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MICROPLASTICS IN WATER SAMPLES COLLECTED FROM URBAN FOUNTAINS

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A b s t r a c t

Publicly accessible urban fountains represent a largely overlooked component of urban water systems, despite their direct human and animal contact and potential role as indicators of local microplastic pollution. There is a lack of information on microplastic studies in publicly exposed fountains. Therefore, the aim of the study was to evaluate concentrations and composition of the aforementioned micropollutants in samples from several fountains in Polish (Gliwice, Rybnik) and German (Halle) cities with similar populations. The sources of microplastic occurrence in the fountains' water were also considered. It should be noted that, so far, microplastics have not been monitored in these places and remain an unidentified concern. Microplastic fractions were detected in each of the studied fountains; however, concentrations, composition, and fractions varied. The most dominant microplastic fraction present in fountain water samples tested was fibers, followed by micro pellets, fragments, and foils. The type of microplastics was not typical for the city but for individual fountains. PET, PA, PE, PP, and PS particles were identified in fountain water; however no dominant polymer could be confirmed. It was concluded that German fountain water contained fewer microplastics than water from Polish cities. The probable explanation is that fewer dust and soil particles were present on German pavements.

Keywords: microplastics, water contamination, source of contamination, public fountains

1. INTRODUCTION

Microplastics are contaminants present in most environmental elements, both natural and anthropogenically transformed. Microplastics are tiny (1 micrometer to 5 mm) pieces of various shapes of plastic, such as micro pellets, fragments, and fibers, which are common pollutants in the natural environment and urban areas. They are of primary or secondary origin (Nocoń et al. 2018).

The occurrence of microplastics in freshwater environments is regularly expanded and updated. Microplastics are common in surface waters such as rivers, lakes, and dam reservoirs, and their concentrations correlate with the degree of urbanization (Nocoń et al. 2018). The content of

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microplastics ranges from a few to several thousand pieces in 1 cubic meter. During rainfall, road dust and, with it, microplastics enter the combined sewer or storm sewer system and, from there, the sewage treatment plant or surface water. However, these micropollutants can also be transferred and deposited from the air. It was confirmed that microplastics are present in dust and soils (Niu et al. 2024).

Outdoor fountains, most often located in squares, plazas, or parks, feature a distinctive water mirror from which the water gushes upwards under pressure, and various sculptural forms from which it flows into the fountain basin. Occasionally, cascading runoff fountains are also found. Due to the prevailing climatic conditions, outdoor fountains in Poland usually operate from May to the end of September. Well-designed and technologically advanced fountains can make a city (facility) more attractive. As a result, designers are increasingly prioritizing not only their decorative function but also their originality and multiple uses. Modern society's expectations of fountains are not only to fulfill a decorative function, to function as a source of water used, among other things, to cool off, to create a specific microclimate, but also, more and more often, to provide an opportunity to watch water performances involving sound, light or interactive play with water, or even to have a bath on hot days (Małecka-Adamowicz et al. 2017).

Despite their many advantages, mainly aesthetic and decorative, fountains can pose certain risks to people. The fact that water from urban fountains is used by people (for soaking hands and feet, taking a bath) and by animals (fountains are also watering places, especially for birds, sometimes for dogs) directly affects the water's quality, especially in outdoor fountains. The cleanliness of the surroundings of the fountain (busy street, secluded place, park), the popularity of the place (more or less frequented), and the care of the fountains by the services responsible for their technical and sanitary conditions are also critical (Małecka-Adamowicz et al. 2017, Yang et al. 2024).

Many public fountains are available across the city and can be found near tourist attractions, parks, gardens, playgrounds, public transport, and markets. Microplastics have not often been monitored in fountains and have received less attention than in other sources (e.g., tap and treated water) (Yang et al. 2024; Shruti et al. 2020). The status of the shape, types, abundance, distribution, and morphologies of microplastics is poorly understood, as only a few studies have examined their presence in water samples from urban fountains.

When considering the sources of microplastics in fountains, several factors should be analyzed, including the levels of these micropollutants in tap water, atmospheric deposition, runoff, urban pollution, and various human activities. Tap water is often used as a source for fountain water. However, some treatment facilities and closed water cycles are in place, and concentrations of microplastics in tap water can serve as a background for assessing fountain water contamination by these plastic particles. Air deposition can be significant because microplastics present in the air can settle down and contaminate fountain water. Depending on the fountain's construction, runoff can reach the fountain water in areas highly contaminated with microplastics. Also, waste from human activities can pollute fountains, especially in areas with high activity (e.g., heavily traveled streets) (Małecka-Adamowicz et al. 2017, Yang et al. 2024).

Until now, studies on microplastic pollution in fountain water have not been widely conducted, as mentioned above. The researchers have obtained various results ranging from a few to hundreds of particles per liter. Data on pollution of fountain water were available, e.g., for some European Union countries. In France (Paris), in urban surface waters, including the ones from fountains, up to 240 particles per liter were observed. Most particles were of sizes smaller than 500 micrometers (Dris et al. 2016). Mainly, fibers and plastic fragments from urban runoffs were identified. Also, air deposition was identified as a significant source of microplastics. In Italy, microplastic origin identification revealed that polyethylene and polypropylene from plastic packaging were the dominant sources (Pivokonsky et al. 2018). In India, polystyrene and polyethylene terephthalate were identified as dominating types of microplastics. This study mainly focused on the water that supplies fountains, in which microplastic concentrations ranged from 4 to 10 particles per liter. The research done in Beijing (China) revealed concentrations of 12 to 75 particles per liter in the fountain water. Higher levels of pollution were observed in fountains near urban centers. Plastic packaging, air dust, and road traffic have been identified as sources of microplastics (Liu et al. 2019). Also, research in India found that degraded plastic packaging and plastic waste were essential sources of microplastics in urban fountains. Similar results were obtained when analyzing microplastic pollution in fountain water in urbanized areas of Chicago (USA). Microplastics were found in public fountains at concentrations ranging from 3 to 25 particles per liter (Mason et al. 2018). Research conducted in coastal areas, such as those in Lisbon region, found that fountains near the coast had higher levels of microplastic pollution than those farther from the coast, probably due to marine atmospheric fallout (Alvim et al. 2020).

Based on the results presented above, there is a need to collect data and investigate microplastic contamination in publicly accessible fountains to better understand the sources and levels of microplastics in their water.

The present study aimed to evaluate concentrations and types of these micropollutants in samples collected from several fountains in Polish (Gliwice, Rybnik) and German (Halle) cities with similar populations. Industrial activity and meteorological conditions in the regions studied may lead to spatial variations in microplastic pollution. Gliwice and Rybnik are situated in the more industrialized areas of Upper Silesia. Furthermore, the following adverse atmospheric conditions—frequent temperature inversions, limited vertical mixing and low wind speeds—may promote the accumulation of particulate matter in the air and intensify atmospheric deposition processes. Although Halle (Saale) has an industrial heritage, it is currently characterised by lower emission levels and more effective atmospheric mixing and ventilation. These factors contribute to a reduction in the accumulation of particulate matter in the air and, consequently, to lower deposition rates in the environment.

It should be noted that, so far, microplastics have not been monitored in these places and remain an unidentified concern.

2. DESCRIPTION OF THE STUDIED AREAS

A total of eight fountains were investigated: two in Gliwice (n = 6 samples), one in Rybnik (n = 3 samples), and five in Halle (n = 15 samples), with sampling conducted during three independent campaigns.

Gliwice is located in Silesian Voivodeship, the most urbanized region in Poland, and ranks 19th among Polish cities by both area and population. As the westernmost city of the Upper Silesian-Dąbrowa Basin, a metropolitan area with approximately 2.0 million inhabitants, Gliwice is the third-largest city in the conurbation and has over 169,000 permanent residents as of 2024.

Rybnik is a city in southern Poland, located in the Silesian voivodeship, approximately 45 kilometers southwest of Katowice, the regional capital, and is part of the Upper Silesian industrial area. Rybnik has a population of around 140,000 inhabitants. The city is part of the larger Upper Silesian metropolitan area, which has a population of over 5 million people.

Halle is the largest city in the German state of Saxony-Anhalt. It is the fifth-most populous city in the former East Germany, after (East) Berlin, Leipzig, Dresden, and Chemnitz, and the 31st-largest city in Germany, with around 244,000 inhabitants. Samples were collected from five fountains in the city center.

3. MATERIALS AND METHODS

Sampling was conducted during three independent campaigns (July 8, 15 and 25, 2024). Each time, water for analysis was collected approximately 2-3 hours before analyses were performed in the laboratory. Water samples were collected from the water jet of each fountain using a sampler into sterile 1000 mL glass containers. The sampled water was stored in a refrigerator at approximately 4°C until analysis. During each campaign, one water sample (1 L) was collected from each fountain, resulting in three samples per fountain.

In Gliwice, water samples for microplastic analysis were collected from two public fountains in the city center. Samples were collected from two fountains in the city center: one near the Municipal House in Gliwice (Fig. 1) and one in the area of Silesian Technical University (Fig. 2).

Fig. 1. Fountain in Gliwice close to Municipal House – Fountain I

Fig. 2. Fountain in Gliwice at the area of Silesian University of Technology – Fountain II

In Rybnik the samples were taken from the fountain located at the Market Square – Figure 3.

Fig. 3. Fountain at Rybnik city Market Square – Fountain III

In Halle (Germany) samples to be analyzed for microplastics were collected from 5 public fountains located in various parts of the city (Fig. 4 – 8).

Fig. 4. Fountain in Halle in the neighborhood of the tourist attractions – Fountain IV

Fig. 5. Fountain in Halle in the park – Fountain V

Fig. 6. Fountain in Halle in the technological center in Halle – Fountain VI

Fig. 7. Fountain in Halle in the main street close to traffic road – Fountain VII

Fig. 8. Fountain in Halle in the main street in the pedestrian center – Fountain VIII

All fountains were supplied with tap water. And despite the ones numbered as Fountain V, Fountain VI, and Fountain VIII were located in an area situated close to the traffic road. Fountain V was untypical because it was situated at the park center, with no traffic road around. It was also unusual because of its large area. Fountains VI and VIII were also situated not close to a traffic road, but were small fountains with no large water reservoir, making it easy for microplastics to deposit.

Microplastics analysis

Microplastic analysis was performed using a filtration–visual identification approach. Each water sample (1 L) was filtered under vacuum through a cellulose nitrate membrane filter (pore size 0.45 µm, diameter 47 mm; Whatman™ NC45 or equivalent), commonly used in microplastic studies of water and wastewater (Moraczewska-Majkut et al, 2025). Filtration was conducted immediately after sample collection to minimize particle loss or secondary contamination.

After filtration, the membranes were transferred to clean glass Petri dishes and covered to prevent airborne contamination. They were dried at room temperature. Microplastic particles on the filters were examined using an optical digital microscope (Keyence VHX series – Fig. 9) at magnifications from 50× to 500×.

Fig. 9. Keyence VHX digital microscope

Particles were visually identified and counted based on their morphological characteristics, such as shape, color, and surface structure. Microplastics were classified into four categories (fibers, fragments, pellets (microbeads), and foils). Fibers were the elongated, thread-like particles with a uniform thickness; fragments were irregularly shaped particles with sharp or uneven edges. Pellets (microbeads) were rounded or near-spherical particles, and foils were thin, flexible particles with flat surfaces. For each sample, all microplastic particles observed on the entire filter surface were counted, and the results were expressed as particles per liter of water (particles/L). To capture temporal variation and provide a more comprehensive assessment of microplastic abundance, each fountain was sampled during three independent sampling campaigns over time.

To reduce the risk of contamination, all glassware used during sampling and filtration was thoroughly rinsed with distilled water prior to use, and filters were handled with metal tweezers. Consistently, only glass or metal equipment was used throughout the analytical procedure. Furthermore, due to the exploratory nature of the study, polymer composition was not analyzed; therefore, the term “microplastics” refers to visually identified synthetic particles.

Polymer identification by FTIR

Visually identified microplastic particles were subjected to Fourier-transform infrared spectroscopy (FTIR) for polymer confirmation. Larger particles were analysed by ATR-FTIR, and smaller particles with µ-FTIR. Spectra were collected over the range of 4000–650 cm-1. Background spectra were recorded before each series. Polymers were identified by comparing spectra with spectral libraries and by manual inspection of absorption bands. Only spectra with acceptable quality and a satisfactory match were accepted. Quality control included procedural blanks, airborne contamination control, and the use of only metal and glass equipment. Characteristic FTIR peaks for the analysed polymers are listed in Table 1. The scheme of FTIR analysis is presented in Fig. 10.

Table 1. FTIR peaks for analyzed polymers

Polymer	Abbreviation	Characteristic FTIR peaks, cm^{-1}
Polyethylene	PE	~2915, 2848 (C-H), 1470, 730
Polypropylene	PP	~2950, 2917, 2838, 1455, 1375
Polyethylene tertrephtalate	PET	~1715 (C=O), 1240, 1100, 725
Polystyrene	PS	~1600, 1490, 1450, 700
Polyamide	PA	~3300 (N-H), 1630, 1540

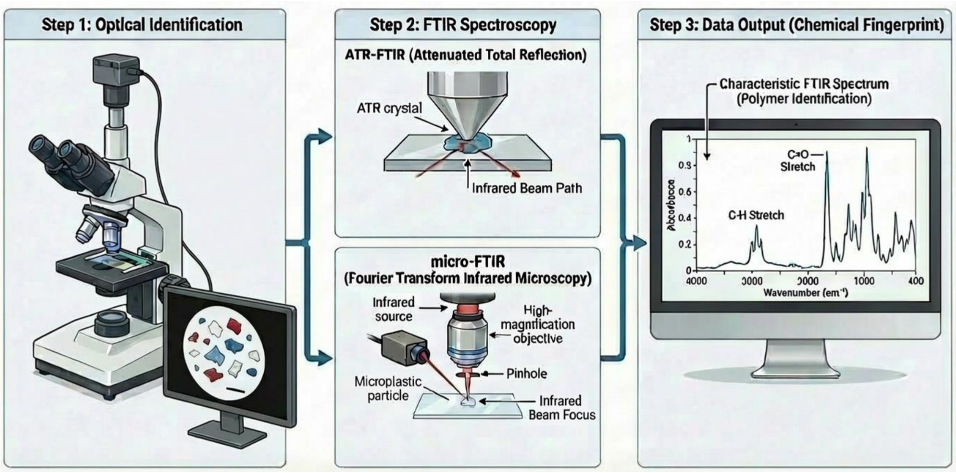

Fig. 10. FTIR analysis of microplastics in fountain water samples

4. RESULTS AND DISCUSSION

Microplastics were found in all taken samples. The results are summarized in Table 2.

Table 2. Concentrations of microplastics found in fountain water during the study

Fountain	Average content of microplastics particles/ L	SD
Fountain I	42	12
Fountain II	64	8
Fountain III	110	25
Fountain IV	25	5
Fountain V	5	2
Fountain VI	4	1
Fountain VII	21	13
Fountain VIII	14	4

The average concentration of microplastics in urban fountains in Poland ranged from 42 to 110 particles per 1 L. The most polluted microplastic water was found in Fountain III (Rybnik), and the least polluted was near the Municipal House in Gliwice. Water from the Silesian University of Technology fountain contained, on average, 64 particles per 1 L. The content of microplastics in all samples taken in Halle (Germany) was lower than in Poland and ranged from 4 to 25 particles per 1 L (on average). More contaminated water with microplastics was found in Fountain IV (25 particles/L) and Fountain VII (21 particles/L). These types of fountains have no reservoir, and the water falls directly onto the plate, which is not separated from the pavement. As a result, human activities likely contributed to the contamination of the fountain water with microplastics. Near Fountain IV, the kids' water playground was located, and during games, some microplastic particles were transferred into the water, possibly originating from clothing. Fountains without a separate water basin allow water to come into direct contact with paved surfaces. These fountains appear particularly susceptible to microplastic transfer from surrounding materials. Pavement dust, footwear abrasion, degraded synthetic materials, and resuspension from pedestrian movement may all increase microplastic loads in such systems. Similar mechanisms have also been reported for urban runoff and splash zones in stormwater-impacted environments (Alvim et al. 2020).

Types of polymers found in the fountain waters are summarized in Table 3. They were PET, PA, PE, PP, and PS. The distribution of plastic types differed between individual fountains. It indicated that both local sources and environmental conditions influenced the composition of microplastics. This was confirmed by the shapes of the microplastic particles observed in fountains – Fig. 11. Fibers were present in all fountains and were dominant (Fountains II – VIII) or a significant fraction (Fountain I). It suggests that atmospheric deposition and textile-derived particles could be an important fraction of microplastics in fountains.

Table 3. Chemical characteristics of microplastics found in individual fountains during the study

Fountain	Polymer type	Likely source
Fountain I	PET, PA, PE, PP	atmospheric deposition, textiles, local human activity
Fountain II	PET, PA, PE, PP, PS	atmospheric deposition, urban dust, infrastructure
Fountain III	PET, PA, PE, PP, PS	human activity, urban runoff, plastic waste
Fountain IV	PET, PA, PE, PP	clothing abrasion, playground materials, runoff
Fountain V	PET, PA	atmospheric deposition
Fountain VI	PET, PA	atmospheric deposition, tap water
Fountain VII	PET, PA, PE, PP, PS	road dust, tire wear, urban runoff
Fountain VIII	PET, PA, PE, PP	human activity, textiles, urban dust

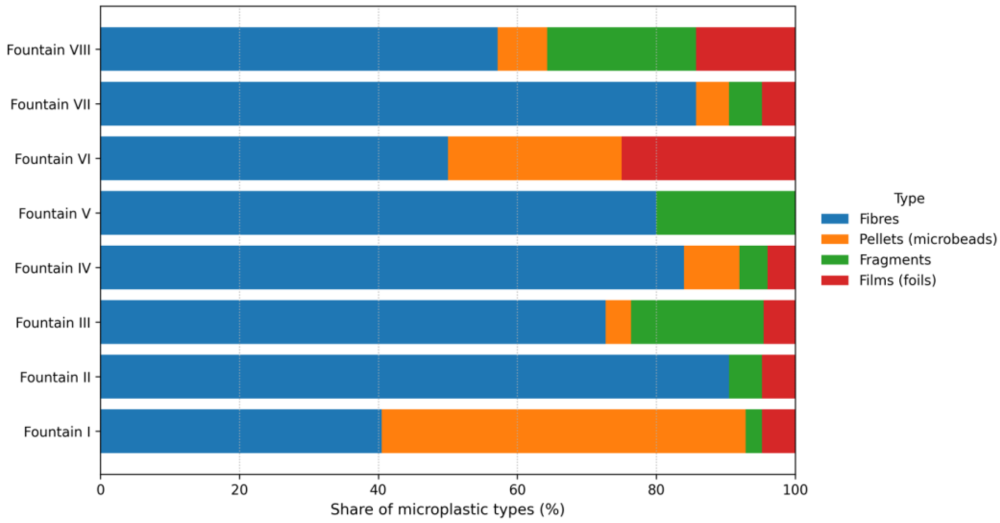

Fig. 11. Percent shares (%) calculated from average particle counts (particles/L) for each fountain

The fibers were mostly composed of PET and PA – Figure 12. Fragments were more common in fountains located near the roads, pedestrian zones, and paved areas. It suggests degradation of plastic packaging and urban materials as an important source of microplastics. These particles were typically composed of PE, PP, and PS (Figure 12). In selected fountains, micropellets were observed. They were particularly typical in areas with intensive human activity. These particles were mainly composed of PE or PP. They could, e.g., originate from degraded plastic materials or pellets. Foils were the least frequent type of microplastics in fountain waters. They were typically PE films, and they probably originated from plastic bags or packaging materials. The differences in microplastic morphology between the fountains confirm that urban fountains can act as reservoirs of microplastics and depend on fountain construction, human activity, traffic, road conditions, and atmospheric deposition.

All fountains probably also contained some microplastics from tap water delivered to the fountain mechanism. According to the authors, the phenomenon that the content of microplastics in fountain water in Poland was higher than in water samples taken from Halle was connected with the fact that in the German city of Halle, the pavements were cleaned more often than in Poland, and no dust was observed on pavements and roads near the sampling places.

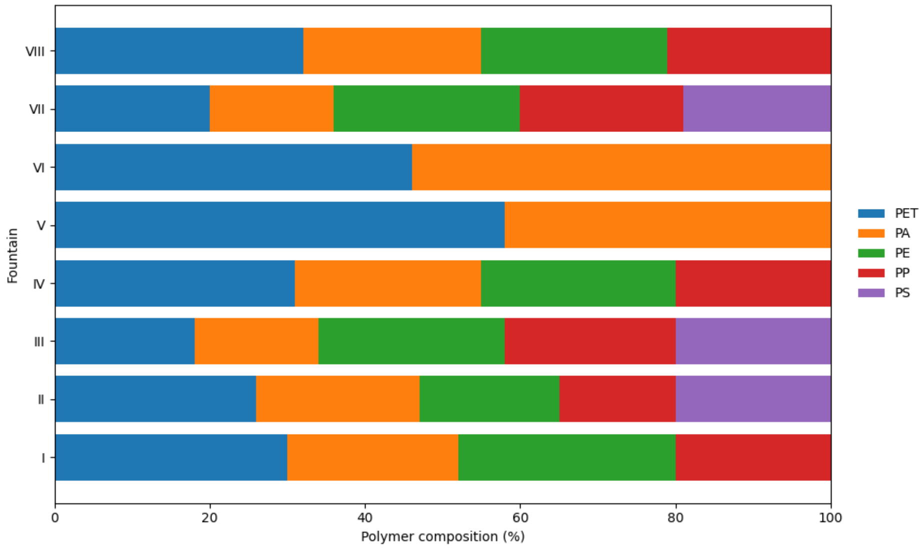

Fig. 12. Microplastics composition in fountain water

The presence of particulate matter in fountain water stems from a combination of local anthropogenic pollution and the deposition of particles from the air. In the former studies according to Dris et al., 2016; Brahney et al., 2020 it was shown that microplastics and other fine particles can be transported through the atmosphere and deposited in urban environments. Therefore, urban fountains can act as passive collectors of such particles, integrating pollutants from both the air and water systems. In most industrialized regions, such as Gliwice and Rybnik, increased emissions from road traffic, coal-based energy production and industrial activity may contribute to elevated concentrations of particulate matter in the air. These effects may be further exacerbated by meteorological conditions, in particular frequent temperature inversions and reduced wind speeds, which limit the dispersion of pollutants and favor local particle deposition. On the other hand, in Halle (Saale), which is characterized by lower industrial activity and more effective atmospheric mixing, there may be a relatively lower accumulation of particles. It should be pointed out, that the filtration-based method used allows for the quantitative determination of particles in water samples without distinguishing between atmospheric deposition and other sources, such as water supply systems, infrastructure wear and tear, or the direct impact of human activity. This limitation is indicated in microplastics research (Hidalgo-Ruz et al., 2012). Thus, the observed differences between the study sites should be interpreted as an indicator of the combined impact of environmental factors, rather than as direct measurements of airborne particulate matter levels. The differences among individual fountains indicate that microplastic contamination in fountain water is not solely due to city-scale factors. Local conditions also play a strong role. Even within the same city, considerable variability among fountains was visible as a result of different designs, surrounding surfaces, and patterns of use. This confirms that urban fountains act as highly localized receptors of microplastic inputs, rather than as homogeneous elements of the urban water system. .

Concentrations of microplastics in fountain water obtained during our study were comparable in terms of concentration and probable origin to those reported by other authors worldwide – Table 4.

Table 4. Average contents and origins of microplastics in water samples from fountains obtained by other authors

Place (city/ country)	Microplastic content, particles/ L	Microplastic type	Hypothesized source of the pollutants	Reference
Paris, France	50 - 240	fibers, fragments	atmospheric deposition, urban dust, wastes	(Dris et al. 2016)
Barcelona, Spain	40 - 80	fibers, fragments	atmospheric deposition, wastes	(Alvim et al. 2020)
New York, USA	10 - 50	fibers, fragments	urban dust, wastes, traffic road	(Mason et al. 2018)
Los Angeles, USA	5 - 35	fibers, fragments	atmospheric deposition, urban dust	
Beijing, China	12 - 75	polyethylene, polypropylene	atmospheric deposition, urban dust, industry	(Liu et al. 2019)
Delhi, India	5 - 15	polystyrene, polyethylene terephthalate	atmospheric deposition, urban dust	(Alvim et al. 2020)
Sydney, Australia	2 - 35	fibers, fragments	atmospheric deposition, traffic road	(Brahney et al. 2010)

In order to evaluate atmospheric deposition of microplastic the data summarized in Table 5 could be useful.

Table 5. Average contents of microplastics in urban air

Place (city/ country)	Microplastic content, particles/ m^3	Microplastic type	Hypothesized source of the pollutants	Reference
Paris/ France	0.3 – 1.5	synthetic fibers, fragment	textile fibers, traffic pollution, industrial emissions	(Dris et al. 2016)
London/UK	0.2 – 0.9	fibers (polyester, acrylic), dust	clothing abrasion, road dust, construction	(Wright et al. 2020)
Barcelona/ Spain	0.15 – 1.1	polyester, polystyrene, PVC	fibers from fabrics, marine aerosol deposition	(Alvim et al. 2020)
Shanghai/ China	0.4 – 2.0	PET, polypropylene (PP), polystyrene	industrial emissions, urban waste, transportation	(Liu et al. 2016)
Delhi, India	0.5 – 2.3	PE, PP, textile fibers	roadside dust, burning plastic waste, industrial pollution	(Alvim et al. 2020)

As shown in Table 4, the data indicate that air pollution was higher in large Asian metropolises such as Delhi and Shanghai. In Europe, the pollution level was 0.15 – 1.5 particles/m^3. However, these data did not correlate with fountain water pollution. E.g., in Paris, maximum levels of fountain water pollution were observed, whereas air contamination was not visible. It indicates that air deposition can be an essential source of microplastic pollution, but other factors are also important, such as contamination of tap water in the individual cities – Table 5, Table 6. Based on the presented data, it is evident that tap water can be a significant source of microplastics in fountain water samples. If we analyze the types of microplastics in fountain water during our study (Figure 11), we conclude that some microbeads and fibers found in fountain water may be of tap water origin.

Table 6. Content range of microplastics in tap water worldwide

Place (city/ country)	Microplastic content, particles/ L	Microplastic type	Reference
New York/ USA	5.2 – 15.5	PET, polypropylene (PP), nylon	(Mason et al. 2018)
Moscow/ Russia	1.8 – 8.0	nylon, PET, synthetic fibers	(Bagaev et al 2019)
Tokyo/ Japan	0.9 – 6.5	polyester, polystyrene, nylon	(Kataoka et al 2019)
Cairo/Egypt	4.8 – 18.6	PVC, PP, synthetic fibers	(Mohamed et al. 2022)
São Paulo, Brazil	7.2 – 22.5	PP, PVC, PET, synthetic rubber	Rocha-Santos 2021)
Cape Town, South Africa	2.0 – 9.8	PE, PET, polystyrene	(Nel et al. 2020)
New Delhi, India	10.0 – 25.8	polystyrene (PS), PVC, textile fibers	(Tyagi et al. 2021)
Barcelona, Spain	2.2 – 9.3	polyester, microbeads, PVC	(Alvim et al. 2020)
Vienna, Austria	0.3 – 2.8	polyethylene (PE), PP	(Alvim et al. 2020)
Warsaw, Poland	2.0 – 7.5	polyester, PVC, textile fibers	(Alvim et al. 2020)
Krakow, Poland	1.8 – 6.2	nylon, microbeads	(Alvim et al. 2020)
Rome, Italy	1.0 – 4.5	polypropylene, Polyester	(Alvim et al. 2020)
Belgrade, Serbia	1.6 – 6.8	PET, synthetic fibers, PVC	(Alvim et al. 2020)

Exemplary microplastics found in fountain water are shown in Fig. 13. Our study confirmed that fibers were the dominant type of microplastics in fountain waters. Fiber-shaped microplastics were present in all investigated fountains. This may be because fibers are efficiently trapped by small water bodies. They are likely transported over long distances by air and precipitation. The prevalence of fibers highlights that atmospheric deposition and clothing abrasion are also key pathways for microplastics entering fountain waters. Other types of microplastics, such as beads or capsules, foils, and fragments, were also found in fountains in varying amounts. An unusual case was noted in Fountain I, where plastic beads were abundant. This is likely related to nearby markets or human activities that contribute to this type of plastic contamination. The results show that pellets and fragments exhibit greater spatial variability. It suggests local and episodic sources. Their higher levels in individual fountains indicate direct input from human presence, recreational use, and infrastructure contact, rather than widespread atmospheric transport.

Fig. 13. Exemplary microplastics present in fountain water

Fragments observed in water could result from leaching from pipes, water supply infrastructure, and human activity. Foils were probably affected by the defragmentation of plastic wastes such as foils. Human activity-sourced microplastics were dominant in water samples from fountains with no water reservoir, at levels higher than the pavement level.

The results show that microplastic contamination in fountain water comes from various pathways. Background inputs from tap water and atmospheric deposition set a baseline level. Site-specific factors, such as fountain design, nearby land use, and the amount of human activity, further influence the final microplastic load and composition. This combination of sources explains the differences found between cities and even between fountains in the same area.

5. CONCLUSIONS

The study confirms the common presence of microplastics in water from urban fountains at all the locations studied, confirming that these systems act as receptacles for diffuse urban pollution. However, the results clearly indicate variability specific to individual locations in abundance and composition which should be interpreted primarily in the context of local environmental conditions rather than global trends. A significant difference in microplastic concentrations was observed between the analyzed countries. In Polish cities, concentrations ranged from 42 to 110 particles per liter, whereas in German cities they were markedly lower (4–25 particles per liter). Given that sampling and analytical procedures were consistent, these differences can be attributed to local-scale factors, including urban maintenance practices, surrounding infrastructure, and intensity of anthropogenic activity. This interpretation is supported by the observed relationship between higher microplastic abundance and locations characterized by increased pedestrian traffic and proximity to paved or recreational areas.

In all examined fountains, the most frequently observed type of microplastic was fibers, followed by pellets, fragments, and foils. The results indicate that clothing, airborne deposition, and precipitation are important primary sources of microplastics in urban water systems. PET, PE, PS and PP were found in fountain water, however no single dominant polymer could be indicated.

The study highlights the role of site-specific sources, such as synthetic clothing and litter, appear to be responsible for observations of pellets and fragments. They seem to be especially important in fountains directly connected to pavements or recreational areas (e.g., Fountain IV). The results demonstrate that factors such as fountain design, surrounding land use, and human traffic intensity are important in controlling microplastic abundance and composition.

While literature data compiled for larger urban systems (e.g., megacities) provide a useful background, direct comparison should be treated with caution. Differences in urban scale, population density, pollution sources, and environmental management practices limit the transferability of such data to smaller urban systems. Therefore, the present study contributes site-relevant insights that complement, rather than directly replicate, existing datasets. Urban fountains are well accessible, have continuous water exchange, and are directly exposed to local environmental conditions. Because of these, they can be considered as potential indicators of microplastic pollution at specific sites. Yet, fountains remain an understudied part of the urban water environment. Further studies are, however, necessary to provide long-term monitoring and wider-area studies incorporating standardized methodologies across cities and integration with analyses of atmospheric pollution and surface runoff. Overall, this study provides new evidence that microplastic pollution in urban environments is strongly dependent on local conditions, highlighting the need to develop location-specific management strategies and further research into microplastic transport pathways and human exposure in urban environments.

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