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Assessment of Indoor Air Pollution by Suspended Micro plastic in Selected Sites of Mosul city

Rihab S. Al-Hussayni
College of Environmental Science and Technologies, University of Mosul, Mosul , Iraq

Kossay K. Al-Ahmady
President of the University of Mosul, Mosul, Iraq

Rasha Khalid Sabri mhemid
College of Environmental Science and Technologies, University of Mosul, Mosul , Iraq

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Abstract

Over the last few years, microplastics in indoor air have increasingly gained attention; however, the rates, shapes, and polymer types of MPs are rarely discussed. In this study, we investigated the abundance and characteristics of microplastic suspended in ninety indoor environments in Mosul City, Iraq, with three replicates at each site for six months. Kindergartens had the highest average MPs among sampling sites (20.2±1.7 MPs/ m^3), while the lowest average was in the medical clinics at about (2.7±0.8 MPs/ m^3). The majority of indoor suspended samples contained MPs in the form of fibers. In suspended samples collected from indoor environments, the colour of MPs was mainly transparent, followed by black, red, blue, green, and yellow. The main types of polymers identified were polystyrene (PS, 40%), polyethylene terephthalate (PET, 25%), polypropylene (PP, 15%), polyethylene (PE, 14%), polyamide (PA, 5%), and polyvinyl chloride (PVC, 1%). Among the most common MPs polymer types found in samples are PS, PET, and PP because they are used in various materials, such as fabrics, furniture, carpets, packaging, and synthetic fibers. The results were statistically analyzed using Excel 2019. Statistically significant differences were found between each site and the others, except between shops, hospital shops, and offices, as between pharmacies and medical clinics, which were not significant. The similarity in terms of population density, furniture, and the lack of carpets and curtains might explain the insignificant difference between these sites.

Keywords: Indoor air pollution; Microplastic; Polymer types; Suspended Particles; Stereomicroscope.

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تقييم تلوث الهواء الداخلي بواسطة الجسيمات البلاستيكية العالقة في مواقع مختارة من مدينة الموصل

رحاب صالح الحسيني
كلية علوم البيئة وتقناتها جامعة الموصل

قصي كمال الدين الاحمدي
رئيس جامعة الموصل

رشا خالد صبري محيمد
كلية علوم البيئة وتقناتها جامعة الموصل

المستخلص

على مدى السنوات القليلة الماضية، حظيت الجسيمات البلاستيكية الدقيقة الموجودة في الهواء الداخلي بإهتمام متزايد، ومع ذلك، نادرًا ما تتم مناقشة معدلات وأشكال وأنواع الجسيمات البلاستيكية الدقيقة. في هذه الدراسة، تمت دراسة وفرة وخصائص الجسيمات البلاستيكية العالقة في تسعين بيئة داخلية في مدينة الموصل-العراق، مع ثلاث مكررات في كل موقع لمدة ستة أشهر. أحتلت رياض الأطفال أعلى معدل للجسيمات البلاستيكية الدقيقة بين مواقع أخذ العينات (٢٠,٢±١,٧ جسيمة / م٣)، بينما كان أدنى معدل في العيادات الطبيأة حوالي (٢,٧±٠,٨ جسيمة / م٣). احتوت غالبية العينات العالقة في الأماكن المغلقة على جسيمات بلاستيكية دقيقة بشكل ألياف. في العينات العالقة التي تم جمعها من البيئات الداخلية، كان لون الجسيمات البلاستيكية الدقيقة شفافًا بشكل أساسي، يليه الأسود والأحمر والأزرق والأخضر والأصفر. أن الأنواع الرئيسية للبوليمر التي تم تحديدها هي البوليستيرين (PS, 40%)، بولي إيثيلين تيريفثاليت (PET, 25%)، بولي بروبيلين (PP, 15%)، بولي إيثيلين (PE, 14%)، بولي أمايد (PA, 5%)، والبولي فينيل كلوريد (PVC, 1%). من بين أنواع البلاستيك الأكثر شيوعًا الموجودة في العينات هي PS و PET و PP لأنها تستخدم في مواد مختلفة، مثل الأقمشة والأثاث والسجاد والتغليف والمنسوجات الاصطناعية. تم تحليل النتائج إحصائياً بإستخدام برنامج Excel 201. ووجدت فروق ذات قيمة معنوية بين كل موقع مع المواقع الأخرى بإستثناء المحلات, و المستشفيات, والمكاتب وأيضاً بين الصيدليات والعيادات الطبية، والتي لم تكن ذات قيمة معنوية. قد يفسر التشابه من حيث الكثافة السكانية والأثاث ونقص السجاد والستائر الاختلاف الضئيل بين هذه المواقع.

الكلمات المفتاحية: تلوث الهواء الداخلي، الجسيمات البلاستيكة، أنواع البوليمر، الجسيمات العالقة، المجهر التشريحي الضوئي.

1. Introduction

A microplastic is a synthetic solid particle or polymer matrix that is available in a variety of shapes and sizes between 1µm and 5mm in length [1]. MPs can be classified as either primary or secondary plastics; A primary microplastic is a particle of MPs that is deliberately manufactured (for example microbeads) for a particular application, secondary microplastics are formed by the fragmentation and degradation of the main microplastic, including the fibers from synthetic textiles [2]. In recent years, plastics have become a global concern [3]. As a result of their low cost, plastics are commonly used in a wide range of products, including food packaging, clothes, car parts, household goods, medical devices, personal care products, toys, and construction. [4],[5]. MPs are present in all ecosystem components [6]: soil, water, suspended particulates in the air, and all matrices of the environment [7], [8], [9]. Due to the increased use of carpets and other products containing plastic. They are found at high concentrations in indoor environments [10]. A vast majority of humans spend most of their time indoors, leading to increased exposure to MPs contamination through various sources such as settled dust and suspended dust [11], [3]. MPs concentrations are higher indoors than outdoors [3]. There is an interesting fact that microplastics created inside can end up polluting the environment outdoors. It is estimated that only 30% of the particulates generated outdoors can cross over into indoor environments [12]. Accordingly, indoor environments represent the primary source of exposure to airborne MPs [13]. The quality of air in indoor spaces plays an important role in human health [14]. Due to their ability to be inhaled by humans, MPs pose an ecological concern since they can cause localized inflammation [15], [16]. Health risks associated with airborne MPs are determined by their abundance, shape, size, and chemical composition [17]. Generally, fibers were reported as the most common form, followed by fragments [18], [19]. Recent research has shown that polyethylene (PE), polystyrene (PS), polypropylene (PP), polyvinyl chloride (PVC), and polyethylene terephthalate (PET) are common components [17], [18], [20]. In Mosul city-Iraq, no studies have been conducted on indoor microplastic pollution. Therefore, MPs quantification and characterization are crucial.

In this study MPs suspended in indoor environments were quantified and characterized at various sites, including (5 kindergartens, 6 mosques, 5 schools, 10 shops, 5 cafeterias, 6 hospitals, 25 dormitories, 7 barber salons, 6 offices, 5 scientific laboratories, 5 pharmacies, and 5 medical clinics). Stereo-microscope analysis of air samples from these sites was performed to determine their shape and colour, on the other hand, Fourier Transforms Infrared (FTIR) analysis was used to determine polymer type. Among the main objectives of this study were to present the first evidence of the presence of microplastics in various indoor environments in Mosul city. Finally, the abundance, shape, and type of polymer are evaluated, thus improving our understanding of microplastic properties in indoor environments.

2. Materials and Methods

2.1 Study Area

The study took place in Mosul city, Iraq's second-largest city by population and area. According to (Figure 1) 90 locations were sampled.

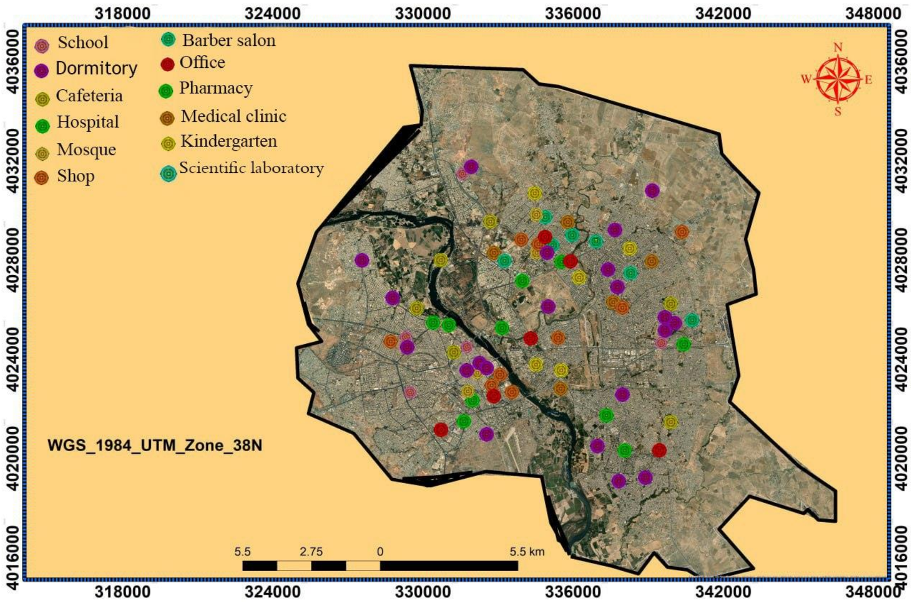

Figure 1. Sampling locations in Mosul City

2.2 Sampling Collection of Indoor Suspended Microplastics.

The suspended rate was calculated by counting MPs per cubic meter (21) from August 2022 to February 2023. 24 weeks were spent collecting indoor suspended MPs. According to the appendix Table (A-1), depicted the number of microplastics found in 90 locations with three replications (270 samples) in different buildings. A variety of environments were sampled in nearly identical conditions for each environment (without ventilation or further house cleaning). Three replicates of each site were collected on the same day to increase accuracy, and samples were collected for 10 minutes each time. There were no unusual activities at the locations during the sampling period. As a result, we gained data that was closer to the fact. Keeping all exterior doors and windows closed as well as not using air conditioning will minimize the maximum effect of air exchange.

Samples were taken directly through the device (vacuum pump volume 3.2 m^3/10 min), Figure 2 displayed the approach which is applied in this study. The filter (pore size of 0.45µm, size of 47mmØ) was placed directly on the device and turned on for 10 minutes. By using steel tongs, the filter was transferred to a glass petri dish for microplastic analysis. To determine the colour, number, and shape of MPs, a stereomicroscope (Motic2300S-V37-45X Zoom, Italy) was used. Whereas, FTIR spectroscopy (IRAffinity-1S, SHIMADUZ, Japan) was applied to characterize the composition (polymer type) of the representative MPs. The FTIR spectrum was captured in 3 seconds and ranged from 4000 cm^{-1} to 600 cm^{-}

[1]. Each measurement consisted of 15 scans. In transmittance mode, the spectral resolution was 4 cm^{-1}. Furthermore, the FTIR offers the performance Lab Solutions IR software.

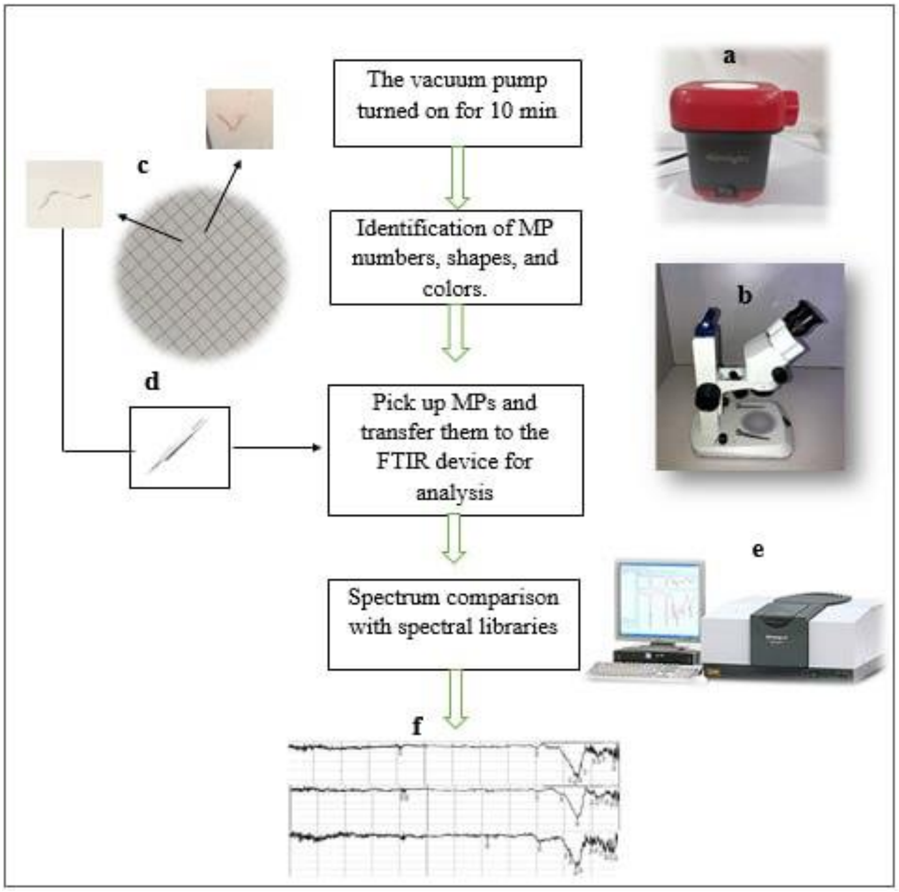

Figure 2. Schematic diagram illustrating this study's MPs analysis approach. (a) Vacuum pump, (b) Stereomicroscope, (c) microplastics choice from filters for analysis, (d) Forceps for picking up microplastics, (e) FTIR device for particle analysis to determine polymer type. (f) The spectrum is compared to the spectrum of a software library

2.3 Data Analysis

Microplastic abundance was measured for MP/m^3. The abundance of microplastics was calculated for each sample with triplicate using the mean and standard deviation. ANOVA single-factor analysis was performed using Microsoft Excel 2019 software. If the difference in the number of MPs between sites (ΔMPs) is more than the least significant difference (LSD) defined as a significant difference, while the ΔMPs are less than the LSD defined as an insignificant difference [22], The following equation calculates LSD.

$$LSD = t \propto \sqrt{((2MSE)/n)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

t: getting from t-distribution table
∝: probability level at 0.05

MSE: mean square within gotten from results of ANOVA table
n: number of notes.

3. Results and Discussion

3.1 Contamination Level of Microplastics Indoors.

During 24 weeks, we collected MPs from various indoor environments. Total MPs suspended were collected at 90 locations. The average suspended particles per cubic meter were as follows: (Figure 3) 20.2 ± 1.7 MP/m^3 of the kindergartens, 13.4±1.2 MP/m^3 of the mosques 12.1±2 MP/m^3 of schools, 11.3±0.9 MP/m^3 of shops, 10.6±101 MP/m^3 of the hospitals, 9.9±1.٢ MP/m^3 of offices 9.6±1.6 MP/m^3 of the dormitory, 7.7±1.4 MP/m^3 of the barber salons, 6.8±0.6 MP/m^3 of the cafeterias, 5.2±1.1 MP/m^3 of the scientific laboratories, 2.9±0.5 MP/m^3 of the pharmacies and 2.7±0.8 MP/m^3 of the medical clinics. There was a significant difference between each site and the other sites when at (ΔMPs > LSD); however, the difference between (shops, offices, and hospitals), and (pharmacies and medical clinics) was not significant. There are several factors responsible for these significant differences, including the carpets, curtains, furniture, and toys for children in kindergartens, as well as people's activities. There is some similarity between pharmacies and medical clinics in terms of furniture and lack of carpets and curtains, which makes the difference not significant, while hospitals, shops, and offices seem to have little difference as a result of the similarity in population density. Residents of Mosul use sunlight to dry their bedding, clothing, blankets, and pillows, which contributes to ambient MPs. Synthetic textiles are more likely to break down when exposed to sunlight frequently [23].

Kindergarten had the highest value because plastic materials are commonly used for toys, chairs, desks, boards, seats, etc. (10). Probably due to the large number of textile products available in mosques, mosque sites are also highly valued. Clinical laboratories, pharmacies, and medical clinics had lower MPs values than other indoor locations. Possibly, these environments are weak for plastic products. The total average of MPs in all sites of this study was 9.5± ٤،١ MP/m^3 in Mosul city, while in Denmark was 9.3 ± 5.8 MP/m^3 [24].

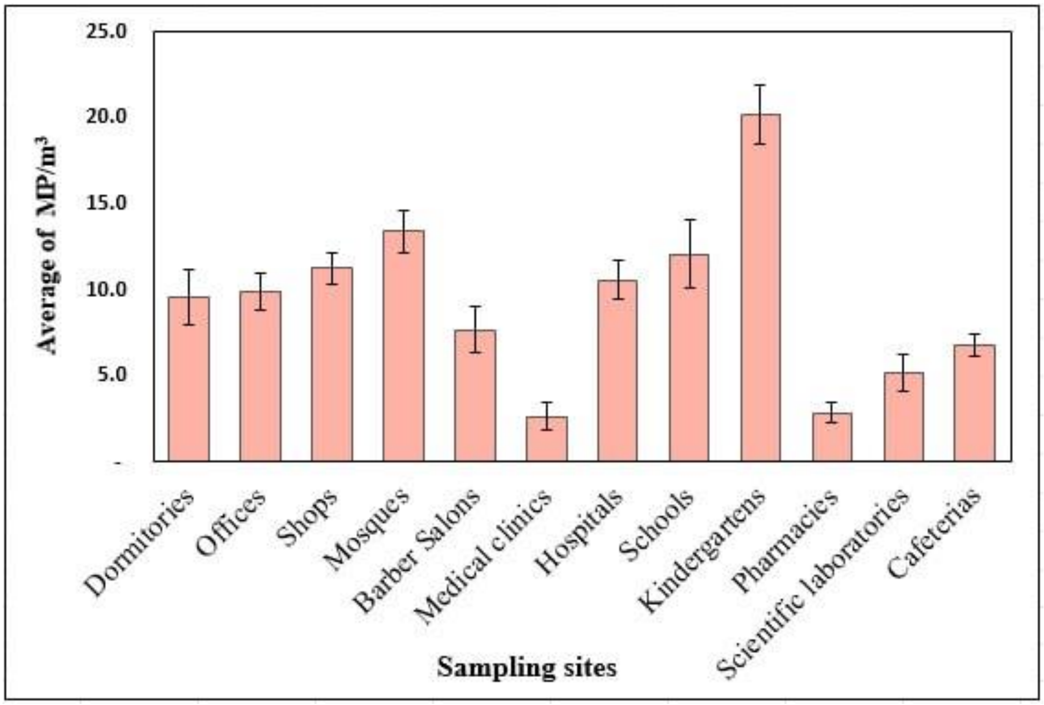

Figure 3. Average abundance of MPs in different sites

3.2. Microplastic Properties in Indoor Environments

3.2.1 Shape of Microplastic

In Figure 4, the shapes of microplastics in the environment are diverse between fibers and fragments. The MPs in this study were mainly fiber-shaped from different indoor environments as shown in Figure 5 about 97% and fragments only make up 3% of MPs. The large number of samples contained fibers, probably because Fibers are readily shed from clothing during wearing, washing, furnishings, synthetic tires, curtains, and carpets (25), (26). The results are similar to other atmospheric MPs studies, in which fibers (91%) and fragments (9%) (15). According to Vianello et al. 2019 (24), fibers are the main type of airborne in Denmark, whereas, the fragments were the second most dominant shape of MPs in indoor suspended samples. In German cities, fragments are the main type of airborne MPs (6). These particles may be derived from larger MPs that disintegrate during the use of cleaning products, furniture, and containers (27). Fibrous microplastics are presumably derived from the abrasion of textiles via washing machines (28). Fragments likely derive from thicker plastic products (29).

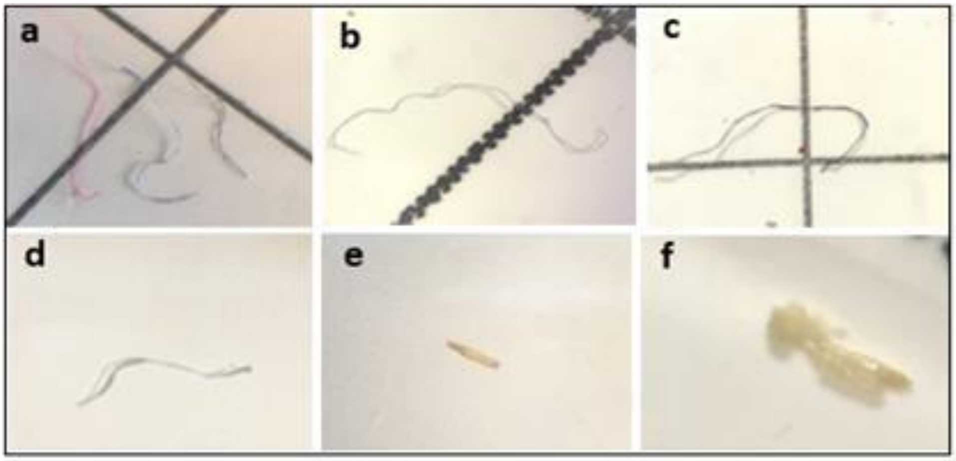

Figure 4. Images of microplastics, where (a), (b), (c), and (d) fibers, while (e) and (f) are fragments

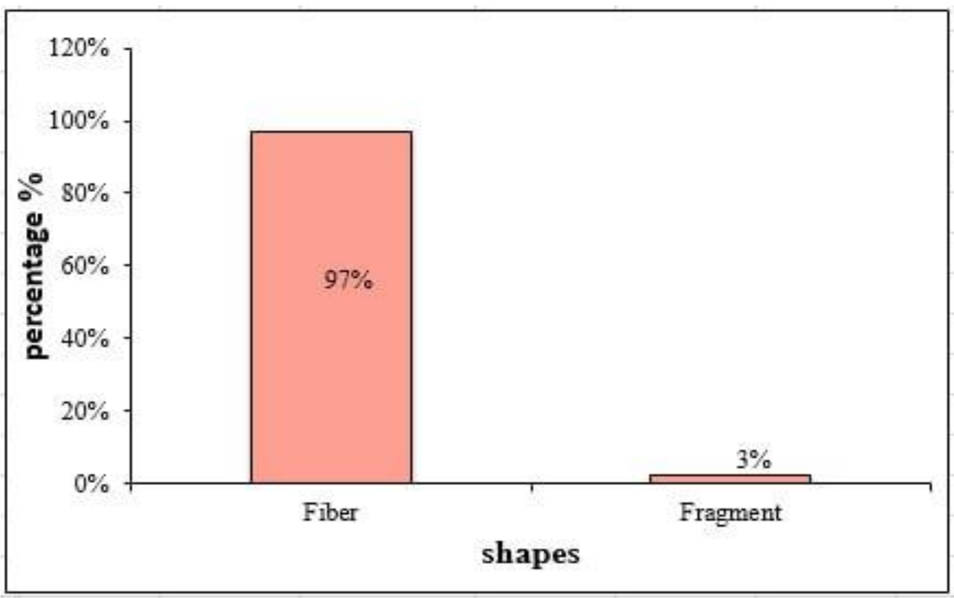

Figure 5. Percentage of MPs shapes of indoor

3.2.2 Colour of MPs in Indoor Samples

Microplastics are reported in a variety of colours. In Figure 6, transparent and black were the most dominant colours of MPs followed by red, blue, green, and yellow. Most packaging is made from transparent plastic bags, which may be the source of the transparent colour whereas the black is likely derived from black clothes, textiles, and building materials indoors [30].

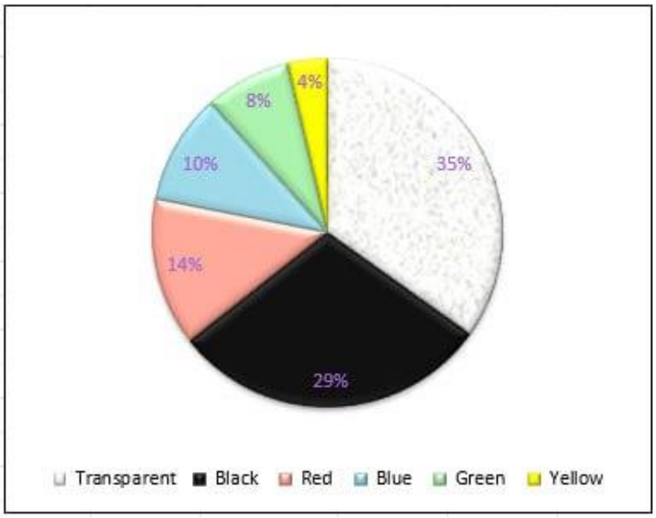

Figure 6. Percentage of MPs Colours

3.2.3 Types of Polymers

Identifying the origin of MPs is easy based on their composition. In other words, MPs with the same appearance can come from a variety of sources [(14).] This study demonstrated six types of synthetic or semisynthetic polymers using FTIR as follows; PS, PET, PE, PP, PA, and PVC. The most dominant polymers particles were (PS, 40%), (PET, 25%), (PE, 14%), (PP, 15%), (PA, 5%) and (PVC, approximately 1%) as shown in Table 1. PS is widely applied for thermal insulation and as packaging material in the fast food industry [(31), (18)]. PS is concentrated indoors due to the existence of people, furniture, and moquette products, and the proportion of PS grows with the increase in the carpeting of the indoor environment. The second most common polymer types found were PET and PE which are commonly used for food packaging (plastic bags and water bottles), in addition to that they are frequently used as construction materials (vapor barriers, window films, and flooring protection), but most notably as textiles (synthetic clothing, fleece sweaters, and blankets) [(32)]. On the other hand, PP are some of the most commonly produced plastic types and are also widely used as packaging materials [(29)].

Table 1. Polymer types percentage of microplastics in sampling sites

Buildings	Types of polymers						
	PE	PS	PET	PVC	PP	PA	other
Dormitories	11%	37%	23%	0%	9%	17%	3%
Offices	-	12%	53%	-	35%	-	-
Shops	10%	38%	33%	-	19%	-	-
Mosques	8%	50%	12%	-	31%	-	-
Barber Salon	14%	36%	27%	-	23%	-	-
Medical clinics	22%	59%	17%	-	3%	-	-
Hospitals	13%	52%	33%	-	2%	-	-
Schools	1%	14%	49%	-	23%	12%	-
Kindergartens	21%	45%	12%	-	17%	4%	-
Pharmacies	-	25%	45%	23%	-	8%	-
Scientific laboratories	24%	35%	12%	-	29%	-	-
Cafeterias	13%	50%	-	21%	17%	-	1%
Average	14%	40%	25%	1%	15%	5%	-

3.3 A Comparison of MPs Abundance and Characteristics in Indoor Suspended from Different Sites.

Microplastics have been assessed in indoor environments in a limited number of studies, and they were compared with this study by looking at the shape, abundance, colour, and polymer composition of MPs to understand the difference in MPs pollution between different countries based on the number of plastic materials that used. Moreover, it is necessary to compare the characteristics of atmospheric MPs with those of MPs found in other environments. As presented in Table 2. In previous studies, MPs in indoor environments were characterized by colour, shape, and polymer type. The abundance of MPs in indoor samples has highly valued variations: 1583 ± 1181 MP/m^3 were recorded in (Wenzhou, China), followed by 1–60 MP/m^3 (Paris, France) followed by 3.24 - 27.13 MP/m^3 (Kuwait), followed by 0.4 - 20.6 MP/m^3 (California, USA) and 9.3 ± 5.8 MP/m^3 (Aarhus, Denmark), and Comparatively, in this study, the abundance of MPs in indoor was 2.7 – 20.2 MP/m^3, detected in a variety of shapes, including fibers and fragments. In Denmark, California, Kuwait, and this study, fibers dominated the indoor samples, while in China, fragments dominated the indoor samples.

There were a variety of colours in the microplastics, but transparent, black, blue, green, grey, red, and yellow were the most prevalent. In some cases, plastic debris sources can be distinguished by their colour [27], [33], however, this can be misleading. The colours of identified MPs in several studies are reviewed in Table 2. Kuwait reported black, transparent, blue, red, and grey MPs [(15), (33)]. While, in this study, the most dominant colours were transparent, black, red, blue, green, and yellow.

Table 2.Comparison of MPs abundance and characteristics of indoor dust from different sites

Study area	Abundance (MP/m^3)	Dominant shape	Dominant colour	Dominant polymer composition	References
Aarhus, Denmark	9.3 ± 5.8	Fiber (13%) Fragment (87%)	NA	PES (81%), PE (6%), Nylon (5%), PP (2%), Other (6%)	(24)
California, USA	0.4 - 20.6	Fibers Fragments	NA	NA	(32)
Kuwait	3.24 - 27.13	Fibers (91%) Fragments (9%)	Black, transparent, blue, red, andgrey.	Polyester, nylon, polyamide	(15)
Paris, France	1–60	Fiber	NA	PP, PA	(34)
Wenzhou, China	1583 ± 1181	Fibers (10.4 %) Fragments (89.6%)	NA	Polyester (28.4%), polyamide (20.54%), Polyethylene (16.3%), polystyrene.	(17)
Mosul, Iraq	٢,٧ – ٢٠,٢	Fiber (97%) Fragment (3%)	Transparent, black, red, blue, green, and yellow.	PS (3٩%), PET (2٥%), PP (1٥%), PE (1٤%), PA (٥%) and PVC (١%).	This study

4. Conclusions

Microplastic pollution associated with human activities is affecting the entire world. In addition, there are no effective measures for disposing of this pollution. However, the study of MPs pollution is still in its infancy. This is the first report in Mosul-Iraq to demonstrate an abundance of suspension MPs in different indoor environments. Kindergartens had the highest concentration of MPs, followed by mosques, schools, shops, hospitals, offices, dormitories, barber shops, cafeterias, scientific laboratories, pharmacies, and medical clinics. Fiber shapes dominate most suspended samples. The MPs came in a variety of colours, including transparent, black, red, blue, green, and yellow. PS dominated mosques, kindergartens, shops, hospitals, dormitories, barber salons, cafeterias, scientific laboratories, and medical clinics, while PET dominated offices, pharmacies, and schools. In most cases, the difference between sites was significant ($\Delta MPs > LSD$); while the difference was little relationship between pharmacies and medical clinics because of similar furniture and a lack of carpets and curtains. Also, the difference was not significant between hospitals, shops, and offices because of the similar density of the population.

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Appendix:

Table (A-1): Depicted the number of microplastics for 270 samples in different buildings

Building type	Sample location	R^{x} particle/m٣	R^{xx} particle/m٣	R^{xxx} particle/m٣	Average particle/m٣	Site description
Dormitory	House 1	8.44	7.80	7.50	7.91	Bedroom
	House 2	6.56	6.20	5.30	6.02	Bedroom
	House 3	10.90	10.30	9.30	10.17	Bedroom
	House 4	10.90	9.90	9.60	10.13	Bedroom
	House 5	7.80	7.50	5.60	6.97	Bedroom
	House 6	8.75	7.80	6.20	7.58	Bedroom
	House 7	11.56	10.60	10.20	10.79	Kitchen
	House 8	11.25	10.60	5.00	8.95	Kitchen
	House 9	11.80	10.60	10.20	10.87	Kitchen
	House 10	11.25	10.00	9.68	10.31	Kitchen
	House 11	11.87	11.25	10.62	11.25	Living room
	House 12	11.50	11.25	10.00	10.92	Living room
	House 13	9.60	9.30	8.70	9.20	Living room
	House 14	9.68	8.75	9.30	9.24	Living room
	House 15	9.68	8.75	9.30	9.24	Living room
	House 16	11.87	11.20	10.00	11.02	Living room
	House 17	10.30	8.70	7.85	8.95	Living room
	House 18	11.56	10.00	9.68	10.41	Living room
	House 19	10.00	9.68	9.37	9.68	Living room
	House 20	11.56	10.00	9.68	10.41	Living room

	House 21	10.30	9.00	7.80	9.03	Corridor
	House 22	12.18	11.56	9.68	11.14	Corridor
	House 23	11.00	10.00	9.86	10.29	Corridor
	House 24	10.30	9.00	8.12	9.14	Corridor
	House 25	11.25	10.00	9.50	10.25	Corridor
Offices	Office 1	12.00	10.90	10.30	11.07	Inside office
	Office 2	10.93	10.00	٨,٥٠	13.43	Inside office
	Office 3	10.90	10.00	9.68	10.19	Inside office
	Office 4	10.30	9.00	8.12	9.14	Inside office
	Office 5	10.30	9.30	8.60	9.40	Inside office
	Office 6	11.00	10.30	8.50	9.93	Inside office
Shop	Shop 1	11.25	10.62	10.60	10.82	Inside shop
	Shop 2	12.20	11.56	11.25	11.67	Inside shop
	Shop 3	12.30	11.87	10.63	11.60	Inside shop
	Shop 4	13.43	11.90	11.50	12.28	Inside shop
	Shop 5	11.25	10.60	10.00	10.62	Inside shop
	shop 6	11.25	10.30	9.70	10.42	Inside shop
	shop 7	11.25	10.90	10.30	10.82	Inside shop
	shop 8	12.20	11.25	10.60	11.35	Inside shop

	shop 9	10.60	10.93	10.90	10.81	Inside shop
	shop 10	13.40	11.60	12.00	12.33	Inside shop
Mosques	Mosques 1	15.30	12.00	11.80	13.03	Inside Mosque
	Mosques 2	14.68	12.81	12.20	13.23	Inside Mosque
	Mosques 3	14.00	12.80	11.87	12.89	Inside Mosque
	Mosques 4	15.30	13.75	13.40	14.15	Inside Mosque
	Mosques 5	15.20	14.70	13.12	14.34	Inside Mosque
	Mosques 6	13.20	13.00	12.30	12.83	Inside Mosque
Barbra salon	Salon 1	6.50	5.93	7.50	6.64	Inside salon
	Salon 2	7.50	6.30	5.90	6.57	Inside salon
	Salon 3	9.37	8.43	8.30	8.70	Inside salon
	Salon 4	7.20	6.25	5.90	6.45	Inside salon
	Salon 5	10.30	9.50	9.68	9.83	Inside salon
	Salon 6	8.00	7.00	6.80	7.27	Inside salon
	Salon 7	9.00	8.50	8.00	8.50	Inside salon
Medical clinics	Clinic 1	4.30	3.75	2.80	3.62	Inside medical
	Clinic 2	3.00	2.80	2.50	2.77	Inside medical

	Clinic 3	5.00	4.50	3.00	4.17	Inside medical
	Clinic 4	3.00	2.50	2.50	2.67	Inside medical
	Clinic 5	3.12	2.80	2.55	2.82	Inside medical
Hospitals	Hospital 1	12.20	11.56	11.25	11.67	Emergency room
	Hospital 2	12.00	10.90	10.30	11.07	Emergency room
	Hospital 3	11.56	10.60	9.60	10.59	Emergency room
	Hospital 4	10.90	10.00	9.68	10.19	Corridor
	Hospital 5	12.50	10.62	8.82	10.65	Corridor
	Hospital 6	10.30	9.30	8.60	9.40	Corridor
Schools	School 1	12.80	12.50	18.60	14.63	Classroom
	School 2	12.18	10.90	11.56	11.55	Classroom
	School 3	11.87	11.87	10.90	11.55	Corridor
	School 4	11.56	11.25	10.60	11.14	Corridor
	School 5	13.40	11.25	10.30	11.65	Classroom
Kindergartens	Kindergarten1	22.80	20.30	19.30	20.80	Games hall
	Kindergarten 2	21.50	18.40	18.10	19.33	Games hall
	Kindergarten 3	23.10	19.30	18.75	20.38	Games hall
	Kindergarten 4	22.18	20.30	18.75	20.41	Corridor
	Kindergarten 5	22.50	19.60	18.75	20.28	Corridor
Pharmacies	Pharmacy 1	3.75	2.80	2.50	3.02	Inside pharmacy
	Pharmacy 2	3.40	2.80	2.50	2.90	Inside pharmacy

	Pharmacy 3	4.00	2.80	2.00	2.93	Inside pharmacy
	Pharmacy 4	3.12	3.12	2.50	2.91	Inside pharmacy
	Pharmacy 5	3.00	2.81	2.20	2.67	Inside pharmacy
Scientific laboratories	Laboratory 1	5.6	4.68	4	4.76	Inside Lab.
	Laboratory 2	5.9	4.68	4.3	4.96	Inside Lab.
	Laboratory 3	5.6	4.3	5	4.9	Inside Lab.
	Laboratory 4	4.6	4.68	4.3	4.5	Inside Lab.
	Laboratory 5	5.9	4.68	4.3	4.9	Inside Lab.
Cafeterias	Cafeteria 1	7.80	6.87	6.56	7.08	Inside cafeteria
	Cafeteria 2	6.87	6.56	5.93	6.45	Inside cafeteria
	Cafeteria 3	7.50	7.15	6.87	7.17	Inside cafeteria
	Cafeteria 4	6.87	5.90	6.56	6.44	Inside cafeteria
	Cafeteria 5	8.12	7.00	6.50	7.21	Inside cafeteria

R^{x}: First repeat, it is taken from the front of the site

R^{xx}: Second repeat, it is taken in the middle of the site.

R^{xxx}: Third repeat, it is taken at the end of the site.