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The presence of microplastics in air environment and their potential impacts on health

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Abstract

There have been many literature reviews on the presence of MPs in water, but study on the presence of MPs in the air and literature reviews on it have not been done much. study on MPs pollution needs to be collected and summarized into one literature review so that this information is easy to find and not scattered. The results found 16 research articles discussed the findings of MPs in ambient air. The 16 research articles found MPs pollution in each location with different levels, the form of MPs in the air that they found the most was fiber because the fiber was lighter in size compared to other MPs shape like fragment, film, or granule. fiber small surface area and thin shape similar like a thread make it easy to be carried by the wind in the air. it turns out that there are 3 main pathways of how MPs enter the human body. the first is by respiration because MPs have been proven to pollute the air human breath, and this supported by a recent study that found MPs in human lungs, a total of 39 MPs were identified within 11 of the 13 human lung tissue samples. the second way is through consumption, because humans consume a lot of seafood that lives in the sea that is contaminated with MPs. MPs are also found in bottled drinking water, fruit, milk, honey, almost all food and beverages consumed polluted by MPs.

Keywords :
Air pollution, plastic pollution, microplastics

1 Introduction

How long the plastic aerosol stays in the air is not exactly known. However, it is estimated that the length of stay of plastic aerosol in the atmosphere is from 1 hour to 156 hours depending on the particle size (Brahney et al., 2021). Plastic can cross the major ocean or the continents either in one trip or by re-suspension over the ocean under the right environment conditions in just a few days (Stohl et al., 2002). The largest contributor to MPs deposition in the Western United States comes from traffic process dust on the road by 84%, besides that, ocean emissions contributing 11% of plastic deposition, dust from agricultural fields also contributes 5% of plastic deposition that carried into the atmosphere (Brahney et al., 2021).

MPs in the air are not the only sourced from traffic processes, ocean emissions, or agricultural field, but also from Artificial Turf Pitches (ATP). The ATP used widely across Europe are a significant source of MPs pollution in the atmosphere. In Europe it is estimated that total ATP is 51616, with an installed area of 112 million m^2 (Hann et al., 2018). Rubber granules that made from used tires are the infill of this ATP. Rubber granules are MPs that are complained about, because it is almost inevitable that they are released into the environment when playing soccer (Hann et al., 2018).

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Previous estimates of MPs released ranged from 50 kg to 1 metric ton per year, the number of MPs released in the air depends on the weight of the fiber or granules used in ATP, possibly increasing with age in the field. 18000 to 72000 tons of granules escape from ATP throughout Europe every year. On the other hand, annually more than 70 kg of granule particles are found in the ATP environment in the Netherlands. The physical, chemical, and microbial reactions with plastic produce an ever-increasing number of MPs in the environment, such as larger plastics straggle in the environment that continue degraded into MPs (Andrady, 2011; Wang et al., 2016). Based on observation, the degradation level of plastic pellets in the air environment was significantly higher than in the solution environments (simulated seawater and ultrapure water) which may be related to the exposure level of oxygen in the environment (Cai et al., 2018). Photo degradation is recognized as the most important process initiating plastic degradation in the environment. Photo degradation of plastics usually involves free radical mediated reactions initiated by solar irradiation that is high energy ultraviolet (UV) irradiation UV-B (290–315 nm) and medium energy UV-A (315–400 nm) (Liu et al., 2019a). Plastics can undergo thermo-oxidative reactions at high temperature, when sufficient heat is absorbed by the polymer to overcome the energy barrier, the long polymer chains can be broken generating new MPs particle (Peterson et al., 2001; Pirsaheb et al., 2020), and this degradation is called Thermal degradation. 50-500 µm is the particle size of MPs that fall after degradation in the air. After one month of UV irradiation of the plastic pellets, MPs appeared in the form of fragments, longer after two months of UV irradiation, MPs appeared to form granules on the surface of the PE pellets (Cai et al., 2018). This paper reviews the presence of microplastics in air environment and their potential impacts on health.

2 MPs sources in the ambient air

According to the results of early studies, MPs were identified moving from cities to rivers, rivers to seas, and recent atmospheric transport studies identified MPs across the terrestrial environment and out to sea (Allen et al., 2019; Klein and Fischer, 2019; Liu et al., 2019b; Wang et al., 2020). Once MPs arrive in the marine environment, winds and global ocean currents can spread them around the world (Derraik, 2002; Thompson et al., 2009), and there is a good understanding of how ocean currents move MPs, and how wind causes MPs accumulate in the center of the ocean (Van Sebille et al., 2016). Using four onshore wind samples as a representation of the MPs indicator blown on onshore. Allen et al. (2020) found onshore air masses giving out approximately (2.96 MP/m^3) 0.024 g/m^3 (on foggy days the air mass contains (19.38 MP/m^3) 0.159 g/m^3). If 50% of the 536000 km long coastline of the world has onshore winds then 135,995 tons/year of MP can be blown ashore globally to onshore, until it ends up as a terrestrial deposit or has the potential to be blown back into the ocean and deposited offshore. If other studies were conducted in more polluted or heavily polluted water bodies then this figure could be much higher, because this study was conducted in the Gulf of Gascoyne Australia which is a medium polluted water body. This calculation estimate includes an assumption that the MPs found in the onshore wind samples are of marine origin. These early findings provide early evidence to support MPs exchange between oceans to atmosphere. (Allen et al., 2020).

Another source that contributes MPs in the air is from the landfills. MPs were found in all 12 leachate samples from active landfill and closed landfill. A total of 621 items of MPs were identified using FTIR from leachate samples. The 12 samples had different concentrations between samples, ranging from 0.42 particles/L to 24.58 particles/L (He et al., 2019). This study conducted in six landfills from four cities, namely Shanghai, Wuxi, Suzhou, and Changzhou China. From each point a 24 L sample of leachate was collected in a PE bucket, then sealed and brought to the laboratory for the following study. Supporting the previous found, Su et al. (2019) do the similar study to identify MPs in leachate and waste samples. The study was obtained in Laogang landfill located in the eastern region of Shanghai, China. This landfill receives about 12,000 tons of municipal waste per day. As a result MPs were found in all leachate samples and waste residues, the abundance of MPs extracted from leachate ranged from 4 to 13 particles/L, while in waste residues samples, the abundance of MPs was in the range of 20-91 items/g (Su et al., 2019).

Another MPs source in the air come from Bottom ash and fly ash from solid waste incineration, as the study from Shen et al. (2021) that conducted in Municipal Solid Waste incineration plant in Changsha, China. Samples were taken using a stainless-steel trowel, and the results found Macroplastic (> 5 mm) and MPs (< 5 mm) were detected in all samples, and the highest number of MPs was found in bottom ash. The total content of plastic particles in bottom ash, fly ash, and soil was measured at 187 ± 15 items/kg in bottom ash, 24 ± 5 items/kg in fly ash, and 94 ± 12 items/kg in soil (Shen et al., 2021). Another study found that the abundance of MPs during storm events was 40 times more abundant than in a normal conditions, so that the abundance of MPs was positively related to antecedent rainfall or successive rain events measured from before the critical rain event to the beginning of the rain, and storm events may be important moments for MPs contamination in the air (Hitchcock, 2020). As a country that is crossed by the equator line, Indonesia is a tropical country that has quite high rainfall. The average rainfall system in Indonesia ranges from 2000-3000 mm per year. It seems that MPs study in Indonesia will find a lot of MPs particles in every sample of the atmosphere study.

3 Distribution of the presence of MPs in the ambient air

In 2019, observations of MPs outdoor air in the rural area south of Hamburg, Germany were carried out. The study found 275 MPs /m^2/day particles, with various MPs sizes found including >300 m, 300–63 m and <63 m. The MPs were found in the form of fragments and fibers, after further investigation turned out that the type of polymer MPs were polyethylene/ethyl vinyl acetate and polyethylene (Klein and Fischer, 2019). In the same year in the city of Asaluyeh, Iran an outdoor study of the distribution of MPs and Microruber (MRs) in the air has been carried out. Studyers found 900 MPs and 250 (MRs) particle per 15 gram of sample street dust. The MPs and MRs are <100 to >1000 m in size, in the form of fibers, films, and fragments, but this study did not examine the polymeric materials of MPs (Abbasi et al., 2019). In the different location, study about the presence of MPs is conducted in Pristine Mountain, Forni Glacier, Stelvio National Park, Central Italian Alps Italy, and found 249 fragments, 73 films and 44 fibers /m^2/day by 2019. This study of outdoor MPs found fibers up to 750 µm long and fragments 300 µm as MPs (Ambrosini et al., 2019).

In year 2020, some study about MPs distribution in the air was carried out. Indoor (58.6 ± 55 µm) and outdoor (104.8 ± 64.9 µm) are the sizes of MPs that found in California. The study found (3.3 ± 2.9 fibers and 12.6 ± 8.0 fragments m^{-3}; m ± SD) (0.6 ± 0.6 fibers and 5.6 ± 3.2 fragments m^{-3}), from the form of fragments and fibers it turns out that the polymer types are polyethylene, polystyrene, and polyethylene terephthalate (Gaston et al., 2020). While in different location, in Aveiro Portugal, a study of MPs in outdoor air was carried out, the study reported (8.5% vs. 4.1%, n = 6) MPs particles. The size of the MPs found was <10 mm, the shape of the MPs found were fragments and fibers (Prata et al., 2020a). A year later, MPs in the form of fragments and fibers with polymer types of indoor polyester, polyamide, polypropylene and outdoor polyethylene, polystyrene, polyester were found in Wenzhou City, China. The study conducted indoor and outdoor found as much as (1583 ± 1181 n/m^3, n=39) in indoor air, and (189 ± 85 n/m^3, n=63) in outdoor air, (224 ± 70 n/m^3, n =45) in urban sites (P<0.01), (101 ± 47 n/m^3, n=18) (P<0.01) in rural sites. The shape of MPs found was smaller than 100 µm (Liao et al., 2021).

In early 2021, MPs distribution in indoor Yorkshire region, U.K., found as much as 3061 particles/7 d. These MPs particles measured 5–250 m in the form of MPs found there are fragments and fibers, types of polymers found such as Polyethylene terephthalate (PET), polyamide (PA) and polypropylene (Jenner et al., 2021). In the different location MPs that conducted indoors in Sydney Australia, found 7401 fibers, 64 fragments, and 18 films size 50-200 m. The plastic polymers of the MPs included Polyethylene, polyester, polyamide, polyacrylic, and polystyrene (Soltani et al., 2021). At the same year 2021, study on a road in Chennai India also found MPs of 227.94 ± 91.37/100 g of street dust sample. The MPs found were in the form of fragments and fibers, the plastic polymers were polyvinyl chloride, poly(ethylene-co-vinyl-acetate), HDPE, poly (tetrafluoroethylene), cellulose microcrystalline, lyocell, superflex-200, wax-1032, and AC -395 (Patchaiyappan et al., 2021). In another location, in La Aljorra Spain, an outdoor study was conducted in 2021. This study found an average of 35.97 ng m^3 MPs particles measuring 125 m to 200 m. All of the particles found in the plastic polymer are polystyrene in the form of fragments and fibers (Peñalver et al., 2021).

After conducting long-term monitoring for one year, recearcher found a lot of fiber in the atmospheric fallout. At site 1 the sample was taken in a densely populated urban area in Paris, found from 2 to 355 particles/m^2/day. The mean of falling particles was 110 ± 96 particles/m^2/day (mean ± SD). While at site 2 the sample was taken for six months in a less densely populated suburban location, found around 53 ± 38 particles/m^2/day (mean ± SD). Fibers measuring 200-600 m are more commonly found, MPs measuring 50-200 m are also found using a stereo microscope. After being analyzed with Fourier Transform infrared (FT-IR) Spectroscopy, it turned out that 50% of the fibers found were natural fibers, that mostly cotton or wool. 21% of the total fiber, produced by the transformation of natural polymers namely rayon or acetate from cellulose. The remaining 17% of the fibers were produced with pure synthetic fibers, such as polyethylene-terephthalate and only one polyamide fiber was found. Another 12% are blended fibers of different materials such as polyethylene-terephthalate and polyurethane blended fibers and fibers which are blends of natural and synthetic materials such as cotton and polyamides (Dris et al., 2016).

In year 2019 in the city of Aarhus, Denmark, a research on MPs in the air was conducted by (Vianello et al., 2019). The research found MPS of 1.7-16.2 particles/m^3 in the indoor air of an apartment. The particles found are 0.004-0.398 mm in size, in the form of fibers and fragments. Polyester, polyethylene, nylon are the types of polymers found in these MPs. In another place the city of Edinburgh, UK study of MPs finding in kitchen indoor air are held in 2018. on that study (Catarino et al., 2018) found 1666-1671 particles/m^2/d. MPs size are not more than 5mm in shape of fiber and film. Type of polymer that found are Polyethylene Terephthalate, and Polyurethane. in Bushehr port, urban city of Iran outdoor air, (Akhbarizadeh et al.) found 5.2 MPs particles/m^3. The particle size is not more than 2.5 mm in shape of Fiber, Fragment, and Film. Type of polymer of MPs found are Polyethylene Terephthalate, Polyethylene, nylon, Polystyrene, Polypropylene.

MPs particle in shape of fiber are found in Beijing, China. The study site are indoor and outdoor air of China University of Mining and Technology in Beijing (CUMTB). The size of MPs found are measuring between 0.005-0.2 mm. but unfortunately this study not identify the sample in FTIR, so there's no type of polymer found (Li et al., 2020) In central city of London, England outdoor air, Wright et al. (2020) found the number of MPs range from 510 to 925 fibrous MPs/m^2/d. The non-fibrous MPs deposition rate ranged from 12 to 99 MPs/m^2/d. the size of particle are measuring to 400–500 m in shape of fiber, fragment, and film. trom the study type of polymer found are Polyethylene and Polypropylene.

Table 1 Total metal distribution and ratio in cat's whiskers

No	Location	Sampling Site	MPs Presence	MPs Size	MPs Shapes	Type of Polymer	Analysis	Reference
1	Aarhus, Denmark.	indoor	1.7-16.2 particles/m^3	0.004-0.398 mm	fragments and fiber	Polyester, polyethylene, nylon	FPA-μFTIR-Imaging analysis (Focal Plane Array-Fourier Transform-Infrared-micro-spectroscopy)	(Vianello et al., 2019)
2	Edinburgh, UK.	indoor	1666-1671 particles/m^2/d	<5 mm	fiber and film	Polyethylene Terephthalate, and Polyurethane	Fourier Transform-Infrared-micro-spectroscopy (FTIR)	(Catarino et al., 2018)
3	Bushehr port, Iran.	outdoor	5.2 particle/m^3	<2.5 mm	fiber, fragment, and film	Polyethylene Terephthalate, Polyethylene, nylon, Polystyrene, Polypropylene	micro-Raman spectroscopy is lower than micro- Fourier-transform infrared (FTIR) spectroscopy	(Akhbari zadeh et al., 2021)
4	Hamburg, Germany.	outdoor	275 MPs /m^2/day particles	0.65mm-3mm	Fragment and Fiber	PE, polyethylene, ethylene vinyl acetate copolymer (EVAC), polyvinyl acetate (PVA), PE, polyethylene, ethylene vinyl acetate copolymer (EVAC), (PTFE), polyvinyl acetate (PVA), Polytetrafluoroethylene (PTFE)	Fourier Transform-Infrared-micro-spectroscopy (FTIR)	(Klein and Fischer, 2019)
5	California, USA.	indoor and outdoor	(3.3 ± 2.9 fibers and 12.6 ± 8.0 fragments m^{-3}; mean ± 1 SD) (0.6 ± 0.6 fibers and 5.6 ± 3.2 fragments m^{-3})	Indoor (58.6 ± 55 μm) outdoor (104.8 ± 64.9 μm).	fiber, fragmen	polyethylene terephthalate, polyethylene, acrylic, Polystyrene	Fourier Transform-Infrared-micro-spectroscopy (FTIR) and Nile Red	(Gaston et al., 2020)
6	Asselyah, Iran.	Outdoor	900 MPs and 250 microrubbers (MRs) per 15 g of sample street dust	0.1-1mm	fibers, films, and fragments	Non	binocular microscopy (Carl-Zeiss), polarized light microscopy (PLM) (Olympus BX41TF) and fluorescence microscopy (Olympus CX31)	(Abbasi et al., 2019)

7	Central Italian Alps, Italy.	outdoor	249 fragments, 73 films and 44 fibers/m^2/day by 2019	fibers up to 750 µm long and fragments 300 µm	Fragment and Fiber	polyamide, polyethylene and polypropylene	Fourier Transform Infrared Microscope System (FTIR; Survey IR Microspectroscopy Accessory coupled with Nicolet iS5 FTIR Spectrometer, Thermo Fisher Scientific; detection limit 100 m)	(Ambrosini et al., 2019)
8	Residence in Aveiro, Portugal.	indoor and outdoor	0.4 to 59.4 for indoor and from 0 to 1.5 particles m^{-3} for outdoor air	<10 mm	Fragment and Fiber	Non	Stereomicroscope, Statistical analysis, namely descriptive analysis, Chi-Square, ANOVA and Kruskall-Wallis tests, were conducted in IBM SPSS Statistics 26, considering an = 0.05	(Prata et al., 2022)
9	China.	indoor and outdoor	(1583 ± 1181 n/m^3, n=39) in indoor air, and (189 ± 85 n/m^3, n=63) in outdoor air	smaller than 100 µm	Fragment and Fiber	indoor polyester, polyamide, and polypropylene. outdoor polyethylene, polystyrene, and polyester	Nile red, fluorescence spectroscopy, and micro-Fourier transform infrared (µFT-IR) spectroscopy.	(Liao et al., 2021)
10	The Hull and East Riding of Yorkshire region, U.K	indoor	3061 particles /7 d	5–250 m	Fragment and Fiber	Polyethylene terephthalate (PET), polyamide (PA) and polypropylene (Patchaiyappan et al.)	FTIR analysis	(Jenner et al., 2021)
11	Sydney, Australia.	Indoor	7401 fibers, 64 fragments, and 18 films	50-200 m	Fragment, Fiber, and Films	Polyethylene, polyester, polyvinyl, polyamide, polyacrylic, and polystyrenemicro-Fourier transform infrared (FTIR)	(Soltani et al., 2021)	
12	Chenai, India.	Outdoor	227.94 ± 91.37 particles/100 g of street dust	Non	Fragment and Fiber	polyvinyl chloride, poly(ethylene-co-vinyl-acetate), HDPE, poly(tetrafluoroethylene), cellulose microcrystalline, lyocell, superflex-200, wax-1032, and AC-395. SEM-EDS	Nile red, and micro-Fourier transform infrared (µFT-IR) spectroscopy.	(Patchaiyappan et al., 2021)
13	La Aljorra, Spain.	Outdoor	average of 35.97 ng m^3 MPs particles	1.25mm-2mm	Fragment and Fiber	Non	non	(Peñalver et al., 2021)
14	China University of Mining and Technology in Beijing, China	indoor and outdor	total fiber particles was 14.1 × 10^3 particles/mL.	between 5 m and 200 m	fiber	Non	non	(Li et al., 2020)

15	Paris, France.	outdoor	2 to 355 particles/m^2/day	200-600 m	Fiber	natural polymers (rayon or acetate from cellulose), polyethylene-terephthalate, polyamide. mixture of different materials including purely synthetic materials fibers (mixture of polyethylene-terephthalate and polyurethane) and fibers being a mixture of natural and synthetic materials (cotton and polyamide), petrochemicals	Fourier Transform infrared (FT-IR) Spectroscopy	(Dris et al., 2016)
16	Central London, England	outdoor	range from 510 to 925 fibrous microplastics/m^2/d. The non-fibrous microplastic deposition rate ranged from 12 to 99 microplastics/ m^2/d	400–500 m (mean 905 ± 641 m)	Fiber, Fragments and films	Polyethylene, and polypropylene	Nile Red (Catarino et al.), fluorescence stereo microscope, FTIR analysis	(Wright et al., 2020)

As seen in Table 1, previous study found several shapes of MPs such as, films, fibers, and fragments. From the three-shape found, the most commonly found are MPS in the shape of fiber. Fishery activities are the source of MPs fiber shape because most fishing nets are made of fiber (Azizah et al., 2020), washing clothes that made of synthetic materials is also the source of fiber type of MPs. From study, Napper and Thompson (2016) MPs can be separated of fiber from ordinary fabrics, polyester, polyester-cotton blends, and acrylic. Secondary MPs shape fragments are commonly from the fragmentation of toy bricks >100 m, or soft drink bottle PET >200 m) (Lehtiniemi et al., 2018).

By analyzing the particle through Micro-Fourier Transform Infrared (-FTIR) or Micro-Raman (-Raman), Spectrophotometer, and Nile Red staining/imaging coupled, describe the type of polymer that formed the MPs. The most polymer found is Polyethylene that usually used as plastic packaging for soft drinks, water bottles, containers, salad dressings, biscuit trays and salad domes, as people consume a lot of single use plastic bottle packaging (Alabi et al., 2019). Polystyrene is also forming the MPs found, Polystyrene is used to make CD cases, plastic cutlery, imitation glass, cheap fragile toys, foamed polystyrene video boxes/cups, protective packaging, building and food insulation.

Polyamide is also commonly found because polyamide is a polymer with repeating units linked by amide bonds, and occur both naturally and artificially. These synthetic polyamides are commonly used in textiles, automotive industry, carpets, kitchen utensils and sportswear due to their high durability and strength. As much as Polyamide,Polyester also found a lot from this data, Polyester is a category of polymers that contain the ester functional group in every repeat unit of their main chain.

4 Sampling method

There are a lot of ways to collect MPs in the atmosphere. Sampling method that used by Liao et al. (2021), Prata et al. (2020b), Li et al. (2020), and (Peñalver et al., 2021) are using air sampler equipment such as MiniVol TAS - Portable Air Sampler by Air Metrics that used in (Prata et al., 2020b), and (Li et al., 2020). LB-120F total suspended particulate sampler that used by (Liao et al., 2021), and Digital DHA 80 Sampler used in (Peñalver et al., 2021) to collect the MPs from the air environment. in the other method (Jenner et al., 2021) used 1 L glass beakers that placed at head height around 1–1.8 m for 7 days. Also, KB-120F intelligent center flow type flow total suspended particulate sampler (Jinshida, Qingdao) with an intake flow rate of 100±0.1 L/min was used in the collection of airborne MPs particles. All sampling at each station was carried out in triplicate for 1 hour and by filtering approximately 6 m^3 of air per sample (Liu et al., 2019a).

Study from Soltani et al. (2021) used glass Petri dishes diameter = 12 cm that had been rinsed on both sides three times, the petri dishes was placed height of 120 cm from the floor for 30-days. Another method that used to collect MPs in the air environment is by using 12 cm diameter PVC pipe buried 50 cm deep for 3 month as the method of (Klein and Fischer, 2019). Sweeping the ground using a small paint brush from a quadrat of 1 m^2, and then transferred to sterile paper bags using a metal pan as used in (Patchaiyappan et al., 2021). Metal pans and wooden brushes were used to carefully sweep the material directly into an airtight, low-density polyethylene bag, with the pan and brush washed with filtered distilled water and dried between successive samples Abbasi et al. (2019). (Dris et al., 2016) also use the stainless steel funnel to collect the sample, the same as (Ambrosini et al., 2019) that using gardening metal shovel and glass jars, also metallic pan and wooden brush to take the MPs sample. Pre-cleaned glass dust deposition gauges diameter: 15 cm height: 40 cm that placed in stainless steel tripod height 170 cm also the another method that used in (Song et al., 2021). (Wright et al., 2020) done study using an aluminum rain gauge with a 0.03 m^2 (200 mm diameter) continuously for three- or four-days sample period. By stepping 1 L glass beaker for 6 month indoor can collect MPs as method by (Jenner et al.).

To simulate the presence of a person breathing the surrounding air, sampling was carried out using a Breathing Thermal Manikin made of aluminum and glass fiber. The manikin is made to resemble a human body sitting on a chair with a height of 110 cm. The manikin is connected to a mechanical artificial lung system, which consists of two pneumatic cylinders driven by electric motors, generating a flow of air that simulates breathing. Air samples were collected from the air intake "mouth" of the mannequin, which had an inner diameter of 9 mm, and the sampling duration was 24 hours (Vianello et al.).

Study from (Catarino et al.) are using plastic petri dish with diameter 90 mm. the sampling duration is around 1 hour. In another place Wright used the aluminium rain gauge with a 0.03 m^2 (NovaLynx 260–2510 Standard Rain and Snow Gauge, US). Diameter of the sampling equipment are 200 mm. (Li et al., 2020) are used MiniVol samplers (Airmetrics, USA) were used to collect total suspended particles (TSP). The equipment are put in 3 different sampling height that is 18 m on the roof, 1.50 m in human respiratory, and on the ground. (Akhbarizadeh et al.) also use the mecine to collect the MPs.Tisch high-volume sampler (TE-6070D, USA) was operated for sampling at a flow rate of 1.4–1.6 m^3/min. the sampling duration is for 24 hours.

5 Analysis preparation

There are some ways to do before analyze the sample such us heat in the oven, or shake with shaking incubator, or vortex mixer, some researcher also use even both ways. There are also an easy way that only take 3 steps to do or quite complicated way that need 5 to 8 steps to do. Based on (Liao et al., 2021) and (Soltani et al., 2021) only use 3 easy step preparation that is washed using 30% H_2O_2, and then heat 60°C until 70°C for 1 hour or until the particle are floating, then filtered using 47 m filter membrane. Also quite difficult way that is washed using H_2O_2, put on shaking incubator in 55°C, then filtered with 47 m membrane filter, then washed with miliQ water as the purest water. Then let dry before analyzed in microscope (Jenner et al., 2021). The same way by (Soltani et al., 2021) that is washed with miliQ water, then elude with vacuum concentrated, then filter with 9 cm or 0.6 mm glass fiber, then put to another petri then wrap with aluminum foil, then rinse and dry until ready to analyze.

Analysis preparation used by Patchaiyappan et al. (2021) is by drying the sample at 70°C in hot air oven for one day, then sieved with a sieve size of 5 mm to eradicate the presence of any particle greater than 5 mm, then digest with 20 mL of 30% H_2O_2 (hydrogen peroxide) and 20 mL 0.05 M Fe(II) solution also added to each of the subsamples And heated up till 75°C for 30 min to remove the organic materials. The sample preparation method used in (Prata et al., 2020b) is by filter and wash the sample with ultrapure water in glass fiber filters (Whatman GF/C™ no.1), then transfer it again to a solution by washing with 10 mL of 1.6 g/cm^3 NaI (Sigma-Aldrich, USA), for density separation. Then shake using the vortex mixer for 1 min and let to settle for 90 min. then do the filtration using fiber filters, these filters were stored in glass Petri dishes, dried over and ready to count. Another modern way is by doing thermal decomposition to the samples in a TGA/DSC 1 HT thermo gravimetric analyzer (Mettler-Toledo GmbH, Schwerzenbach, Switzerland) flowing nitrogen atmosphere of 50 mL for 1 min, temperature 30 to 800 °C with a heating speed of 10 °C for 1 min. As used in (Peñalver et al., 2021).

All study sources used a stereo microscope to identify the MPs found. Some of the microscopes used are fluorescence stereo microscope (M165FC, Leica) at 40× to 120× magnification (Liao et al., 2021), stereomicroscope analysis (Olympus SZX10, Olympus Corporation, Japan) (Jenner et al., 2021), fluorescence microscope (Soltani et al., 2021), (Gaston et al., 2020) fluorescent microscope (Olympus CX41) (Patchaiyappan et al., 2021), FEI Scios DualBeam SEM (FEI, Ltd., Hillsborough, USA) (li2020), fluorescence microscope (Zeiss Axio Lab A.1) (Klein and Fischer, 2019) Tescan VEGA 3 electron microscope (Abbasi et al., 2019). After analyzing in stereo microscope, some studyer continue to see the plastic polymer through FTIR, and other study use nile red and SPSS to analyzing the MPs sample.

6 Health impacts of MPs

There are three main pathways of how MPs enter human body. First is through human consumption or oral. MPs can enter human body through what human eat and drink. There are a lot study about finding MPs in beer (Liebezeit and Liebezeit, 2014), milk, soft drinks (Diaz-Basantes et al., 2020), tab water, and plastic bottle (Danopoulos et al., 2020), soft drinks, energy drink, and tea (Shruti et al., 2020). MPs are also found in all kind of seafood (Smith et al., 2018), fruits and vegetables (Oliveri Conti et al., 2020), honey (Liebezeit and Liebezeit, 2013), salt (Iñiguez et al., 2017). Second route how MPs enter human body is through respiration. As MPs have been found in the air, and the technology to filter pure oxygen free from MPs are not yet found, that could possibly mean human are breathe the MPs together with the oxygen. This suspicion is proven by the finding of MPs inside human lung tissues that obtained after autopsies. Amato-Lourenço et al. (2021) found 33 plastic polymeric particle and 4 MPs in shape of fiber inside human lungs. This study gives clear evidence that MPs are inhaled by human. Another way is through dermal exposure through cosmetics and wounds in human bodies. The ability of MPs to penetrate through the skin seems a little difficult, because the absorption of particles throughout the skin requires penetration of the striatum conium which is limited to particles below 100 nm, but nanoplastics (NPs) can certainly penetrate into human skin (Sykes et al., 2014). This skin contact can occur when humans interact using water containing MPs, especially when washing face using facial wash that containing scrubs, or bathing using body scrubs containing MPs (Hernandez et al., 2017), (Revel et al., 2018).

Plastic polymers certainly have a negative impact on human health. The health risks that occur in humans are associated with the presence of various plastic additives that make up these plastics (Araújo et al., 2002). Studies by Erkekoglu and Kocer-Gumusel (2014) have found a relation between phthalate exposure as the kind plastic polymer, and cancer. (Bay et al., 2006) also found a relation of phthalates with human growth, as well as decreased thyroid function when phthalates enter human body (Andra and Makris, 2012), and impaired fertility (Meeker et al., 2010). Recent evidence has shown phthalates to be detrimental to cardiovascular health. This hypothesis is based on studies reporting the relation of phthalate exposure with cardiovascular risk factors such as obesity, lipid metabolism, blood pressure, and atherosclerosis (Muscogiuri and Colao, 2017). MPs with polystyrene polymers cause pulmonary cytotoxicity by inducing reactive oxygen species (Peñalver et al.). MPs with polystyrene polymers are associated with disruption of the barrier or bridge between the blood and lung circulation by depleting the ZO protein, Zonula Occludens also known as tight junction protein. Inhalation of MPs with polystyrene polymer increases the risk of chronic obstructive pulmonary disease (Dong et al., 2020).

Apart from being composed of various additives, MPs can also absorb organic contaminants (Wright and Kelly, 2017), (Gasperi et al., 2018). Elements such as lead, nickel, zinc, and cadmium can also be absorbed by MPs (Wright and Kelly, 2017), (Rochman et al., 2014). So MPs are considered a priority pollutant vector in the Stockholm and Basel Conventions because of the potential adverse effects it can have on health (2018), (Gallo et al., 2018). If MPs are ingested or inhaled, MPs can accumulate and cause toxicity in the body and affect the immune response. MPs exposure to the body is of greater concern, because it can have an accumulative effect. Although there is a potential for MPs that have an impact on human health, it is necessary to know in advance how much exposure to MPs is in the body (Amato-Lourenço et al., 2020). In his study (Zimmermann et al., 2019) compared eight main types of polymer plastic consumer products according to their toxicological and chemical markers using in vitro bioassays and non - target high resolution mass spectrometry . findings Most (74%) of the 34 plastic extracts containing the chemical had one effect, including baseline toxicity (62%), oxidative stress (41%), cytotoxicity (32%), estrogenicity (12%), and antiandrogenicity (27%). Polyvinyl chloride (PVC) and polyurethane (PUR) extracts caused the highest toxicity, while polyethylene terephthalate (PET) and high-density polyethylene (HDPE) did not cause toxicity or low toxicity. High initial toxicity was detected in all "bio plastics" made of polylactic acid (PLA). The relationship of Phthalate and its metabolites with blood pressure and hypertension has been demonstrated in an accurate assessment of the PIVUS study revealing a significant inverse correlation between MEP and systolic (SBP) and diastolic blood pressure (DBP) (Olsén et al., 2012). Phthalate-associated hypertension may be associated with increased echogenic plaque and intimal media thickening and echogenicity that is more likely to occur in subjects exposed to phthalates (Lind and Lind, 2011). MPs fragments increase acute inflammation, cell membrane damage and cell death due to chemical toxicity. The roughness of MPs fragment shape was quantitatively analyzed to correlate toxicity. Although most ingested MPs in humans are excreted through the digestive tract, some of the smaller plastics can cross the intestines and accumulate into other tissues. Therefore, researcher assume that MPs have accumulated in the human body throughout their lives (Choi et al., 2020).

7 Conclusions

Microplastics have been found to contaminate the air both indoor and outdoor, such as in Aarhus, Denmark indoor air, Edinburgh, UK indoor air, Bushehr port, Iran outdoor air, Hamburg, Germany outdoor air, California, USA indoor and outdoor air, and other locations have been polluted with microplastics in the air with different levels of microplastics, sizes, shapes, types of polymers, and methods. Plastic polymers certainly have a negative impact on human health. The health risks that occur in humans are associated with the presence of various plastic additives that make up this plastic particle. plastic constituents such as phthalates, BP-A, and benzene have been shown to interfere with the development of human hormones. and microplastics that enter the body continuously accumulatively are feared to block the blood flow to atherosclerosis. This literature review aims to summarize and collect research on the presence of microplastics in the air including the number of microplastics found, their shape, and size, the methods used, and how to identify these microplastics.

Declaration of competing interest

The authors declare no known competing interests that could have influenced the work reported in this paper.

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