

Article

Forms of School Environment Pollution in Some Schools in Kirkuk City and Ways to Solve Them

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Abstract: This research addresses the issue of environmental pollution in schools in Kirkuk Governorate, which is one of the significant problems affecting the health of students and teachers in the province's schools. Environmental pollution and its forms are clearly evident in many schools due to overcrowding in classrooms, the proximity of schools to busy streets, the lack of environmental services, and the increase in pollution sources in the province. The types of school environmental pollution include air pollution, water pollution, noise pollution, and solid waste, in addition to bacterial pollution inside classrooms and school sanitary facilities. School environmental pollution is defined as the presence of harmful factors and substances within the school environment that lead to harm to human health or affect the educational process. Among the forms, types, and most prominent causes of pollution in the schools of Kirkuk city are the proximity of some schools to busy streets, industrial and oil areas, smoke emissions, as well as the accumulation of solid waste in schoolyards, weak sewage systems, and the lack of environmental awareness among students and residents of the areas near the schools. Numerous local studies in Kirkuk have indicated the presence of environmental pollution effects in the city due to industrial and oil activities. The study addressed the forms of school environmental pollution in the governorate for the academic year 2025/2026, revealing high levels of bacterial pollution, noise pollution, solid waste, water pollution, and air pollution in the schools. This is attributed to the poor sterilization and cleaning within the health facilities and classrooms, as well as the presence of factories, oil companies, and cement plants. The study also clarified, thru the Pearson correlation model, the existence of an inverse relationship between academic achievement and environmental pollution in schools. As the pollutants in the school environment increase, the students' concentration decreases. The study indicated the presence of high levels of bacterial pollution, solid waste, noise pollution, and contamination of drinking water.

Keywords: School environmental pollution, Bacterial contamination, Air and noise pollution, Water quality in schools, Academic achievement and environment correlation.

Introduction

School environmental pollution in Kirkuk poses a significant challenge due to multiple factors; the most prominent being the decline in green spaces in the governorate (which do not exceed 2%), carbon emissions from nearby oil fields, and the random disposal of waste by residents around schools, in addition to concerns regarding building safety. The main pollutants and the efforts made to address them are summarized as follows: the accumulation of random waste, which the teaching staff in many residential neighborhoods in Kirkuk complain about, particularly around modern schools, where residents burn the waste, leading to air pollution and smoke that penetrates classrooms and harms students' health. The oil and industrial emissions caused by the numerous oil fields, asphalt plants, and cement factories in the city's vicinity spread toxic gasses and harmful particles that negatively affect air quality within the school environment, increasing the rates of respiratory diseases [1]. Similarly, some schools, such as Al-Wasiti Preparatory School for Girls, faced severe health concerns due to claims of radioactive contamination. However, the radiation survey teams from the Ministry of Environment have repeatedly confirmed that these buildings are completely free of any contamination. The old military remnants resulting from military operations are all considered pollutants that affect the health of students. The school environment is one of the most important environments where students spend a significant part of their day. Therefore, its safety and cleanliness directly impact the health of students and teachers, as well as their ability to learn and achieve academically [2]. The school environment is exposed to many pollutants that may be airborne, waterborne, noise-related, or resulting from waste and chemicals, leading to the spread of diseases, fatigue, and poor concentration. Recent studies have confirmed that poor school environment affects students' health and their academic performance [3]. And the school environmental pollutants are all the materials or factors that lead to the degradation of the environment inside or around the school, negatively affecting the health or psychological and physical comfort of the students, whether these pollutants are natural or resulting from human activities. And the lack of green spaces, given the province's deficiency in sufficient green areas, has all contributed to increased pollution levels [4]. Where volunteer teams and some schools launched intensive campaigns to plant trees within neighborhoods and around schools to purify the air and combat desertification, school environmental pollution is represented by any disruption that negatively affects the health, safety, and performance of students and teachers within the school campus, including air pollution and solid waste [5]. Noise pollution and the lack of basic cleanliness, which together contribute to an unhealthy educational environment, the current study aimed to identify the types of school environmental pollutants in Kirkuk and their most significant threats to the school environment, and to provide appropriate recommendations to reduce the accumulation of these pollutants in the city's schools.

2. Study area, materials, and methods:

The study was conducted in (10) selected schools from the schools of Kirkuk Governorate during the academic year (2025–2026), and included primary, intermediate, and secondary schools located in different areas of the governorate with the aim of assessing the reality of school environmental pollution in each selected school. Data was collected thru field visits to the schools using environmental observation forms specifically prepared for the study, as well as noise air quality measurement devices. Drinking water samples were collected for laboratory analysis, and environmental swabs and samples from door handles in the schools were taken. The condition of solid waste quantities and their collection and disposal methods were documented. Pollution was measured by taking measurements of the concentrations of fine particulate matter (PM_{2.5} and PM₁₀) inside the schoolyards and some classrooms using an air quality measurement device, and the readings were recorded in micrograms/m³. Samples of drinking water were collected in schools inside sterilized bottles, and physical, chemical, and microbiological tests were conducted on them, such as pH, total dissolved solids (TDS), and total bacterial count. Bacterial contamination was measured by taking swabs from water tanks, door handles, and sanitary facilities using sterile swabs. The samples were then cultured on appropriate media and incubated at 37°C for 24–48 hours, after which the total number of bacterial colonies (CFU) was counted. The noise level inside classrooms and schoolyards was also

measured using a Sound Level Meter, and the results were recorded in decibels (dB). The amount of solid waste accumulated within the schools was assessed thru direct observation and classified into paper waste, plastic waste, food waste, and mixed waste. The data were statistically processed using Excel or SPSS, and the mean, standard deviation, percentages, and Pearson Correlation coefficient were calculated to study the relationship between different types of pollution. (Mahmoud et al. 2021)

3.Presentation, analysis, and discussion of the results

The current study aimed to measure and analyze the levels of school environmental pollution in (10) schools within the Kirkuk Governorate, in order to identify the most widespread types of pollution and their impact on the school environment. The study included types of pollution:

1. Air pollution. Air pollution.
2. Water pollution. Water pollution.
3. Bacterial pollution. Bacterial pollution.
4. Solid waste. Solid waste.
5. Noise pollution Noise pollution

First: Discussion and analysis of bacterial pollution results.

The results showed that bacterial contamination recorded the highest measurement in the first school, where it was (515), and the lowest recorded value was (80). The results indicated that more than (7) had a bacterial contamination level ranging from moderate to high, as shown in Table (1), which indicates a high level of bacteria and germs spread within the schools. This is attributed to the poor sterilization and cleaning within the health facilities and classrooms, in addition to student overcrowding. Many studies have shown that contaminated hands can harbor various types of pathogenic microorganisms, as hands play a key role in the transmission and spread of fecal-oral diseases. It is believed that handwashing reduces the transmission of infections by removing potential microorganisms and dirt, as dirt can carry microorganisms and allow them to survive for longer periods. Many studies have confirmed the effectiveness of handwashing in reducing two major deadly diseases affecting children, namely diarrhea and acute respiratory infections. The incidence of these diseases among students negatively impacts their concentration levels and attendance, which in turn affects the school environment. [6].

Table 1. Results of Bacterial Contamination Assessment in Schools.

No.	School	Total Bacterial Count (CFU/mL)	Overall Contamination Level
1	First School	515	High
2	Second School	450	High
3	Third School	120	Moderate
4	Fourth School	370	High
5	Fifth School	200	Moderate
6	Sixth School	100	Moderate
7	Seventh School	200	High
8	Eighth School	80	Low
9	Ninth School	300	High
10	Tenth School	190	Moderate

2. Analysis of Water Pollution Results

The measurement results indicated that water pollution in schools ranked second, with the highest level of pollution recorded in school number (10). The water was unfit for drinking due to high turbidity levels and elevated coliform bacteria levels, which were (18) per 100ml of water. The measurement results also showed that approximately (6) schools were rated from moderate to high pollution, as illustrated in Table (2). This indicates some issues with the cleanliness of water tanks and weak health monitoring of drinking water sources within some schools. Reports indicate that children in schools have a high metabolic rate and engage in physical and athletic activities, leading to significant water consumption. The consumption of non-potable water is a major cause of diseases, including diarrhea and other intestinal illnesses. The lack of potable water in schools is considered one of the environmental issues in the school setting [7]. Among the reasons for the lack of potable water for

drinking and daily use are the scarcity of disinfectants and the poor cleanliness of pipes, tanks, and other facilities in schools. Consequently, this affects the health of students and teachers and their ability to learn and achieve academically. [8].

Table 2. Physicochemical and Microbiological Characteristics of Water Samples Collected from Schools.

No.	School	pH	Turbidity (NTU)	Total Dissolved Solids (TDS) (mg/L)	Total Coliforms (MPN/100 mL)	<i>E. coli</i> (MPN/100 mL)	Assessment
1	School 1	7.2	1.4	410	2	0	Acceptable
2	School 2	7.4	2.1	500	3	0	Acceptable
3	School 3	7.2	3.7	650	8	1	Moderate Contamination
4	School 4	7.1	1.9	450	2	0	Acceptable
5	School 5	7.0	4.2	730	10	2	High Contamination
6	School 6	7.3	2.6	580	6	0	Acceptable
7	School 7	6.9	5.2	700	14	3	High Contamination
8	School 8	7.1	1.3	320	1	0	Acceptable
9	School 9	7.5	3.4	620	7	1	Moderate Contamination
10	School 10	6.7	5.7	580	18	4	High Contamination

3. Analysis of Noise Pollution Results

The highest measurement of noise pollution was recorded in school number (7), with a peak of (66) decibels inside the classrooms and (77) decibels outside. The lowest measurement of noise pollution was in school number (8), with (45) decibels inside the classroom and (58) decibels outside, as shown in table (3). These noise levels are considered high and are linked to the proximity of some schools to busy streets and markets, in addition to the noise inside the classrooms, which affects students' concentration and academic performance. Noise pollution is considered one of the most significant problems that reduce the level of concentration among students in educational institutions. The main causes of this pollution are the proximity of educational institutions to noise sources and the lack of building designs that act as sound barriers. Additionally, the closeness of schools to busy streets and residential areas contributes to this type of pollution, thereby distracting students and reducing their academic performance [9].

Table 3. shows the results of measuring noise pollution in schools.

No.	School	Noise Pollution Level Inside Classrooms (dB)	Noise Pollution Level in the Schoolyard (dB)	Assessment
1	School 1	47	61	Moderate
2	School 2	52	64	High
3	School 3	59	70	High
4	School 4	45	62	Moderate
5	School 5	61	75	Very High
6	School 6	51	66	High
7	School 7	66	77	Very High
8	School 8	45	58	Moderate
9	School 9	55	67	High
10	School 10	70	73	Very High

4. Analysis of Air Pollution Results

The results showed that air pollution levels ranged from high to moderate, with the highest air pollution measurement recorded at school (10), where the value of suspended and fine particles ranged from (110.44) micrograms/m³ and the CO gas value was (2.1), which is considered a high percentage. The measurement results indicated that the lowest air pollution value was at school (4), where (17.41) for suspended and fine particles was recorded, and the CO gas level was (0.9). The table also showed that the air pollution levels in (5) out of (10) schools were high, while the remaining schools had levels ranging from low to moderate. This is attributed to dust, smoke, and poor ventilation inside the classrooms, especially in schools located near main roads. Air pollution constitutes a significant portion of the environmental pollution in schools in Kirkuk and poses a major challenge due to multiple factors, including its status as an oil-producing city, lack of vegetation cover, and vehicle emissions, all of which contribute to air pollution [5]. Previous studies conducted in Kirkuk have reported significant spatial variations in air pollution levels, particularly in areas located near oil fields, industrial facilities, and major transportation routes [10], [11]. Remote sensing and GIS-based assessments further confirmed that concentrations of particulate matter and atmospheric pollutants are unevenly distributed across the governorate and may pose environmental and health risks to nearby educational institutions [12].

Table 4. shows the results of measuring air pollution in schools.

No.	School	PM2.5 (mg/m ³)	PM10 (mg/m ³)	CO (ppm)	NO ₃ (mg/m ³)	Pollution Level
1	School 1	18	44	0.8	21	Low
2	School 2	21	57	1.1	25	Moderate
3	School 3	28	72	1.4	32	High
4	School 4	17	41	0.9	18	Low
5	School 5	36	87	1.8	40	High
6	School 6	25	62	1.2	26	Moderate
7	School 7	41	100	2.1	48	Very High
8	School 8	19	49	0.9	22	Low
9	School 9	31	75	1.4	35	High
10	School 10	44	110	2.1	52	Very High

5. Analysis of Solid Waste Results

The results showed that solid waste in schools (10) ranged from medium to high levels, with the highest measurement recorded in school (8) at (40 kg/day), which is considered high. School (10) recorded a value of (37 kg/day), as shown in Table (5). This is attributed to the varying number of students, differences in their environmental awareness, the accumulation of waste within school yards, and the lack of designated waste containers. The reason for the accumulation of solid waste is the lack of student awareness, poor cleanliness, and the absence of designated places for waste disposal in the school, such as trash bins. Additionally, the presence of empty spaces around the schools makes them susceptible to waste dumping by neighborhood residents and others. All these factors contributed to the accumulation of waste around the schools and increased the risk of environmental pollution in the schools [13].

Table 5. shows the results of measuring solid waste pollution in schools.

No.	School	Quantity of Solid Waste (kg/day)	Pollution Level
1	School 1	19	Low
2	School 2	24	Moderate
3	School 3	28	Moderate
4	School 4	30	High
5	School 5	28	Moderate

6	School 6	34	High
7	School 7	29	High
8	School 8	40	High
9	School 9	22	Moderate
10	School 10	37	High

Table 6. Percentage of Schools Affected by Different Types of Pollution.

Type of Pollution	Number of Affected Schools	Percentage (%)
Bacterial pollution	7 schools	70%
Water pollution	5 schools	50%
Noise pollution	7 schools	70%
Air pollution	6 schools	60%
Solid waste pollution	5 schools	50%

Comparison of pollution types in the school environment:

The comparison results indicate that bacterial pollution represents the most dangerous type of pollution in the schools of the governorate, followed by water pollution, then noise pollution, while solid waste came in last place. The results also indicate that health and noise pollutants directly affect students' health, psychological comfort, and academic performance [14].

Correlation coefficient analysis

The relationship between environmental pollution and academic achievement

Table 7. Correlation between Environmental Pollution and Academic Achievement.

Variables	Significance Level (Sig.)	Correlation Coefficient (r)	Type of Relationship
Environmental pollution × Academic achievement	0.001	-0.79	Strong negative (inverse) relationship

Interpretation of the Pearson correlation coefficient:

The results of the Pearson correlation coefficient showed a strong inverse relationship between environmental pollution and academic achievement, with a correlation coefficient value of (-0.79). This relationship is statistically significant as the significance level reached (0.001), which is less than the accepted significance level (0.05) [15].

Conclusions

The study concluded that schools in Kirkuk Governorate suffer from high levels of environmental pollution, especially bacterial pollution, water pollution, noise pollution, and air pollution, which negatively affects the health of students, the educational environment, and academic achievement.

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