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Synthetic Textile Microfibres as Emerging Pollutants: A Critical Review of Environmental and Health Consequence

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***Abstract*:Microfibres pollution is a serious environmental problem that has been created by the ongoing commercial use of synthetic textiles for clothing. When washed, these textiles release tiny pieces of plastic, also known as microfibres. Many of these fibres enter into wastewater or treatment plants and then into the aquatic environment, where they cause harm to human health and marine ecosystems. The negative impacts from microfibres pollution (air quality, water and energy consumption, and chemical pollution due to detergent) are covered in this study. Moreover, the uptake of microfibres through ingestion or inhalation poses significant risks to human health. There are several action steps that can be taken to minimize this pollution, such as the use of sustainable textiles, changing washing routines, and the use of microfibres collection machines. Moreover, structural changes (such as public educative campaigns and policy campaigns) to greatly increase the development should be realized. This study highlights solutions that can be undertaken to address the problem of microfibres pollution and safeguard the planet and public health. The above terms refer to the defining features of microfibres: Micro-sized, Microfibres pollution, the impact on your health—Health hazard and Microfibres-catching equipment—The equipment designed to catch the microfibres.**

Keywords: Microfibres, Microfibres pollution, Health hazard, Microfibres-catching equipment

I. INTRODUCTION

In recent years, microfibre contamination has grown to be a major environmental problem due to the immense quantity of tiny synthetic fibres released during the laundering of garments. These microfibres are typically less than 5 mm in length and are commonly shed from manmade fabrics such as nylon, polyester, acrylic, and other similar materials. These small fibres enter wastewater when people wash their clothes, particularly in washing machines. Natural fibres can decompose naturally, whereas synthetic microfibres persist in the environment and ultimately become deposited in rivers, lakes, seas, and even the air. Microfibres pollution can also affect human health and ecosystems, particularly through its impacts on aquatic organisms such as fish. The use of synthetic fibres and the extremely high volume of washing worldwide has made it necessary to find solutions to microfibres shedding and its effects on the environment. Microfibres are extremely fine and can be less than 10 micrometres in diameter, particularly when compared with conventional synthetic fibres. They have high absorbency, durability, and softness and, hence, are useful for a number of products [1].

Types of Microfibres

Microfibres are incredibly fine synthetic fibres that have been incorporated into many applications throughout the world because of their unique properties and versatility. The most common types of microfibres are polyester, nylon, polyamide, mixed microfibres, acrylic, and hydrophilic microfibres. They have different properties that are best suited for particular uses. Each type of microfibre, although similar, has its own uses and advantages. The options available include

nylon, polyamide, and polyester microfibres, which are favoured due to their strength and versatility. Microfibres can either be blended, which is a mixture of the best properties of several different fabrics, or made from acrylic fibres to make fabric soft. Last but not least, hydrophilic (water-absorbing) microfibres can absorb moisture, which is a quality necessary for moisture-absorptive products. Their various properties will continue to play an important part in fields such as skincare, sports, automobiles, and medicine.

Environmental Impact

In many ways, washing clothes, particularly synthetic fabrics, can result in significant environmental emissions. The primary sources of pollution are microfibres shedding, chemical release, and water consumption, which can adversely affect aquatic life, ecosystems, and human health. The following paragraphs provide explanations of the various kinds of pollution that can be caused by laundry.

Microfibres Pollution

Washing textiles is one of the significant sources of microfibre pollution. Microfibres are particles of synthetic materials such as acrylic, polyester, and nylon fibres that break off when certain synthetic clothes are washed. These materials are often used in fabric apparel because they have the characteristics of being low in cost, low in weight, and high in strength. However, when they are washed, some of the microfibres, which are frequently less than 5 millimetres in size, are released. These fibres are very small in size and can easily pass through washing machine filters and enter the sewage system. These microfibres can subsequently enter water bodies after being released into oceans, rivers, and lakes, as illustrated in Fig. 1. They pose a significant threat to marine life. Small fish and plankton are examples of feeding organisms that can sometimes mistake microfibres for food. They ingest these plastic particles, and the fibres may contain dangerous chemicals that can be harmful to their bodies and digestive systems and may even have toxic effects. This poses a greater problem for the entire food chain because of the potential harm to smaller organisms. If these harmful microfibres make their way into larger animals through ingestion, they may eventually reach humans through the food chain.

Moreover, synthetic microfibres do not decay over time like natural fibres such as cotton or wool and may also create fragments in the environment. Another significant hazard from synthetic microfibres is that they do not degrade in the environment like cotton or wool fibres do. Rather, they remain in the environment for many years, contaminating water and impacting wildlife. They are very small and, therefore, are difficult to clean up after they are released into the environment. As time passes, the number of plastic contaminants added to the ocean continues to increase, and these materials can remain there for a long time, particularly considering how difficult they are to remove.

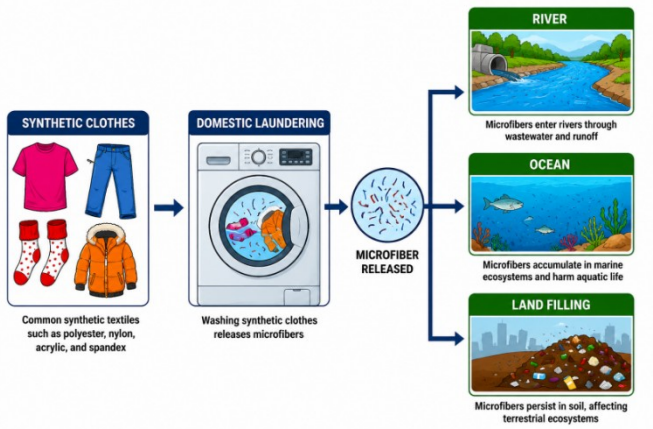


Figure1. Microfibres released during the washing process [7]

Chemical Pollution

A variety of chemical contaminants, including surfactants, builders, bleaching agents, optical brighteners, enzymes, fragrances, dyes, chelating agents, and textile-associated chemicals such as alkyl phenols, organophosphate esters, and PFAS, are released into wastewater during clothes washing [1,3]. These substances are released from laundry products such as cleaners, softeners, dyes, etc., used in laundering. These products may be used to make clothes "clean and fresh," but they also contain chemicals that can be extremely harmful to the environment, particularly to bodies of water and the organisms therein [8]. Synthetic fragrances, phosphates, and surfactants are ingredients often found in detergents and fabric softeners. While these ingredients may appear safe when used in our kitchens and bathrooms, they can be dangerous in rivers, lakes, and oceans when they flow with wastewater from our households. Surfactants are harmful to aquatic organisms, and phosphates are responsible for eutrophication. Too many nutrients in the water lead to rapid algal growth. When the algae die, the oxygen is consumed by bacteria that decompose them, reducing the amount of oxygen available to animals, fish, and other organisms living in the water.

The fabrication of dyes and the release of microfibres from fabrics, especially synthetic fabrics, are additional sources of pollution. One of the more common causes of bright, coloured clothes is the use of chemical dyes, which can enter the environment when clothes are washed in laundry facilities. When these pigments are discharged, they cause pollution and harm marine life, as do the tiny pieces of plastic released from synthetic fibres. Additionally, many manufactured clothes undergo finishing and flame-retardant processes using chemicals that are eventually washed out and released into the water [10]. These chemicals have a detrimental effect on the environment. They can negatively affect fish, frogs, and other aquatic organisms, influencing their toxicity, growth, breeding, and general welfare. Some of these chemicals can have effects that persist longer in the environment and can affect the hormones of animals and the functioning of ecosystems. Worse still, some chemicals can be stored in marine organisms over time, a process referred to as bioaccumulation. The presence of these toxic chemicals can

increase when they are consumed by larger animals, as they may accumulate in smaller fish and animals that are subsequently consumed by larger organisms. This can further increase the risk, particularly to birds, marine mammals, and humans who consume seafood. As these animals consume organisms containing toxic chemicals, these substances can become increasingly concentrated and can subsequently be found in animals, including birds, marine mammals, and even humans who consume seafood.

Water Consumption and Wastewater

The report also covers water consumption, wastewater, and stormwater. In many cases, water is utilized indoors in the laundry area, where water availability may be insufficient, and laundry can require a considerable amount of water. In many areas of the world, water is a very valuable resource, and it is frequently used for washing laundry. However, the process does not end there; the water that flows down the drain carries dirt, oils from clothes, harmful chemicals, and minute microfibres with it [12].

This water subsequently becomes a significant source of pollution. For many wastewater treatment plants, the ability to remove all the microfibres and chemicals found in laundry wastewater is limited. As a result, these pollutants can be discharged into rivers, lakes, and oceans. They can adversely affect the flora and fauna of natural water bodies, reduce water quality, and negatively impact entire ecosystems when they enter natural waters [13].

The situation is even worse in some areas where washing water is not treated before its release into the environment. Laundry water may be contaminated with pollutants and present a danger to people who share the community's water supply for drinking, farming, or recreational activities such as swimming and fishing. Such pollution not only affects wildlife but also places a burden on communities, as it can be detrimental to human health and everyday life, as depicted in Fig. 2.

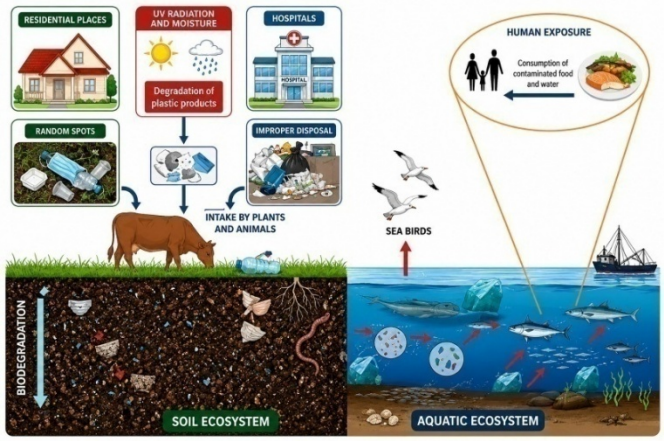


Figure 2. Impact of microfibres pollution on aquatic biota [14]

Energy Consumption and Carbon Footprint

The use of clothes washing has an impact on water systems and also involves significant energy consumption and pollution. Electricity is used when we operate a washing machine or dryer. In many areas, electricity continues to be produced using non-renewable fuels such as coal, oil, or natural gas. When these fuels are burned to generate electricity, greenhouse gases (GHGs) are emitted into the atmosphere, and these are associated with climate change and global warming. Electricity generation influences the environmental impact of laundry to a great extent. Clothes washing has a much higher carbon footprint if it is heavily dependent on fossil fuels. This may involve simply wearing clothes and washing them, resulting in further greenhouse gas emissions and impacting the planet's climate. This is because electricity is consumed during the drying process, especially when tumble drying is used. Dryers consume a lot of energy and cause a significant release of microfibres from synthetic fabrics due to heat and friction. These microfibres can then be carried into the air or deposited on surrounding surfaces, thus contributing to environmental pollution and even indoor air pollution [15,16].

Impact on Soil and Air Quality

Laundry activities mainly affect water quality but can also pollute the air and land. Microfibres and other pollutants can remain in water or be carried by currents through various components of the environment and then released, causing more harm than originally thought. One of these mechanisms is the release of airborne microfibres. These fibres can be shed during washing and also when clothes are worn and dried, such as during ironing or in a tumble dryer. When released into the air, they can travel long distances with the wind and be inhaled by humans and animals. Inhalation of these synthetic particles has been associated with adverse health effects over the long term, since many of them may contain toxic chemicals [17]. There are also other pathways through which soil pollution can occur. Treated water may contain microfibres that can enter the ground when discharged into the environment or when washing-machine effluent is applied to agricultural land. Over time, these fibres can accumulate in the soil, impairing its quality and potentially threatening soil microorganisms. Concerns include the persistence of contamination and its potential impacts on human health and the environment, as it can even be transferred to crops and food that we consume [18].

Health Impacts

Textiles, such as polyester, nylon, and acrylic, pose very serious health and environmental risks. Microplastic fibres are released into water when synthetic clothes are washed, or they may enter water through other routes before reaching wastewater systems.

Ingestion and Bioaccumulation

Microfibres can be released from man-made fabrics into wastewater streams and subsequently deposited in water systems. These small pieces of plastic threads can be

consumed by marine organisms, such as fish, crabs, and crustaceans, when they are ingested from the water. These organisms are also a critical part of the human diet, and microfibres can bioaccumulate and pass up the food chain to humans. This bioaccumulation poses important questions about the long-term impacts of plastic particles and related toxicants. For all foods except seafood, one of the other most significant sources of exposure is drinking water. Numerous studies conducted in many parts of the world have found microplastics in drinking water sourced from both drinking water supply systems, including tap water and bottled water. The body may be sensitive to the presence of microfibres and their chemical constituents when ingested over an extended period, and some of these chemical constituents have been found to adversely affect immune and hormone function [19].

Chemical Leaching

Synthetic microfibres often contain harmful chemicals such as phthalates, bisphenol A (BPA), and flame retardants, which are commonly added to synthetic materials to provide fire resistance, flexibility, and toughness.

Regulations and Standards

The increasing recognition of chemical hazards associated with synthetic textiles has led to the development of regulatory measures and safety standards in several countries. In the European Union, Regulation (EU) 2018/1513 introduced restrictions on 33 carcinogenic, mutagenic, or toxic-to-reproduction (CMR) substances in clothing, textiles, and footwear under the REACH framework. These restrictions are particularly relevant to children's products because exposure may occur through skin contact, inhalation, or unintentional ingestion of textile fibres and dust [20].

In India, the Bureau of Indian Standards (BIS) has established standards addressing the safety of children's products, including IS 9873 (Part 9):2017, Safety of Toys—Certain Phthalates Esters in Toys and Children's Products, which specifies requirements concerning certain phthalates [21]. BIS has also developed safety requirements specifically for children's apparel, including IS 19523:2026, Textiles—Children Apparel—Safety Requirements, reflecting the growing emphasis on chemical and physical safety in children's clothing [22]. Therefore, incorporating regulatory requirements and standards into discussions of synthetic microfibres is important for understanding the measures available to control hazardous chemical exposure associated with textile products.

Humans or aquatic organisms may consume microfibres, which may cause these compounds to seep into biological tissues and have toxicological consequences. These chemicals can enter the body and disrupt hormone regulation and hormone signalling pathways. Research has shown that these chemicals can cause neurological problems, developmental delays, reproductive issues, and a higher risk of developing various cancers [23].

Respiratory Effects

Microfibres pose a significant risk to the respiratory system in addition to ingestion, particularly indoors. Small activities, such as laundering or using clothes dryers, can release these microfibres into the air, where they can remain suspended. When synthetic fabrics are used, they can release tiny fibres that settle as dust indoors or are blown out through dryer vents. These fibres can be inhaled, particularly in rooms with poor ventilation, and subsequently enter the respiratory system. Chronic exposure to microfibres may cause a variety of respiratory issues, including airway inflammation, inflammation of lung tissues, and potentially more serious conditions such as asthma and pulmonary fibrosis. Children, people with pre-existing respiratory diseases, and persons who work in laundry and textile manufacturing plants may be particularly vulnerable [24,25].

Inflammatory and Immune Responses

New laboratory studies have raised concerns about the biological effects of MF pollution on cells. Microfibres and microplastics can penetrate biological barriers and enter human cells when ingested or inhaled, causing oxidative stress, cellular inflammation, and disruption of immune system activity. Microfibres are recognised by the body as foreign particles, which triggers immunological reactions and can cause damage to the surrounding tissue, as well as impairments in cellular activity. Chronic health problems, such as cardiovascular, autoimmune, and neurodegenerative diseases, may develop as cells become repeatedly stressed over a prolonged period. Chronic inflammation and ageing, which are known to increase with oxidative stress are both major contributors to many non-communicable diseases [26]

Sources of pollution caused by washing clothes

Water Pollution

Washing clothes is a common aspect of everyday life, but it has unintended consequences for the environment. The pollutants from laundry processes can be very hazardous to waterways. They often include harsh materials, bleach, optical brighteners, microfibres from synthetic textiles, and chemicals in fabric softeners and detergents.

Phosphates, surfactants, enzymes, and perfumes are among the compounds found in many commercial laundry detergents. These compounds are effective cleaners, but they also pose significant environmental risks (see Tables 1 and 2). These materials are usually too challenging to remove efficiently and effectively from wastewater treatment plants. They can therefore enter lakes, rivers, and other natural water bodies. Phosphates are of particular concern because of their impact on eutrophication, which is the rapid growth of algae stimulated by large quantities of nutrients present in the water. Overgrowth of algae decreases the dissolved oxygen in the water, causing “dead zones” where aquatic organisms cannot survive. Furthermore, surfactants and other chemicals can be

toxic to fish and invertebrates, consequently impacting aquatic ecosystems and biodiversity.

When washing synthetic fabrics such as polyester, nylon, and acrylic, the washing process also sheds chemical contaminants as well as microfibres, which are tiny pieces of plastic fibre that have broken away from the fabric. Because these microplastics are too small to be filtered out by conventional wastewater treatment systems, they can enter rivers, seas, and other marine ecosystems. Marine organisms, such as fish and shellfish, often ingest microfibres present in the water. These fibres can subsequently enter the food chain and may pose a threat to marine food chains, raising concerns about microplastic exposure through human dietary intake.

Another potential source of water pollution is the use of bleach and optical brighteners when washing laundry. These chemicals are used to bleach fabrics and make clothes appear lighter and cleaner. However, even at low concentrations, they can be harmful to aquatic life. Discharged bleach can adversely affect the growth and reproductive processes of fish and other biota, leading to long-term ecological effects [27].

Air Pollution

Laundry also contributes to air pollution, in addition to water pollution. This is primarily because of the greenhouse gases generated by fossil-fuel-based electric dryers and the volatile organic compounds (VOCs) released from laundry products and chemicals.

VOCs are found in a number of products, including fabric softeners and perfumery chemicals. These chemicals can be emitted into the environment during the washing of clothes and while the items are being dried. When released into the atmosphere, these VOCs can interact with sunlight and other chemicals in the air to form key components of urban air pollution, including smog and ground-level ozone. This reaction can directly affect human health and decrease air quality. High levels of VOC exposure can result in headaches, dizziness, respiratory problems, and sore throat, nose, or eye irritation. Longer exposure may lead to chronic health effects, particularly asthma and other breathing-related diseases.

VOCs can also contribute to air pollution through the use of electric dryers. The drying categories, which include tension, thermal, and vacuum drying, can be more reliant on their electricity source when determining their environmental impact. In regions where electricity generation relies heavily on fossil fuels such as coal and natural gas, gaseous emissions from dryers are an indirect consequence, more specifically an increase in CO_2 emissions. These emissions play a significant role in global warming and climate change. Additionally, the combustion of fossil fuels emits chemicals and particulate matter, which affect the environment and human health [15,19].

Soil Pollution

Poor rural communities or areas, in particular, may negatively influence the environment; as a result, water, air, and soil can become polluted during laundry activities. One aspect of environmental degradation that is often overlooked is soil degradation caused by the use of laundry water outdoors and a lack of awareness regarding its proper handling.

In some areas without sewage or drainage systems, laundry water is simply discharged onto the ground. This improper waste disposal occurs when various chemicals, detergents, and microfibres are introduced into the soil. Over time, these compounds can enter deeper soil layers and pollute groundwater, thereby adversely affecting the environment. The use of detergents and cleaners can disrupt the natural conditions of the soil that are conducive to proper plant growth and fertility. This can result in a progressive loss of soil quality, with potential local impacts on vegetation and agriculture.

As with outdoor washing methods, the use of the ground or proximity to water sources over time can result in contamination. This becomes a significant problem if excessive amounts of powdered detergent are used. Many of these products contain fillers and potent chemicals that are not readily absorbed or degraded in the environment. While used detergent remains present in the soil, the pH and chemical balance of the soil can change, reducing its ability to support plant growth and potentially becoming toxic to surrounding organisms [28,29].

Thermal Pollution

Laundry activities have chemical and plastic pollution impacts and may also cause thermal pollution by releasing hot water from washing machines into natural water bodies without adequate treatment or cooling. This is an under-reported type of pollution with potentially serious ecological effects. Warm or hot water is typically more effective at cleaning clothes in most washing machines, especially when removing stains or heavily soiled materials. Sometimes, this warmed water is discharged directly into a river, lake, or stream without adequate wastewater treatment systems in place. Even a slight rise in water temperature can have a significant impact on the equilibrium of an aquatic ecosystem.

The warmer the water, the less oxygen it can contain, which is essential for aquatic life. If oxygen levels decrease, this can cause stress or death to fish, amphibians, and aquatic plants. Furthermore, temperature fluctuations can affect the reproduction and life processes of aquatic organisms, which may lead to the elimination of some species and the prevalence of species that are more resistant to warm temperatures.

Moreover, temperature changes have the potential to stimulate the growth of algae and harmful bacteria, thereby further disturbing the ecosystem and water quality. These alterations could propagate through the food chain, impacting wildlife and humans that depend on these waterways.

These percentages are based on a general study of the environment and laundry and are only estimates. The biggest factor is water pollution caused by detergents, micro fibres and bleach, followed by air pollution (VOCs and dryer emissions), and soil pollution, noise pollution and thermal pollution are the less prominent but also important ones.

TABLE 1
Environmental Impact of Laundry [7]

Pollution Type	Specific Source	Key Pollutants/Agents	Affected Area	Main Environmental Impact
Water Pollution	Detergents and Softeners	Phosphates, Surfactants, Fragrances	Rivers, Lakes, Oceans	Eutrophication, Aquatic toxicity
Water Pollution	Synthetic Fabrics	Microfibres / Microplastics	Oceans, Marine food chain	Marine pollution, Ingestion by sea life
Water Pollution	Bleach and Brighteners	Sodium hypochlorite, Optical chemicals	Freshwater ecosystems	Reproductive harm in aquatic species
Air Pollution	Scented Laundry Products	VOCs	Indoor/Outdoor Air	Smog formation, Respiratory issues
Air Pollution	Electric Dryers (fossil-fuel powered)	CO_2, Particulates	Atmosphere	Greenhouse gas emissions, Climate change
Soil Pollution	Improper Wastewater Disposal	Detergent chemicals, Microplastics	Soil, Groundwater	Soil degradation, Fertility loss
Soil Pollution	Outdoor Washing Practices	Powder detergent residues	Soil	Long-term soil contamination
Thermal Pollution	Hot Water Discharge	Heated wastewater	Rivers, Lakes	Reduced oxygen levels, Aquatic stress

TABLE 2
Estimated Environmental Impact of Laundry (Percentage Breakdown) [7]

Pollution Type	Source	Estimated Contribution (%)	Key Environmental Impact
Water Pollution	Detergents and Softeners	30%	Eutrophication, Aquatic toxicity
Water Pollution	Microfibres from Synthetic Fabrics	25%	Marine pollution, Ingestion by sea life
Water Pollution	Bleach and Optical Brighteners	15%	Reproductive harm to aquatic life
Air Pollution	Volatile Organic Compounds (VOCs)	10%	Smog formation, Respiratory issues
Air Pollution	Electric Dryers (fossil-fuel powered)	10%	Greenhouse gas emissions, Climate change
Soil Pollution	Improper Wastewater Disposal	5%	Soil degradation, Fertility loss

Soil Pollution	Outdoor Washing Practices	3%	Long-term soil contamination
Thermal Pollution	Hot Water Discharge	1%	Reduced oxygen levels, Aquatic stress

Mitigating Measures to Reduce Microfibres Pollution Caused by Washing Clothes

Microfibre pollution is a significant environmental issue due to the increasing use of synthetic fibres in clothing, which can be released into water during washing. Along with shed fibres, apparel made from polyester, nylon, or acrylic materials can release fragments of the material during the laundry cycle, which are called microfibres. Some microfibres may be smaller than the filter size used in wastewater treatment plants and, therefore, may enter water bodies such as rivers, lakes, and oceans. There, they pose a serious risk to aquatic life and can ultimately enter the human food chain. Mitigation can be implemented at the system level or on a region-by-region basis through a variety of mitigation strategies.

Use of Laundry Accessories: To reduce microfibre contamination, fibre-capturing devices, such as special filters, can be used as one of the effective solutions. Filters for washing machines (e.g., Filtrol or PlanetCare filters) can be fitted to washing machines to capture microfibres before they enter wastewater systems. In addition, products such as the Guppyfriend Washing Bag and Cora Ball can collect microfibres released from clothes during washing. The quantity of microfibres released into the environment can be greatly reduced through the use of these easy-to-use tools.

Washing Procedures: Another important step is reducing the shedding of fibres during washing procedures. Using gentle cycles, washing clothes less frequently, and using cold water are some of the practices that can help reduce microfibre emissions. It is also recommended to wash full loads, as this can reduce rubbing between clothes in the washing machine. Sodium soap (powder detergents) may adversely affect the washing process and may damage fabrics; therefore, the use of liquid detergents is recommended because they are less aggressive during the washing process.

Fabric Selection: Another important consideration when creating a wardrobe is fabric selection. It is important to choose eco-friendly or "green" fabrics. Hemp, cotton, and wool fibres, in comparison, are natural fibres and generally do not contribute to synthetic microfibre pollution. Additionally, choosing high-quality, durable, and long-lasting clothing that sheds fewer microfibres into the environment can help decrease the amount of microfibres released from clothing.

Drying Procedures: Drying procedures also have an impact on microfibre pollution. Air drying can result in lower emissions of airborne microfibres, as well as less damage to fabrics, and can help extend the lifespan of clothing. Although air drying may take longer, it can be less damaging to the environment and can increase the service life of clothes.

Infrastructure and Policy: Infrastructure and policy are important with respect to changes in advocacy and policy. Governments can make a significant difference by ensuring that new washing machines are equipped with effective microfibre filters. For example, France has introduced legislation requiring microfibre filters for certain new washing machines from 2025 onwards. Legislative measures may be developed in the long term to promote such requirements and encourage manufacturers to develop new fabrics with lower microfibre shedding.

Consumer Behaviour: Finally, it is essential to raise awareness about microfibre pollution, as consumers are on the front line of addressing this issue. Educating the population about the problem and encouraging them to adopt and share practical solutions within their communities can support greater community involvement. Individuals, organisations, and educational institutions have a responsibility to spread awareness and promote more sustainable behaviour [1,2,3].

Washing machines, laundry detergents, and textile products are widely used consumer products; therefore, the Bureau of Indian Standards (BIS) can play a significant role in developing standardised testing protocols and appropriate standards to minimize microfibre emissions during laundering [28]. The implementation of harmonized methods for quantifying microfibres release could facilitate the evaluation and improvement of textile and washing-machine performance with respect to microfibres shedding [29]. Beyond laundering, the disposal of used and discarded clothing represents an important pathway of textile waste generation and environmental pollution [30]. Synthetic textile wastes can persist in the environment and undergo fragmentation, potentially contributing to the accumulation of microfibres in terrestrial and aquatic ecosystems [30]. Consequently, integrating microfibres-control criteria with textile durability, reuse, recycling, and end-of-life management strategies is essential for reducing the environmental impacts of synthetic textile products [30].

II. CONCLUSION

Clothes made from synthetic fibres contribute significantly to microfibres pollution in the environment. The thesis emphasises the need to develop effective measures to reduce the discharge of microfibres, ultimately ensuring that ecosystems and people are protected from the impacts of their release into water bodies. The issues discussed are relevant with respect to the effects that microfibres contamination can have on aquatic organisms, chemical contamination from detergents, and the overall impact on the environment,

including energy consumption, water consumption, and air quality. Moreover, there are significant health risks associated with the ingestion or inhalation of microfibres. Some of these issues can be addressed through simple measures, such as selecting suitable clothing materials, adopting more effective washing systems, and using microfibres-collection devices. Significant policy-related and systemic progress can also be achieved through public awareness campaigns. In conclusion, mitigating microfibres pollution requires a multifaceted approach and collective effort to safeguard ecosystems and ensure a sustainable future for everyone.

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