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RESEARCH PAPER

Assessment of Indoor Air Quality in Schools from Anatolia, Turkey

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ABSTRACT
Air pollution damages children's health in many different ways, through both chronic and acute effects. The aims of our research are to reveal the indoor air quality levels in schools. Subject and indoor air measurements were performed in 34 primary schools located in the Central Anatolia region. PM_{10}, $PM_{2.5}$, CO_2, CO, CH_2O, relative humidity, temperature, and total bacteria and fungus levels were measured. In the urban region, mean PM_1 was higher than the other regions($p=0.029$). PM_{10} and $PM_{2.5}$ were higher in schools in rural areas. According to CO_2 measurements, only one school was identified to be below the upper limit recommended by the WHO. Total microorganism concentration was exceeded in 44.1% of classrooms. Indoor PM_1, $PM_{2.5}$, PM_{10}, CO_2, total bacteria and fungus levels were high and above recommended limits. Human activities, movements of students could be considered the most important indoor factors for particle matter increase. Indoor parameters could be lowered by organizing the school environment.
keywords: Children, Dust, Air Pollution, Particular matter, Respiratory diseases.

INTRODUCTION

Indoor air quality (IAQ) in schools is a commonly observed environmental problem (Haverinen-Shaughnessy et al., 2012) and is associated with negative health effects in children (Mendell et al., 2011; Borràs-Santos et al., 2013). Children, breathing more air according to body weight and with lungs still in the developmental stage, are the group most susceptible to air pollutants. The increasing incidence of respiratory tract diseases in the childhood period, especially in developing countries, has motivated studies about the indoor air quality in schools (WHO, 2005). Considering that children spend a long portion of their days in school and the items and educational activity materials used in classrooms, the indoor air quality in schools becomes important (Mainka & Zajusz-Zubek, 2015).

Fine particles can easily enter a child's body during their play activities. They are deposited in the lower respiratory tract, there by having a greater effect on causing or aggravating respiratory diseases (Bernstein et al., 2008). Many studies performed in school

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buildings stated that CO_2 concentrations did not meet standard limits and found insufficient ventilation systems (Madureira et al., 2012; Annesi-Maesan et al., 2013; Madureira et al., 2016). Many chemical compounds humans are exposed to every day comprise risk factors for development of a variety of pathologies (Daisey et al., 2003). Especially, exposure to indoor air pollution without exposure to outdoor air may be a greater danger (Lim et al., 2014). Microbial exposure in schools is linked to the indoor space resources and building characteristics, for example, excessive humidity and insufficient ventilation, and associated with low school attendance, respiratory tract infections, asthma and allergies in children and adults (Mendell et al., 2011).

This study has been conducted to determine indoor air quality in school environment. A study conducted in Ankara that CO_2 and CH_2O ratios are higher in crowded classes. In addition, pathogen microorganisms were detected in 71% of primary schools. The absence of ventilation in schools was identified as a problem (Babayigit et al., 2014). In Germany, the different fractions of indoor PM have been studied for mass density and particle numbers in 64 classrooms. In the study, the researchers found that increasing PM concentrations significantly correlated with increasing CO_2 concentrations and lower levels (Fromme et al., 2007).

This study was completed in 34 schools in a city in the Central Anatolia region. The main aims of our research are: (a) to reveal the indoor air quality levels in schools (PM, CO_2, CO, CH_2O, total bacteria and fungi); (b) to compare the measured concentrations with the relevant standards; and (c) to analyze the seasonal and regional changes in indoor pollutant concentrations.

MATERIALS & METHODS

Indoor and outdoor air samples were collected from 34 classrooms of primary schools located in Kirşehir (Figure 1). Measurements were made in classrooms on the ground floor overlooking the north side of the schools. The areas where schools were located were defined as urban, suburban and rural region. First measurement was performed in spring period and the second one was performed in fall period. Characteristics of classrooms where samples were collected are shown in Table 1.

Fig 1. The geographical location of Kirsehir.

Within the scope of the study, PM10, PM2.5, CO2, CO, CH2O, RH, temperature measurements were performed. Measurements were completed during lesson time. In every school, the measurements were conducted once for each monitoring session one day during the school day, from 8:30 AM to 4:30 PM. The sampling period was approximately 7∼8 h except for CH2O. CH2O were sampled for approximately 60– 100 min. Indoor measurements were collected about 90 cm above the floor. Devices were placed in the center of the classrooms for measurements. For outdoor measurements, devices were placed at 1 m height 3 m from the building. The study used a TSI brand Dusttrak II Aerosol Monitor 8532 device for particulate matter measurements (PM10, PM2.5 , PM1). For CO2, CO, temperature and humidity measurements, a TSI brand IAQ-Calc Indoor air quality meter 7545 device was used. For indoor formaldehyde (CH2O) level measurements, a PCE Thermo Hydro Formaldehyde device was used.

With the aim of bacteria and fungi isolation, an ECO MAS100 Microbial air sampler device was used. After petri dishes containing potato dextrose agar (PDA) for fungi and plate count agar and nutrient agar for bacteria are placed in the device, the upper lid of the sampling device is opened and programmed to absorb 100 m^3 air per minute. Samples are incubated at 37°C for 48h for growth of bacteria and at 25°C for 7 days for incubation of fungi. With the aim of identification, observed plate are stored a at +4 °C in refrigerator and later bacteria and fungi counts are performed under a microscope with the simple colony counting method and calculated as colony forming unit/m3 (CFU) air.

For CO2, PM, RH, T, CO, total bacteria and fungi counts, the results were reported as median, interquartile and ranges. For the analysis of IAQ results, the statistical significance of the differences between the urban, suburban and rural areas were evaluated by the Kruskall Wallis test for non-normally distributed data. The statistical significance of the differences between the winter and spring measurements was evaluated with the Mann-Whitney U test for non-normally distributed data. Indoor-outdoor differences were evaluated by means of Wilcoxon signed rank test. Mean concentration values for each school were considered when calculating indoor/outdoor ratio and for the statistical evaluation of indoor vs. outdoor and urban, suburban, rural differences. A P-value lower than 0,05 was assumed to be statistically significant. All analyses were performed in IBM SPSS statistics v.23.

RESULTS AND DISCUSSION

There are 34 school in Kirşehir provincial center. Measurements were made in one classroom from each school. In 34 schools, measurements were performed 2 times in the fall (December-January) and spring (April-May) periods. The location for the study is in the Central Anatolian region and the most important industrial factory in the region is a tire factory covering 3 million m2 area. Industrial pollutants, in addition to traffic in the urban area and pollutants due to urban living, increase in number. Additionally, air pollutants are released from low-quality fuels used especially for heating in the winter months.

The median building age of schools with measurements performed was 12.00 years (1-77 years). The dimensions of the classrooms used for measurements were determined to be from 18 to 50 m3. The median number of students in the classrooms was 18.00 (6-34 people), with amount of air per person (number of people/volume of the class) calculated as 4.44 (1.18-11.43). In the winter due to heating, windows were not opened very much during the day. Only one school used coal/stove for heating purposes. When the regions for the schools are examined, 44.12% were urban, 41.17% were suburban and 14.71% were in rural regions (Table 1).

Table 1. Physical characteristics of schools with measurements performed

School No	Urban environment	Ventilation	Building age (years)	Heating with coal	Type of blackboard	Number of students	Flooring	Class volume (m^2)	Air per person
1	Suburban		26		Smart board	22	laminate	45	4,09
2	Urban				Smart board	31	laminate		2,71
3	Suburban		36		Chalk	13	laminate	49	7,54
4	Urban		20		Smart board	22	Concrete	35	3,18
5	Urban		3		Whiteboard	18	laminate	48	5,33
6	Urban		15		Whiteboard	34	laminate		2,41
7	Suburban		7		Smart board	19	laminate	18	1,89
8	Urban		12		Whiteboard	15	Concrete	42	5,6
9	Urban		10		Whiteboard	24	laminate	42	3,5
10	Suburban		10		Smart board	12	Concrete	40	6,67
11	Urban		18		Smart board	23	laminate	40	3,48
12	Urban		27		Smart board	18	Concrete		4,44
13	Suburban		5		Smart board	13	laminate	48	7,38
14	Rural		40	**X**	Smart board	6	Concrete	30	10
15	Urban		26		Smart board	21	Concrete	45	4,29
16	Suburban		26		Chalk	10	Concrete	49	9,8
17	Suburban	Windows/ doors	30		Smart board	9	Concrete	45	10
18	Suburban		25		Smart board	7	Concrete	40	11,43
19	Urban		10		Smart board	18	laminate	40	4,44
20	Suburban		7		Chalk	22	laminate	49	4,45
21	Urban		77		Smart board	34	Concrete	20	1,18
22	Suburban		10		Smart board	13	laminate	50	7,69
23	Urban				Whiteboard	18	laminate	40	4,44
24	Urban		12		Smart board	10	laminate	50	10
25	Rural								
26	Urban		2		Whiteboard	30	laminate	40	2,67
27	Urban		4		Smart board	25	laminate	50	4
28	Suburban		29		Whiteboard	21	Concrete	42	4
29	Suburban		1		Smart board	26	laminate	49	3,77
30	Rural								
31	Urban		7		Smart board	22	laminate		3,64
32	Rural								
33	Rural		43		Smart board	8	Concrete	30	7,5
34	Urban		10		Chalk	17	laminate	45	5,29

Table 2. Comparison of measurement results from fall and spring semesters

Parameters	Fall semester	Spring semester	P value
Mean CO_2 (ppm)	1974.00 (1109-4484)	1813.00 (637-3334)	0.144
Mean CO (ppm)	0.750 (0-12.6)	0.550 (0.1-1.1)	0.070
PM_{10} (µg/m^3)	141.50 (65-576)	83.50 (24-304)	**<0.001***
$PM_{2.5}$ (µg/m^3)	73.00 (22-265)	44.00 (19-166)	**<0.001***
PM_1 (µg/m^3)	42.00 (7-174)	15.00 (9-133)	**<0.001***
CH_2O (ppm)	0.25 (0-2.10)	0.25 (0.13-0.56)	0.456
Temperature (^{o}C)	21.65 (18.6-26.3)	24.10 (20.4-27.7)	**<0.001***
Humidity (%)	45.95 (31.7-62.8)	52.25 (24-69.7)	**<0.001***
Total bacteria (CFU/m^3)	157 (38-2628)	604 (33-2628)	**<0.001***
Total fungus (CFU/m^3)	8.00 (3-120)	33.00 (3-117)	**<0.001***

PM10, PM2.5 and PM1 concentrations are shown in Table 2. When the median indoor values are investigated in all classrooms, the PM2.5 and PM10 concentrations appeared to exceed the 25 µg/m3 and 50 µg/m3 guideline values recommended for a 24h sampling period by the WHO (Figure 2) 4.

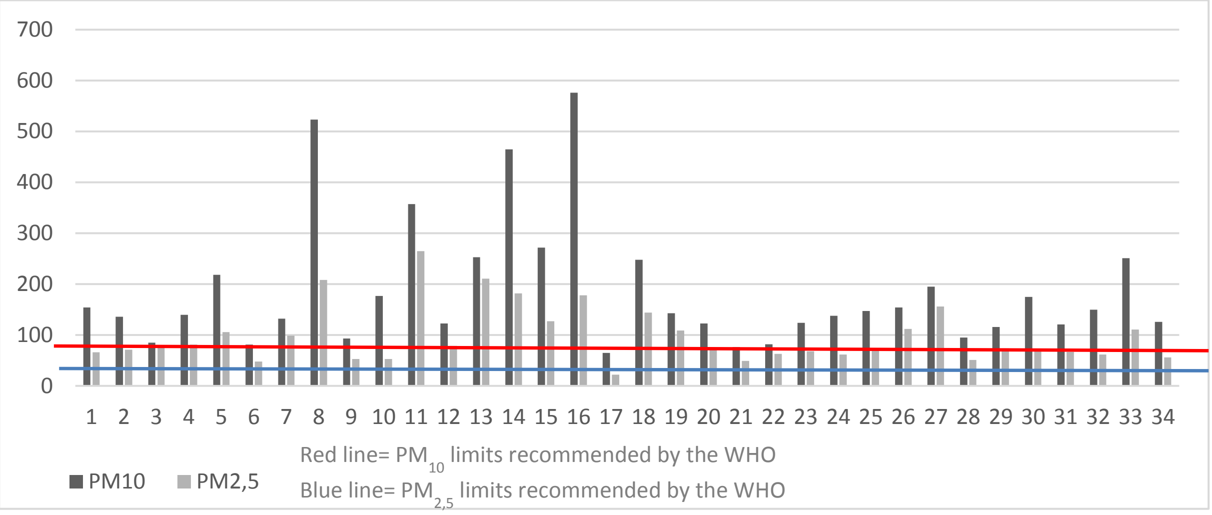

Figure 2. Comparison of PM10 and PM2.5 data in the fall period in schools and WHO limit values.

There were statistical differences between the seasons ($p<0.001$, $p<0.001$, respectively). Measurements in the fall period were identified to be higher compared to the spring period. The highest median values were measured in the rural region (Table 3). There was a statistical difference in PM1 results between the periods ($p<0.001$). Measurements in the fall period were identified to be higher compared to the spring period. According to PM1 results, the highest median values were measured in the urban region (Table 3).

Table 3. Comparison of fall and spring semester measurements between regions

Parameters	Urban(n=15)	Rural (n=5)	Suburban (n=14)	P value
Fall Semester				
CO_2 (ppm)	2300.00 (1202-4484)	2055.00 (1595-2392)	1756.50 (1109-3061)	0.189
CO (ppm)	0.80 (0.0-1.0)	0.20 (0.1-12.6)	0.95 (0.1-1.4)	0.145
PM_{10} (µg/m^3)	136.00 (76-357)	175.00 (147-465)	135.00 (65-576)	0.239
$PM_{2.5}$ (µg/m^3)	79.00 (48-265)	72.0 (62-182)	72.50 (22-211)	0.919
PM_1 (µg/m^3)	46.00 (18-174)	25.00 (24-101)	41.50 (7-156)	0.489
CH_2O (ppm)	0.15 (00-1.63)	0.39 (0.0-0.47)	0.28 (0.0-2.10)	0.454
Temperature (°C)	22.60 (20.1-26.3)	21.00 (18.6-25.5)	21.40 (19.5-24.1)	0.220
Humidity (%)	47.3 (31.7-62.8)	45.10 (33.5-48.2)	44.25 (33.6-60.4)	0.437
Total bacteria (CFU/m^3)	202.00 (40-557)	1448.5 (158-2628)	127.00 (38-287)	**0.012***
Total fungus (CFU/m^3)	7.00 (3-120)	3.00 (9-58)	8.00 (4.00-33.00)	0.110
Spring Semester				
CO_2 (ppm)	1875.0 (637-3334)	175600 (1162-2550)	1462.00 (1069-2903)	0.562
CO (ppm)	0.7 (0.1-1.1)	0.6 (0.3-0.8)	0.45 (0.3-0.8)	0.291
PM_{10} (µg/m^3)	83.00 (24-163)	96.00 (79-304)	80.50 (45-156)	0.271
$PM_{2.5}$ (µg/m^3)	42.00 (19-73)	47.00 (44-97)	44.00 (27-166)	0.183

Parameters	Urban(n=15)	Rural (n=5)	Suburban (n=14)	P value
PM_1 ($\mu g/m^3$)	15.00 (10-28)	14.00 (13-24)	14.00 (9-133)	0.721
CH_2O (ppm)	0.25 (0.13-0.56	0.25 (0.17-0.33	0.24 (0.13-0.55)	0.877
Temperature (^oC)	24.9 (20.9-27.7)	22.90 (22.2-24.2)	23.7 (20.4-26.2)	0.335
Humidity (%)	51.4 (24.0-63.1)	52.2 (48.8-69.7)	52.55 (43.8-57.6)	0.891
Total bacteria (CFU/m^3)	504.00 (138-2628)	2628.00 (376-2628)	1547.50 (33-2628)	0.464
Total fungus (CFU/m^3)	41.00 (18-106)	68.50 (40-117)	17.50 (3-71)	**0.007***

There were positive correlations between PM10 with PM2,5, PM1, CO, and air per person (r=0.815,p<0.001; r=0.536,p<0.001; r=423,p=0.013;r=0.389,p=0.031, respectively); while there were negative correlations found with CO2, humidity and student numbers (r=0.348,p=0.044; r=-0.44,p=0.009;r=-0.407,p=0.023, respectively). There was a positive correlation between PM2.5 with PM1 (r=0.911,p<0.001) and a negative correlation with humidity (r=-0.433,p=0.009) identified.

In both seasons, indoor PM10 amounts were higher than outdoor amounts (p<0.001). In the spring period, the indoor PM2.5 and PM1 amounts were higher than the outdoor amounts (p<0.001). In the winter, the outdoor PM2.5 and PM1 amounts were identified to be higher compared to indoor amounts. This result was statistically significant for PM1 (p=0.016). This shows that one of the sources of indoor pollution in the winter is the outdoor environment (Table 4).

Table 4. Comparison of outdoor and indoor measurement results.

	Fall semester			**Spring semester**		
Parameters	**Indoors**	**Outdoors**	**P value**	**Indoors**	**Outdoors**	**P value**
CO_2 (ppm)	1974.00 (1109-4484)	380.50 (325-1914)	**<0.001**	1813.00 (637-3334)	320.50 (297-421)	**<0.001**
CO (ppm)	0.750 (0-12.6)	0.60 (0.0-2.50)	0.144	0.550 (0.1-1.1)	0.800 (0.20-1.80)	**0.004**
PM_{10} ($\mu g/m^3$)	141.50 (65-576)	97.00 (12-315)	**<0.001**	83.50 (24-304)	46.50 (18-124)	**<0.001**
$PM_{2.5}$ ($\mu g/m^3$)	73.00 (22-265)	88.00 (16-249)	0.443	44.00 (19-166)	20.50 (12-34)	**<0.001**
PM_1 ($\mu g/m^3$)	42.00 (7-174)	58.00 (8-224)	**0.016**	15.00 (9-133)	11.00 (7-33)	**<0.001**
Temperature (^oC)	21.65 (18.6-26.3)	10.60 (4.80-24.0)	**<0.001**	24.10 (20.4-27.7)	25.75 (19.50-34.60)	**<0.001**
Humidity (%)	45.95 (31.7-62.8)	48.80 (22.2-62.9)	0.225	52.25 (24-69.7)	40.10 (12.10-56.30)	**<0.001**

CO_2 levels measured indoors in the fall period were higher compared to the spring period, but were not found to be statistically significant (Table 2). Only one school was observed to be within the limits recommended by the N15251 European Standard (European Standardization Committee, 2007) in the spring period (Figure 3). All other classrooms were measured above the limit value of 1500 ppm (Olesen, 2007). There was a positive correlation found between CO2 with humidity and student numbers (r=0.733, p<0.001; r=0.512, p=0.003). Measurements were observed to be higher in more crowded and smaller classrooms. In both seasons the indoor CO2 amounts were higher than in the outdoor environment (p<0.001) (Table 4). High CO2 amounts indoors are considered to be due to the classes being crowded and insufficient ventilation.

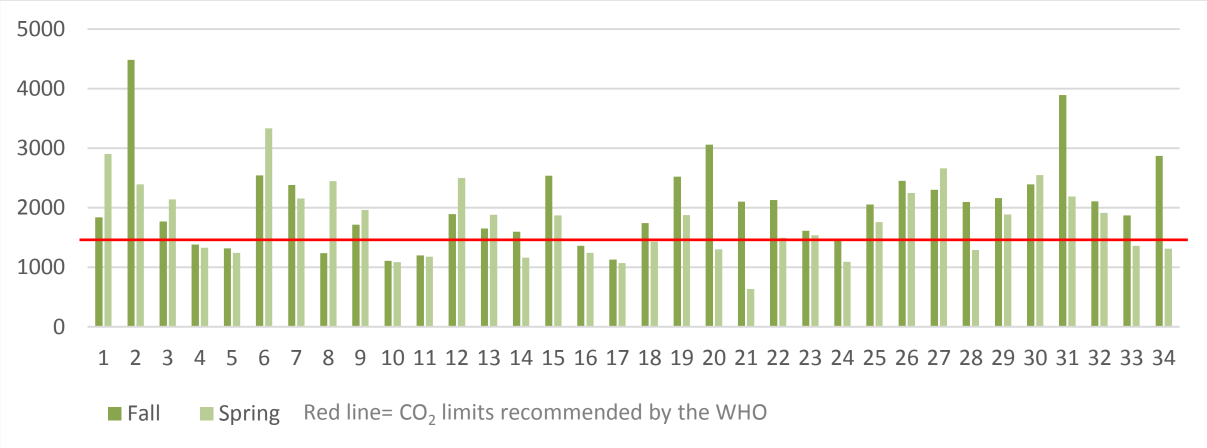

Fig 3. Comparison of CO2 data in the fall period measured in schools and WHO limit values.

According to measurement results, the bacteria and fungi concentrations showed high variability. In the fall period, median indoor bacterial counts were 157 (38-2628) CFU/m3, while in the spring period it was 604 (33-2628) CFU/m3. In 2 schools in the fall period and in 15 schools in the spring period nearly 3000 CFU/m3 was identified. The median fungal concentrations in the fall and spring periods were identified as 8.00 (3-120) CFU/m3 and 33.00 (3-117) CFU/m3, respectively (Table 2). When evaluated seasonally, the bacterial and fungal concentrations were statistically higher in the spring period ($p<0.001$). Total bacterial concentrations are examined higher in the rural region compared to other regions in fall period ($p=0.012$) (Table3). Total fungus concentrations are determined higher in the rural region compared to other regions in spring period ($p=0.007$) (Table 3). There was a positive correlation found between total bacteria and student numbers ($r=0.401$, $p=0.028$).

The indoor humidity and temperature measurements in the fall period were 45.95% (40.07-4.72), and 21.65% (20.75-23.32) and in the spring period were 52.25% (47.40-55.23) and 24.10% (22.77-25.02) (Table 2). In the fall period, 70.6% of classrooms and in the spring period 85,3% of classrooms were within the interval of 40-60% recommended by the WHO. In terms of indoor temperature, in the fall period 50.0% and in the spring period 11.8% of classrooms were between the 20-22oC recommended by the WHO. There was a negative correlation between PM10 with humidity ($r=-0.44$,$p=0.009$).

Median CH2O value was low compared to the WHO guidelines. The indoor CO amount in the winter was higher than the outdoors; however, there was no statistically significant difference ($p=0.144$). In the school using coal for heating, the CO level was measured as 12.6 mg/m3 (Table 4).

In this study, all schools in an area in the Kirşehir provincial center were monitored in terms of indoor air quality in winter and spring seasons. According to WHO limit values, PM2.5 measurements apart from one school, PM10 and PM2.5 measurements were identified to exceed limit values. When the CO2 limit values are examined, it appears all classrooms exceeded limit values. Seasonal assessment observed the fall period indoor air measurements were higher compared to the spring period measurements. Additionally, CO2 and PM10 levels were higher indoors, while PM1 was higher outdoors. In the spring period, CO2, PM10, PM2.5 and PM1 were higher indoors, while CO was identified to be higher outdoors. Regional comparisons identified the total bacterial and fungal counts were higher in the rural area and that the ages of these buildings were higher compared to buildings in other areas.

PM2.5 was above the standard value of 25µg/m3 in all classrooms bar one. When the PM10 limit value of 50 µm/m3 is examined, all classrooms were above the limit value. PM measurement data comply with data in the literature (Fromme et al., 2007; Simoni et al., 2010). Indoor PM concentrations were statistically high. These shows the PM concentrations were due to the indoor environment. It is considered that PM is due to the low amount of air per person, fixed furniture attracting particles, lack of ventilation, skin and hair residues from the human body, and dust particles on children's shoes and clothes (Alves et al., 2013; Tian et al., 2014).

PM10 was observed to be higher in the rural area. The reason for this is thought to be sourced in the outdoors due to the greater use of coal as fuel for heating purposes, agriculture, domestic animals, dirt roads and dry climate in the rural region. In urban areas, high PM2.5 and PM1 is thought to be due to school buildings being old and the density of roads in the surroundings. As a result, it is recommended that these risk factors should be calculated when choosing the site for new school buildings and that environmental organization be made accordingly. At measurement times, the entry and exit times for the classrooms and activities during lessons caused peaks in the PM concentrations (Madureira et al., 2012).

The indoor air quality in schools may affect the health, comfort and academic performance of both employees and students (Mendell & Heath, 2005). In this study, measurements in winter identified 1500 ppm and above in 26 schools. The classroom with highest values had 4484 ppm measured. In the spring, 19 schools were identified to be 1500 ppm and above. This shows that windows were kept open for longer periods in the spring period and this lowered CO2 levels. There appeared to be a strong correlation between CO2 levels and student numbers. CO2 concentrations varied seasonally. A study by Coley et al. determined CO2 levels were observed to be higher in the fall period compared to the spring period (Coley & Beisteiner, 2002). Studies have shown a consistent correlation between high CO2 concentrations and ventilation rates and health symptoms (Seppänen et al., 1999). A study in France by Canha et al. measured CO2 concentrations in 17 preschools and primary schools. They identified that 35% of classrooms had CO2 concentrations of 1500 ppm and above (Canha et al., 2016). In this study, this rate was higher. The reason for this is considered the student numbers and the lack of ventilation systems. Additionally, multicenter European research showed school children exposed to CO2 levels higher than 1000 ppm had significantly high degrees of dry cough and rhinitis risk (Shendell et al., 2004; Simoni et al., 2010).

CO is generally one of the most characteristic traffic pollutants observed in urban areas (Zayasu et al., 1997). In spring CO levels varied from 0.1 to 1.1 mg m3, while in the winter the highest value of 12.6 mg m3 was measured. Another study in primary schools identified the CO level as 1.6. They stated the source for this was fuel used in the kitchen indoors, while the outdoor source was traffic density (Yoon et al., 2011). In this study the school with highest CO amounts identified was heated with a stove. Due to heating in the winter and insufficient ventilation, CO amounts were higher than the outdoor values.

Studies in schools have stated that indoor materials are sources of CH2O (Liu et al. 2006; Yoon et al., 2011). The limit value of 0.6 mg m-3 was not exceeded (Kaden et al., 2010). There are many possible sources of formaldehyde in primary schools. Among these are paints, varnishes, cleaning materials, insecticides, construction material, new furniture, adhesives and compressed wood furniture (Yoon et al., 2011).

Environmental conditions surrounding schools and classrooms, and plants and soil in school playgrounds may be significant sources of microorganisms (Hanninen, 2011). In 86% of the classrooms with measurements performed, mean indoor bacterial levels were found to be higher than 500 CFU/m3, similar to findings from 11 schools in Porto in the winter (Madureira et al., 2016). For indoor air samples, total fungal counts were lower compared to other studies (Godwin & Batterman, 2007). In winter, students generally spend more time indoors, windows are frequently closed due to outdoor weather conditions or as heating systems are turned on and ventilation may be insufficient. A study by Madureira et al. found a positive correlation between optimal humidity and temperature intervals for fungal species and the fungal concentration in indoor air and indoor temperature (Madureira et al., 2016).

This study has some limitations, one-day measurement was performed in schools in every season. Continuous measurement could not be performed due to we have a few devices and a great number of schools.

CONCLUSION

Many IAQ parameters showed variability between schools and appeared to exceed limit values. Student activity can be considered as the indoor source affecting air particulate matter concentrations in school environments. Classroom activities increase particulate matter concentrations. Particulate matter concentration in rural areas is due to particulate matter concentration in the outdoor environment. Students and their activities have a direct impact on indoor CO2 concentration levels. The results show that there is a positive correlation between the mean CO2 concentration and the number of students. In this case, adequate ventilation routines are required in classrooms, such as opening windows during recess or lunch breaks to lower the CO2 concentration level. Concentration of total bacteria and fungi was found to be higher in rural schools. It was because of the high age of the school buildings in the rural area. It will increase the incidence of respiratory diseases such as asthma and allergies in children. As a result, it is recommended that school buildings be designed to prevent indoor pollutant sources. This situation requires more space and openness between classrooms, reduction in fill rates per classroom. In addition, it should be considered that the studied buildings do not have any ventilation systems. Developing future research activities on smart natural ventilation systems to improve indoor air quality in school environments. Strategies based on control of IAQ pollutant sources are accepted as the most consistent and effective method to prevent negative health outcomes for children and adults. The need for multiple and long-term surveillance locations to find indoor pollutant sources, calculate seasonal variation, and evaluate whether there is a causative relationship between exposure to pollutants in schools and health symptoms was determined. Regular surveillance of IAQ will ensure people living within buildings will live in safe conditions.

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CONFLICTS OF INTEREST

The authors declare that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

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