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Original article

The Impacts of Mining Activities in Some Sites of Al- Abyar City, Libya, on Particulate Matter Concentration and Noise Level

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Abstract
Pollution from human activities remains a significant environmental concern. One of the most notable activities in Al-Abyar city in the Benghazi region of Libya is the production of construction materials such as various types of gravel and calcium carbonate. In this study, we collected particulate matter (PM_{10} and $PM_{2.5}$) concentration data from 18 locations along the ring road in the center of Al-Abyar over three months (June to August) to assess air quality and its relationship to weather conditions. The average concentrations of $PM_{2.5}$ and PM_{10} were found to be 4 to 5 times higher than the 24-hour air quality guideline (AQG) levels set by the World Health Organization (WHO) for classical air pollutants. This study found that temperature and humidity had no significant impact on particulate matter (PM), specifically $PM_{2.5}$ and PM_{10}, as air temperature increased from 27.2°C to 44.9°C during the study period. We concluded that individuals who spend extended periods outdoors are particularly vulnerable to the adverse health effects of dust and traffic emissions from road transport operations related to rock mining in Al-Abyar. Finally, the average noise levels across all sites in the study area were below the World Health Organization's permissible limit of 90 decibels. Research on particulate matter (PM) and noise pollution remains limited, we recommend conducting a follow-up study to evaluate the health impacts of prolonged exposure to outdoor air pollution in the study area. Additionally, it is crucial to implement effective and sustainable strategies to reduce exposure.
Keywords. Particulate Matter, Noise Pollution, Human Activities.

Introduction

The Industrial Revolution and advancements in modern technologies have led to new environmental challenges, including noise pollution, air pollution, and water pollution, which continue to impact ecosystems and public health worldwide. There is a long and fascinating history of efforts to understand and reduce the impact of air pollution on human health and well-being (1,2). In 2004, the American Heart Association released its first scientific statement on "Air Pollution and Cardiovascular Disease," concluding that exposure to particulate matter (PM) air pollution plays a role in cardiovascular morbidity and mortality. Environmental pollution has been a matter of concern for many years(3). In 2019, air pollution was recognized as the fourth leading risk factor for early mortality worldwide(4).

Air pollution from diesel-powered vehicle emissions, as well as tire and brake wear, includes particulate matter (PM) such as PM10, PM2.5, and ultrafine particles (with diameters of ≤10 μm, 2.5 μm, and 0.1 μm, respectively), along with harmful gases like nitrogen dioxide (NO_2). These pollutants, individually or in combination, have been linked to increased early mortality and adverse respiratory and cardiovascular effects(5) . In 2019, air pollution was estimated to have caused 6.67 million deaths worldwide. In the European Union, 97% of the urban population is exposed to fine particulate matter levels exceeding the latest guidelines set by the World Health Organization.(6). In 2018, 73.6% of the EU urban population was exposed to excessive levels of fine particulate matter (PM2.5), which is recognized as the fifth leading risk factor for mortality. The primary contributors to $PM_{2.5}$ concentrations in the EU were institutional, commercial, and household sources (55.5%), followed by road transport (10.7%)(7). In 2016, $PM_{2.5}$ pollutions was linked to over four million deaths worldwide, with Europe accounting for approximately 10% of that total(8).

Excessive noise is not only unpleasant but also triggers a range of physiological and psychological effects. Prolonged exposure to noise pollution poses a significant threat to human health, especially for individuals subjected to high noise levels continuously over extended periods(9). Beyond its auditory effects, noise can also have non-auditory impacts on the human body, affecting overall health and well-being. These effects stem from noise exposure but exclude direct harm to the hearing system and issues related to the masking of auditory information, such as communication difficulties(10). This study aimed to assess air pollution at eighteen locations along the main ring road in the Al-Abyar city of the Benghazi Region-Libya by measuring ground-level fine particulate matter (PM), specifically $PM_{2.5}$ and PM_{10}, as well as noise levels. Additionally, it sought to examine the statistical relationship between atmospheric temperature, humidity, and PM pollution.

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Methods

Study area

The study area was located along the ring road, starting from Al-Abyar Street, where heavy traffic from vehicles transporting mine rock products is prevalent. The study specifically focused on 18 points along the main ring road.

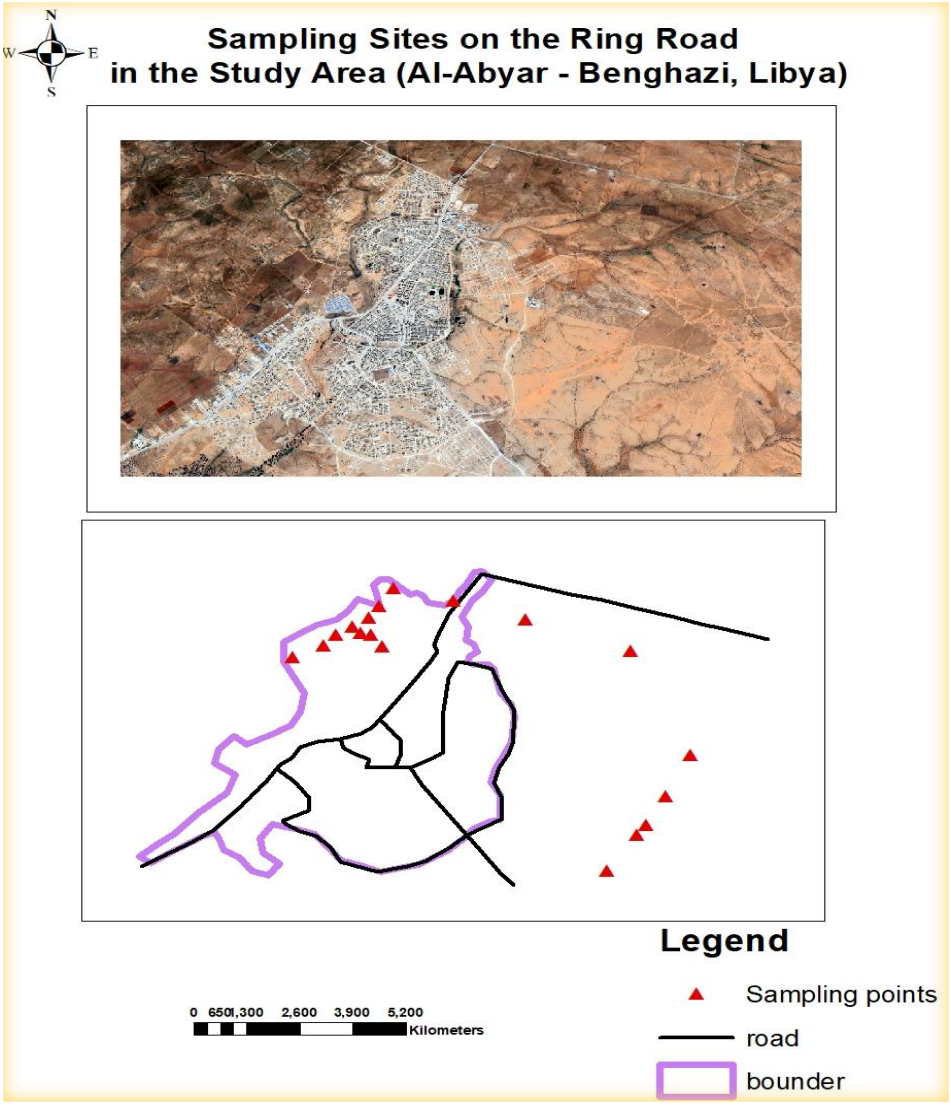

Figure 1. The ring road begins at Al-Abyar Street, where heavy traffic from vehicles transporting mine rock products.

Measurement Locations

Eighteen sites were selected along the ring road, beginning at Al-Abyar city in Street**,** where heavy traffic from vehicles transporting mine rock products is prevalent (Table 1).

Table 1. The coordinates of air quality measurement sites in Al-abyar city.

Number	Names of air quality measurement sites	Elevation (m)	Geographic coordinates
S1	Sultan's Ghout entrance	295	N: 32˚16'147"
			E: 20˚55'049"
S2	Bouzahab gas station	293.5	N: 32˚17'057"
			E: 20˚56'830"
S3	City Mall	294.5	N: 32˚17'057"
			E: 20˚57'557"
S4	Ring intersection	284	N: 32˚18'460"
			E: 20˚58'582"
S5	Fawqi market intersection	275.3	N: 32˚18'014"
			E: 20˚59'088"
S6	Al Hasad Bakery	278.6	N: 32˚17'869"

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			E: 20˚59'776"
S7	Opposite the cemetery	313.1	N: 32˚16'908"
			E: 20˚60'513"
S8	Next to the old hospital	299.3	N: 32˚19'250"
			E: 20˚59'564"
S9	Feed factory	297.5	N: 32˚20'256"
			E: 20˚60'164"
S10	Solouk intersection	299.7	N: 32˚21'813"
			E: 20˚61'086"
S11	Calf gate, Salouk road	311.3	N: 32˚20'580"
			E: 20˚65'017"
S12	Dirt road intersection (rest houses), Salouk road	337.4	N: 32˚18'880"
			E: 20˚69'698"
S13	Al Hanawa next to the mosque	586	N: 32˚16'277"
			E: 20˚75'994"
S14	Al Jaheishiya fuel station	548	N: 32˚09'121"
			E: 20˚77'677"
S15	Jabal Arafat Company	544	N: 32˚06'131"
			E: 20˚75'071"
S16	Opposite Al-Tariq	538	N: 32˚05'340"
			E: 20˚74'349"
S17	United Lighthouse Company	543.6	N: 32˚04'882"
			E: 20˚73'836"
S18	Al-Maqour Area	533.8	N: 32˚03'238"
			E: 20˚71'943"

Measurement Periods

Data for these points were collected over a three-month period, resulting in a total of 270 measurements. These included daily average levels of $PM_{2.5}$, PM_{10}, noise levels, air temperature, and humidity, which were analyzed using gravimetric methods.

Instruments used

The Particle Counter

The Particle Counter was used to measure the concentration of fine particulate matter (PM). This instrument provides precise measurements of particulate matter in the air, helping to assess pollution levels at ground level.

Table 2. The recommendations on classical air pollution levels(AQG levels)(1).

Pollutants	Average time	AQG levels
particulate matter 2.5 in size	Annual	5
	24-hour	15
particulate matter 10 in size	Annual	15
	24-hour	45

The Noise Measurement

The sound level scale is based on the decibel (dB) as a unit of measurement, which is a logarithmic scale that expresses the intensity of sound relative to the human hearing threshold. The Noise Measurement Device was used to assess the noise levels at the selected sites along the ring road. Noise levels vary significantly depending on the source. Table 5 presents noise levels from various sources and areas, as documented in previous studies(11, 12).

Table 5. Noise levels from various sources and areas.

Noise Sources	Noise levels, in dB	Noise Sources	Noise levels, in dB
Air compressors	95-104	Trains	96
Quiet garden	30 110	Power-operated portable saw	108
KV-diesel generator	95	Trucks	90-100
Ticking clock	30	Steam turbine	91
Lathe Machine	87	Car horns	90-105
Computer rooms	55-60	Pneumatic Chiseling	118
Milling machine	112	Jet takeoff	120

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The Temperature and Humidity Sensor

The Temperature and Humidity Sensor was used to measure air temperature and humidity levels at each data collection point. This data is crucial for understanding the environmental conditions that can influence the dispersion and behavior of air pollutants.

Statistical Analyses

Data were analyzed using SPSS 24 to perform descriptive statistical analyses. This involved calculating measures such as average, minimum, maximum, and standard deviation (st-dev) to summarize the collected data on air pollution and environmental parameters at the study sites.

Results and Discussions

Particulate Matter (PM)

One of the key indicators of air quality is the quantity of particulate matter (PM). While high levels of PM can cause discomfort for everyone, they pose serious health risks to individuals with upper respiratory tract diseases, as well as to the elderly and children. Table 3 shows the statistical description of $PM_{2.5}$ levels, including the average, minimum, maximum, and standard deviation of $PM_{2.5}$ concentrations recorded across the sampling sites.

Table 3. Statistical Description of PM-2.5 Levels in Al- Abyar City.

Location	Average mg/m3	Min	Max	SD
1	28	9	50	20.6
2	26.33	7	54	24.5
3	33	9	54	22.6
4	17.66	16	19	1.5
5	17.66	7	34	14.3
6	18.33	10	33	12.7
7	12.33	4	27	12.7
8	32.66	18	58	22.03
9	21	6	33	13.7
10	9	3	18	7.9
11	5.33	4	6	1.1
12	8.66	7	12	2.8
13	17.33	4	42	21.3
14	26.66	7	39	17.2
15	5.66	3	10	3.78
16	41.66	18	60	21.5
17	77.33	48	99	26.3
18	29.66	6	50	22.1

Table 4 shows the statistical description, including the average, minimum, maximum, and standard deviation of PM_{10} concentrations recorded across the sampling sites**.** Particulate matter quantity was assessed for along the ring road, beginning at Al-Abiyar Street, where heavy traffic from vehicles transporting mine rock products is prevalent. The mean lowest values for measurements made in eighteen points along the main ring road were 3 for particles 2.5 µm in size and 8 for particles 10 µm in size. The mean highest values were estimated to be 99 for particles 2.5 µm in size and 216 for particles 10 µm in size.

Table 4. Statistical Description of PM-10 Levels in Al- Abyar City.

Location	average	min	max	st-dev
1	53.3	19	85	33.08
2	45.6	15	93	41.5
3	59.3	16	90	38.59
4	50	30	84	29.5
5	31.6	15	56	21.5
6	38	22	68	26
7	26.3	10	57	26.5
8	55	33	92	32.23
9	40.6	11	64	27.06
10	18.66	8	38	16.7
11	10.3	10	11	0.57

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12	17	12	26	7.81
13	32.66	10	77	38.39
14	54.66	18	77	32.00
15	12	6	21	7.93
16	70.66	39	90	27.64
17	150	86	216	65.02
18	50.6	12	77	34.21

Noise level

The World Health Organization (WHO) recognizes community noise, including traffic noise, as a major public health concern, leading to the publication of the Community Noise Guidelines in 1999(13). These guidelines specify noise levels above which adverse effects on health and well-being are expected. Traffic is the most prevalent source of noise, and exposure to it is associated with various effects on human health and well-being. This section highlights the critical issues associated with road noise, primarily stemming from traffic related to road transport operations for mining rock in Al-Abyar. Table 5 shows the statistical description of noise Levels, including the average, minimum, maximum, and standard deviation of noise Levels recorded across the sampling sites in Al-Abyar City**.**

Table 5. statistical Description of noise Levels in Al-Abyar City.

Location	Average in dB	Min Noise levels, in dB	Max Noise levels, in dB	SD
1	73.7	71	76	2.52
2	69.13	63	74	5.60
3	68.66	67	70	1.52
4	65	63	68	2.64
5	59	54	62	4.35
6	63.66	58	73	8.14
7	65	62	67	2.64
8	71	67	74	3.60
9	66.66	62	72	5.03
10	70	69	71	1
11	64.66	56	78	11.71
12	75.66	54	89	18.92
13	72.33	67	76	4.72
14	59	55	63	4
15	73.33	66	80	7.02
16	72.66	72	74	1.15
17	76.33	71	79	4.61
18	70	67	72	2.64

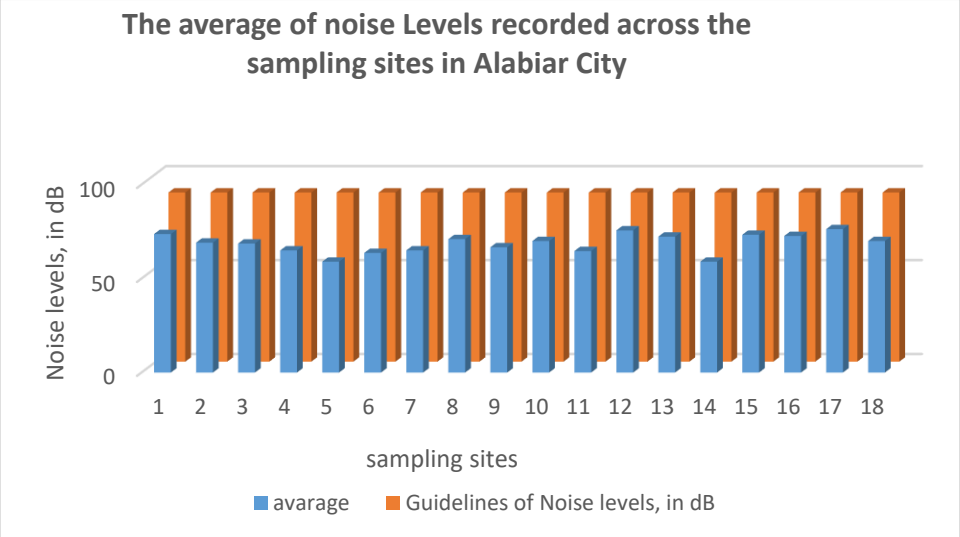

Figure 2. The average of noise Levels recorded across the sampling sites in Al- Abyar City.

Temperature and humidity

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In this study, the correlation of temperature and humidity on Particulate matter quantity concentration was studied for along the ring road in Al-Abyar city at Street, where heavy traffic from vehicles transporting mine rock products is prevalent. Tables 6, 7, and 8 show the statistical Description of Air Temperature and humidity and the correlation between them on Particle matter quantity concentration along the ring road in Al-Abyar city.

Table 6. Statistical Description of Air Temperature in Al-Abyar City.

Location	Average	Min	Max	SD
1	31.83	27.2	40	7.09
2	33.9	30.5	40.5	5.6
3	35.6	32.5	40.7	4.45
4	36.7	33.2	41	3.9
5	38	35.2	41	2.90
6	37.4	35	41	3.1
7	37.36	33.7	41	3.65
8	35.6	31.4	41.7	5.38
9	35.96	32.6	40.8	4.29
10	38.8	32.8	42.3	5.26
11	35.3	31.4	40	4.35
12	38.4	31.2	44.1	6.59
13	37.23	30.8	42.9	6.08
14	35.63	31.3	38.6	3.8371
15	36.3	32.2	41.7	4.8
16	37.76	33.5	44.9	6.21
17	36.9	33.7	42.5	4.81
18	36.73	32.7	42.2	4.90

Table 7. Statistical description of Air humidity in Al-Abyar City.

Location	Average	Min	Max	DS
1	59.6	56	62	3.17
2	54.6	53	56	1.52
3	50.6	47.8	56	4.67
4	50	46	57	6.08
5	49.5	45.6	57	6.46
6	48.83	44.8	56	6.22
7	47.2	40	56	8.11
8	50.66	45.8	56	5.11
9	42.63	36.9	47.4	5.31
10	38.03	34.3	43.7	4.9
11	49.4	37.1	62	12.45
12	40.43	36.6	47.8	6.38
13	39.7	33.9	47.6	7.07
14	40.4	36	47.4	6.08
15	38.76	34.3	41.5	3.9
16	40.06	36.6	41.9	3.00
17	39.4	37.3	40.6	1.82
18	37.7	34.2	39.8	3.05

Table 8. The correlation between temperature, humidity, and noise level on Particle matter quantity concentration along the ring road in Al-Abyar city.

Correlations (Pearson Correlation)	Average of PM 2.5	Average of PM 10	Average of Noise	Average Temperature	Average of Humidity
Average of PM-2.5	1				
Average of PM-10	.985**	1			
Average of Noise	.340	.298	1		
Average of Temperature	-.131	-.116	-.057	1	
Average of Humidity	-.062	-.058	-.226	-.683**	1
**. Correlation is significant at the 0.01 level (2-tailed).					

Conclusion

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This study evaluated air pollution across eighteen locations along the main ring road in Al-Abyar city, Benghazi Region, Libya. By measuring fine particulate matter ($PM_{2.5}$ and PM_{10}) and noise levels, it provided critical insights into the environmental conditions of the area. Furthermore, the study explored the statistical relationship between meteorological factors, including air temperature and humidity, and the concentration of atmospheric pollutants. The findings highlight that temperature and humidity exhibit a negative correlation, with rising temperatures leading to a substantial decrease in humidity levels. Although a slight negative correlation was observed between temperature and particulate matter concentrations, further analysis revealed no significant impact of temperature and humidity variations on $PM_{2.5}$ and PM_{10} levels. However, a strong positive correlation was identified between $PM_{2.5}$ and PM_{10}, indicating that as fine particulate matter levels increased, coarse particulate concentrations also rose. A concerning discovery was that the average $PM_{2.5}$ and PM_{10} concentrations significantly exceeded the World Health Organization's (WHO) 24-hour air quality guideline levels, reaching up to 4 to 5 times higher than the recommended limits. This raises serious public health concerns, particularly for individuals who spend prolonged periods outdoors. The adverse health effects of exposure to dust and traffic emissions from road transport operations, particularly those associated with rock mining activities in Al-Abyar, emphasize the need for immediate intervention. In contrast, the study found that noise levels across all locations remained within the WHO's permissible limit of 90 decibels. While this is a positive indicator, the cumulative impact of noise pollution and particulate matter exposure warrants further examination.

Given the high concentration of rock mining companies in the region, implementing effective short- and long-term interventions is essential to mitigate air pollution and its health effects. Additionally, due to the limited research available on particulate matter and noise pollution in the area, a follow-up study is recommended to assess the long-term health implications of prolonged exposure. Sustainable and effective strategies must be developed to minimize public exposure to harmful pollutants and ensure the well-being of residents in Al-Abyar city.

Conflict of interest. Nil

References

1. Organization WH. WHO global air quality guidelines: particulate matter (PM2. 5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide: World Health Organization; 2021.
2. Agnew CT, Brimblecombe P. The Big Smoke: A History of Air Pollution in London since Medieval Times. Geographical Review. 1989;79(2):246.
3. Brook RD, Rajagopalan S, Pope CA, 3rd, Brook JR, Bhatnagar A, Diez-Roux AV, et al. Particulate matter air pollution and cardiovascular disease: An update to the scientific statement from the American Heart Association. Circulation. 2010;121(21):2331-78. doi: 10.1161/CIR.0b013e3181dbece1. PubMed PMID: 20458016.
4. Sinharay R, Gong J, Barratt B, Ohman-Strickland P, Ernst S, Kelly FJ, et al. Respiratory and cardiovascular responses to walking down a traffic-polluted road compared with walking in a traffic-free area in participants aged 60 years and older with chronic lung or heart disease and age-matched healthy controls: a randomised, crossover study. The Lancet. 2018;391(10118):339-49.
5. Mills IC, Atkinson RW, Kang S, Walton H, Anderson H. Quantitative systematic review of the associations between short-term exposure to nitrogen dioxide and mortality and hospital admissions. BMJ open. 2015;5(5):e006946.
6. Popescu LL, Popescu RS, Catalina T. Indoor Particle's Pollution in Bucharest, Romania. Toxics. 2022;10(12). doi: 10.3390/toxics10120757. PubMed PMID: 36548590; PubMed Central PMCID: PMC9786567.
7. Report. European Environment Agency. https://www.eea.europa.eu/publications/air-quality-in-europe2018 (2018). 2018
8. Anenberg SC, Achakulwisut P, Brauer M, Moran D, Apte JS, Henze DK. Particulate matter-attributable mortality and relationships with carbon dioxide in 250 urban areas worldwide. Scientific reports. 2019;9(1):11552. doi: 10.1038/s41598-019-48057-9. PubMed PMID: 31399636; PubMed Central PMCID: PMC6689059.
9. Mehrotra A, Shukla SP, Shukla A, Manar MK, Singh S, Mehrotra M. A comprehensive review of auditory and non-auditory effects of noise on human health. Noise and Health. 2024;26(121):59-69.
10. Natarajan N, Batts S, Stankovic KM. Noise-induced hearing loss. Journal of clinical medicine. 2023;12(6):2347.
11. Murali Krishna K. Air pollution and control (p. 307). Kakinada (AP), India: Kaushal & Co. 1995.
12. Fredianelli L, Bolognese M, Fidecaro F, Licitra G. Classification of Noise Sources for Port Area Noise Mapping. Environments. 2021;8(2):12. doi: 10.3390/environments8020012.
13. Berglund B, Lindvall T. Community noise: Center for Sensory Research, Stockholm University and Karolinska Institute; 1995.

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المستخلص

التلوث الناجم عن الأنشطة البشرية لا يزال يشكل مصدر قلق بيئي كبير .وتعد المحاجر لانتاج مواد البناء مثل أنواع مختلفة من الحصى وكربونات الكالسيوم من أبرز الأنشطة البشرية في مدينة الأبيار بمنطقة بنغازي في ليبيا. في هذه الدراسة، جمعنا بيانات تركيز الجسيمات(PM2.5و PM10) من 18 موقعًا على طول الطريق الدائري في وسط الأبيار في مدة ثلاثة أشهر (من يونيو إلى أغسطس) لتقييم جودة الهواء وعلاقتها بالظروف الجوية. وقد وجد أن متوسط تركيزات PM2.5 و PM10 أعلى بمقدار 4 إلى 5 مرات من مستويات إرشادات جودة الهواء على مدار 24 ساعة (AQG) التي حددتها منظمة الصحة العالمية (WHO) لملوثات الهواء. وجدت هذه الدراسة أن درجة الحرارة والرطوبة لم يكن لهما تأثير كبير على الجسيمات(PM) ، وتحديدًا PM2.5 وPM10، حيث ارتفعت درجة حرارة الهواء من 27.2 درجة مئوية إلى 44.9 درجة مئوية خلال فترة الدراسة. خلصت الدراسة إلى أن الأفراد الذين يقضون فترات طويلة في الهواء الطلق معرضون بشكل خاص للآثار الصحية الضارة لانبعاثات الغبار وحركة المرور الناتجة عن عمليات النقل البري المتعلقة باستخراج الصخور في الأبيار .وأخيرًا، كان متوسط مستويات الضوضاء في جميع المواقع في منطقة الدراسة أقل من الحد المسموح به لمنظمة الصحة العالمية والبالغ 90 ديسيبل .ونظرًا لمحدودية الأبحاث المتعلقة بالجسيمات الدقيقة (PM) والتلوث الضوضائي، نوصي بإجراء دراسة متابعة لتقييم الآثار الصحية للتعرض المطول لتلوث الهواء الخارجي في منطقة الدراسة .بالإضافة إلى ذلك، من الضروري تطبيق استراتيجيات فعالة ومستدامة للحد من التعرض .

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