the views of these children poor ventilation and insufficient cleaning or unhygienic usage of these areas, lack of supplies, such as soap, and students smoking in these areas create a very unhealthy environment. It is highlighted that particularly male students expressed more opinions for these areas than female students. Accordingly, it can be said that the discomfort felt in men’s rooms inside the school buildings are prominent. This situation can also be associated with the directors and staff in charge of the cleanliness of the school.

### **Discussion**

First, it was tested whether each type of symptoms is related to gender and it was found that female students experience more headaches ( $p < 0.001$ ), eye discomfort ( $p < 0.05$ ), and physical and mental fatigue conditions ( $p < 0.001$ ) as compared to the male students. Most of the researches investigating the relationship between SBS and gender showed that females experience SBS more than males (Stenberg and Wall, 1995; Brasche, Bullinger, Morfeld, Gebhardt, and Bischof, 2001). However, age of participants was revealed to be an important factor in males (Brasche et al., 2001). However, in many studies conducted on age, a constant relationship between age and SBS was not

found (Norback, 2009). In another study, it was pointed out that age, gender, background of allergic disorders, and sense of smell may be associated with SBS (Wang, Li, Yang, Yu, Wang, et al. 2013). In this research, it was tested whether there is a difference between the median ages of the students who have/do not have illness by age, a significant difference was found between the median ages of the students who have and do not have concentration disorder ( $p = 0.018$ ), and no significant difference was found for other illnesses. Hence, age can be considered as a determinant in some of the SBS symptoms.

When the SBS symptoms are assessed by school building age, it can be said that the findings support the views of Bluestein (2001). Indeed, SBS symptoms were observed even in the one-year-old school building, although more SBS symptoms were observed in the forty-year-old school building in this research. Hence, the age of a school building is not enough alone to claim that this building has SBS. It is understood that heating, lighting, ventilation, acoustic, and hygiene conditions in schools are more determinant in the occurrence of SBS symptoms. However, it can be said that poor comfort conditions inside school buildings (cold, stuffy, and dirty classrooms) threaten the health of students. According to similar researches, the pollution or garbage inside school buildings can lead to symptoms like allergy or asthma or absenteeism preventing learning or using medications that weaken the performance of the students. For example, it was revealed by researches that asthma is one of the primary chronic diseases causing absenteeism in primary schools and high schools at a ratio of 20% (Mendell and Heath, 2005).

According to the literature, it is seen that personal characteristics affect the likelihood of getting SBS. For example, tendency to somatization (Berglund and Gidlöf Gunnarsson, 2000) or neuroticism have been shown to be associated with SBS (Gomzi, Bobic, Radosevic-Vidacek, 2007). On the other side, anxiety and depression have also been associated to SBS positively. Moreover, stress affects people negatively when they expose to environmental stressor (VOC) according to experimental study results (Fiedler, Kelly-McNeil, Ohman-Strickland, Zhang, Ottenweller, Kipen, 2008). In fact, in this research, the symptoms included in the “other symptoms” group were reported by 10 students in total. This situation can arise because of several factors, such as the central examination system practice in Turkey, high school and exam anxieties, or family pressures. Hence, stress and psychological disorders reported other than certain SBS symptoms are considered to be associated with the pressure imposed by the educational system or practices rather than the building.

The findings of this research are parallel with the findings obtained from a research conducted in Hong Kong. In the research, the air conditioning and ceiling fans were examined for indoor air quality and according to the results of this study, CO<sub>2</sub> concentrations often exceeded 1000 µl/l in air-conditioning and ceiling fan classrooms, indicating inadequate ventilation. It was revealed that the most important indoor air quality issues in the classrooms are associated with carbon dioxide (CO<sub>2</sub>) and respirable particulate matter (Lee and Chang, 2000).

An important characteristic of sustainable building designs is the energy efficiency. Hence, natural and hybrid ventilation systems have become an important part of the school designs in England. In several researches (Awbi and Pay, 1995; Coley, 2004), it was revealed that carbon dioxide levels reach extremely high levels during the occupancy of students (approximately 4000 ppm), and exposure to air containing this level of carbon dioxide negatively affects the learning performance of students (Clements-Croome, Awbi, Bako-Biro, Kochhar and Williams, 2008). Another study has indicated that the complaints about the poor air quality at schools are related to deficiencies in the indoor environment (Smedje, Norbäck and Edling, 1997). Moreover, indoor chemical air pollutants of mainly outdoor origin could be risk factors for pupils' respiratory symptoms at school (Zhao, Zhang, Wang, Ferm, Liang and Norback, 2008). Hence, the complaints of the students about the dust and stuffiness in the classrooms and sports halls support the results obtained from this research. However, it was seen in the five-year-old school building that the students feel uncomfortable due to the smell of damp and moisture in the basement floor. In a study about the moisture and damp observed in schools, it was reported that care must be taken to maintain the moisture level below 1000 spore/m<sup>3</sup> because the level of moisture in a school building can cause skin disorders such as fungal skin in students (Santilli and Rockwell, 2003). Smedje and Norbäck (2000) revealed that the students showed less asthma symptoms in the schools having new ventilation systems. However, in another study, it was reported that the emissions formed the equipment in renovated or newly constructed school buildings, such as furnishings made of PB and MDF, negatively affect the indoor air quality and this may adversely impact the health of students ((Yang, Sohn, Kim, Son and Park, 2009).

In a study by Mizoue, Reijula and Andersson (2001), it is found that Environmental Tobacco Smoke (ETS) exposure is a determinant of SBS symptoms in workplaces with a high prevalence of smoking. Because some students reported their discomfort regarding smoking, it can be concluded that smoking in intensely occupied areas in the school, such as washrooms and cafeteria, may also lead to SBS. Therefore, prohibition of smoking in indoor spaces should be strictly audited and natural ventilation should be provided.

### **Conclusion**

As a result of the literature review, it can be seen that old school buildings cause certain illnesses. However, this research showed that the age of a building is not a determinant for human health; cleanliness, proper ventilation, heating, lighting, and other comfort conditions of an environment are determinants for the SBS. Therefore, the necessity of hygiene, natural ventilation, and air conditioning inside a building are the factors affecting the health and safety of the students and all other occupants of a school building. However, in another study, it was shown that the agents used to clear the insects and dust in a building also pose risk for human health. Hence, appropriate care must be taken when using chemical poisons and cleaning agents. However, it is understood that air pollution and bad odor in the indoor environment of a school building can affect both the physical and

the psychological health of students. Furthermore, adverse environmental conditions in school buildings lead students to avoid eating in unhygienic cafeterias or using the toilets, thus awaiting till the end of the school day and hence, exhibit behaviors that are harmful for them. Hence, the school administrators can be recommended to consider following points:

- To prevent the occurrence of the symptoms associated with SBS, appropriate indoor air conditioning requirements should be met and the emissions of indoor air pollutants should be reduced. Chemical emissions from building materials should be reduced by selecting low emitting materials and products.
- Student absenteeism and failures may be prevented by maximizing the efforts for avoiding health issues, thus ensuring that the students are in a relaxed, comfortable, clean, and safe environment. For this purpose, school managers should ensure that the cleaning of the existing equipment in a school is performed regularly and periodically. It is important to ensure that not only floors but also all surfaces are cleaned to prevent SBS. Moreover, carpeting and other textile materials should be minimized; otherwise they should be properly cleaned.
- It can be recommended to remove the pests when students are not in the school building to reduce the toxic air particles emitted via natural ventilation. For example, this procedure can be performed on weekend right after students leave the school for weekend holiday, thereby utilizing this period for natural ventilation and cleaning.
- It can be recommended to constantly ventilate the areas where students intensely and actively inhabit (e.g., corridors, sports halls, etc.) and to periodically wipe the ceilings and other surfaces in the environment using water only.
- It can be recommended that intensely utilized areas in the school, such as cafeteria, toilets, and kitchen, are audited by school principals.
- It can be recommended to inform the principals and corresponding maintenance and repair personnel in schools regarding SBS. Hence, several seminars can be held.
- It can be recommended that design elements to relieve the discomfort due to stress, anxiety, pressure, and other psychological factors are utilized in the school buildings. For example, various colors, distinct decorations, and various arrangements to be used in the school building can create more comfortable and peaceful environments for students.
- These practices exercised for SBS in schools can also be recommended for home environments of students or hospitals.
- Further qualitative researchers can be recommended because the discomforts reported by individuals in SBS are important determinants.

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