MICROPLASTICS AS AN EMERGING HEALTH CONCERN: PREVENTIVE INSIGHTS FROM AYURVEDA.

Abstract:

Background: Microplastics (MPs) are ubiquitous environmental contaminants (≤5 mm), generated from the degradation of plastic products, direct industrial and consumer sources. Human exposure predominantly occur through ingestion and inhalation, with dermal exposure also reported. Their detection in human biological specimens has increased concern regarding potential effects on human health including inflammation, oxidative stress and endocrine disruption. Despite high public awareness of plastic pollution, corresponding preventive lifestyle and dietary practices remain inadequate in the general population. Ayurveda emphasizes preservation of health through appropriate *Ahara*, *Dinacharya*, *Ritucharya*, *Sadvritta*, hygiene and community awareness. This review evaluates microplastic exposure pathways and synthesizes a preventive framework derived from Ayurveda.

Methods: A systematic integration of observation, clinical and systematic reviews are extracted from online databases. Contemporary evidence is critically compared with relevant Ayurvedic preventive concepts described in the *Charaka Samhita*, *Sushruta Samhita* and *Ashtanga Hridaya*. Emphasis was placed on human biomonitoring data and the core Ayurvedic domains of *Ahara*, *Dincharya*, *Ritucharya* and *Sadvritta*.

Results: Microplastics have been reported in food, drinking water, air and various human biological specimens including blood, placenta, lung tissue, colectomy specimens, feces and semen. Current human evidence suggests associations with inflammatory, oxidative-stress and endocrine biomarkers, although causal relationships with specific chronic diseases remain insufficiently established. From an Ayurvedic perspective, prevention may focus on reducing exposure through appropriate dietary practices, hygienic food and water handling, minimizing unnecessary plastic contact, environmental cleanliness, behavioural modification and community awareness.

Discussion: A preventive correlation can be proposed between contemporary pathophysiological concerns such as oxidative stress, cellular injury, inflammation and Ayurvedic health-preserving measures through *Ahara*, *Dinacharya*, *Ritucharya* and *Sadvritta.* These approaches should be considered exposure-reduction strategies rather than proven methods of microplastic elimination. Integrating Ayurvedic preventive principles with modern environmental health evidence may provide a holistic and scientifically relevant approach to this emerging health concern.

Keywords: *Dinacharya*, Environmental health, Microplastics, Preventive health, *Ritucharya*, *Sadvritta*.

INTRODUCTION

Plastic has become an integral component of modern life because of its durability, versatility, low cost and wide applicability. However, increasing production, consumption and inadequate disposal have resulted in extensive environmental contamination. Progressive environmental fragmentation of plastic materials generates microscopic particles collectively referred to as microplastics (MPs). MPs are generally defined as plastic particles measuring ≤5 mm, with nanoplastics generally referring to particles below approximately 1 µm. MPs are broadly classified into primary microplastics, which are intentionally produced at microscopic dimensions and secondary microplastics, which arise from fragmentation and degradation of larger plastic products. [1,2] They are now distributed across aquatic, terrestrial and atmospheric environments.

Widespread polymer species found in environmental and human matrices include Polypropylene (PP), Polyethylene (PE), Polyethylene Terephthalate (PET), Polystyrene (PS) and Polyvinyl Chloride (PVC). [3] Advanced analytical techniques like Fourier-transform infrared spectroscopy (FTIR) and Raman microspectroscopy are used to identify these polymer types in human specimens. Systematic reviews confirm that Polypropylene (PP) is the most frequently identified polymer in human biological specimens, including feces, colon, hair and saliva. [4,5]

Microplastics exist in multiple physical shapes: fibers, fragments, spheres, pellets and films. [6] Fibers are commonly derived from synthetic textiles and clothing, whereas fragments and films originate from packaging degradation. These particles have high surface area-to-volume ratios and hydrophobic surfaces, which facilitate physical and chemical interactions with biological tissues. [7] Additives are incorporated during synthesis to modify plastic properties. They are not chemically bound to the polymer matrix and can easily leach out into human tissues. [8] Key additives of concern include Phthalates, Bisphenol A (BPA), Polybrominated diphenyl ethers (PBDEs), Triclosan, Alkylphenols and heavy metal stabilizers/pigments like Lead, Cadmium and Chromium. [9]

MPs act as passive samplers in aquatic and soil systems, adsorbing persistent organic pollutants (POPs) such as Polychlorinated Biphenyls (PCBs), Polycyclic Aromatic Hydrocarbons (PAHs), organochlorine pesticides and trace metals. [10-12] MPs in soil and water serve as substrates for the development of complex microbial communities, forming "biofilms". These biofilms can transport pathogenic bacteria and antibiotic-resistance genes, functioning as vectors for infectious diseases. [13]

A) Microplastic exposure Pathways -

Microplastics enter human environments through food packaging, synthetic textiles, cosmetics, industrial activities, agricultural practices, and degradation of plastic waste. Human exposure is increasingly recognized as multifactorial occurs through ingestion, inhalation and to a lesser extent, dermal contact. Food and drinking water represent important ingestion pathways, while indoor dust, airborne particles and synthetic fibers contribute to inhalational exposure. Dermal exposure may occur through contact with certain consumer products. Contemporary reviews similarly identify ingestion, inhalation and dermal contact as the principal routes of human exposure. [1]

Table 1. Major human exposure pathways [1,2]

Exposure pathway	Important sources
Ingestion	Food, drinking water, food packaging, plastic-contact materials
Inhalation	Household dust, airborne fibers, occupational environments, synthetic textiles
Drinking water	Bottled water, environmental and distribution-system contamination
Food-contact materials	Plastic packaging, storage containers and processing materials
Dermal exposure	Environmental and occupational contact
Occupational exposure	Plastic manufacturing, recycling, textile and waste-management activities

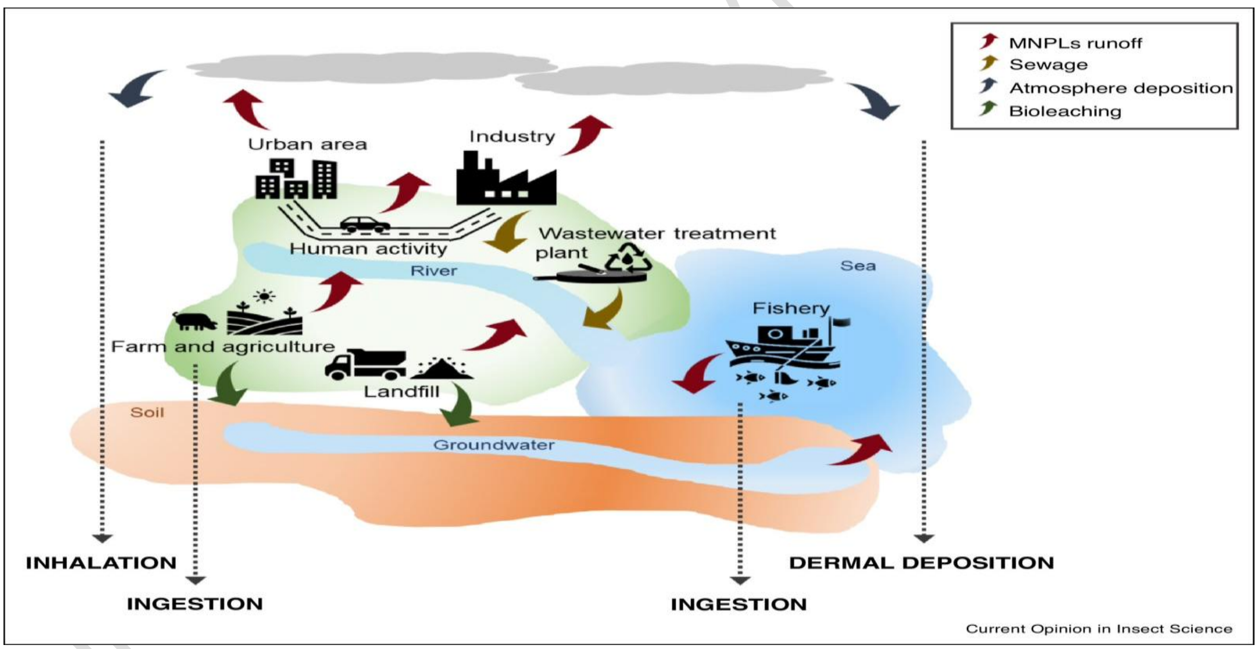

Fig No. 1 Showing major human exposure pathways of microplastics

B) **Detection of Microplastic in human biological specimens** -

The detection of plastic particles in biological specimens represents an important development in environmental-health research. Microplastics have been detected in human specimens including human blood, lung tissue, placenta, colon tissue, stool, testes and semen. [3-9]
Leslie et al. reported polymeric particles in blood samples from healthy volunteers using pyrolysis-gas chromatography/mass spectrometry, demonstrating that plastic-associated material

can be detected in the human bloodstream.[14] Jenner et al. subsequently demonstrated microplastics in human lung tissue using micro-Fourier transform infrared spectroscopy.[15] Ragusa et al. reported microplastics in human placental samples, raising concern about possible maternal-fetal exposure.[16] Ibrahim et al. detected microplastics in all examined colectomy specimens, while Schwabl et al. detected microplastics in all stool samples examined in their pilot study.[17,18]

Microplastics have also been detected in the male reproductive system. Zhao et al. identified MPs in human testicular and semen samples, while another study using Raman microspectroscopy reported plastic fragments in six of ten semen samples. [19,20]

The presence of microplastics in human tissues indicates exposure, but it does not necessarily mean that they are responsible for causing disease or adverse health effects.

Table 2. Evidence for microplastics in human biological specimens

Biological specimen	**Representative evidence**	**Interpretation**
Blood	Leslie et al.	Demonstrates internal exposure to plastic polymers
Lung tissue	Jenner et al.	Supports inhalation and pulmonary deposition/exposure
Placenta	Ragusa et al.	Indicates maternal-fetal exposure is biologically plausible
Colon tissue	Ibrahim et al.	Demonstrates presence within gastrointestinal tissue
Stool	Schwabl et al.; Yan et al.	Demonstrates gastrointestinal exposure and excretion
Testis/semen	Zhao et al.; Raman study	Demonstrates reproductive-system exposure
Atherosclerotic plaque	Marfella et al.	Demonstrates presence in vascular tissue; clinical significance requires further study

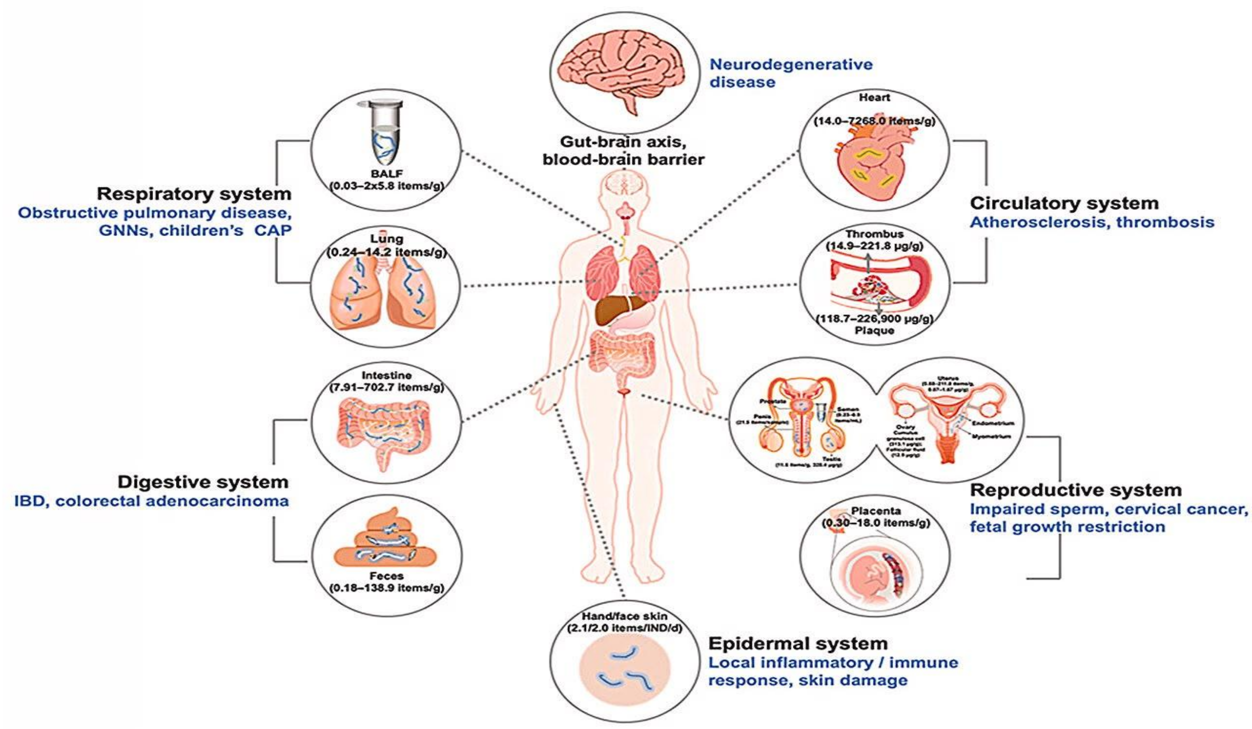

Fig No. 2 Showing microplastic in human biological specimens

The biological effects of MPs are an emerging area of research. Experimental studies indicate possible oxidative stress, inflammation, immune modulation, endocrine disturbances, alterations in gut microbiota and cellular injury. [10]

C) Potential health effects -

1) Gastrointestinal System

High concentrations of MPs in human stool samples are statistically associated with increased markers of subclinical intestinal inflammation.[17,18] Prospective observational cohort studies show that patients diagnosed with active inflammatory bowel disease (IBD), such as ulcerative colitis, exhibit significantly higher concentrations of microplastics in their feces compared to healthy age-matched controls. [22] Subclinical gastrointestinal symptoms including bloating, gas and transient abdominal discomfort, show moderate statistical associations with high dietary intake of plastic-packaged foods. [23]

2) Respiratory system

Occupational epidemiological studies in synthetic textile workers and plastic-processing employees demonstrate high rates of persistent cough, dyspnea and occupational asthma, alongside chronic pulmonary function deficits. In the general population, inhalation exposure is linked to subclinical airway irritation and elevated inflammatory markers in nasal lavage fluid. [24,25]

3) Cardiovascular concerns

Preliminary observational studies identify microplastics within vascular plaques and human blood, which statistically correlate with an increased risk of acute cardiovascular events, though direct causal disease links are not established. [26,27]

4) Reproductive and developmental effects

Detections of microplastics in human placenta (mother and fetal sides), amniotic fluid, menstrual blood and semen are associated with altered perinatal biomarkers, although direct clinical causation of infertility or pregnancy loss remains unproven in humans. [16,28]

5) Endocrine and Metabolic Effects

Strong statistical associations exist between elevated internal microplastic burdens and altered thyroid hormone profiles, elevated cortisol and impaired lipid/glucose homeostasis, particularly in pregnant cohorts and children. [29,30]

6) Neuroinflammation and Possible Neurological Effects

Limited cross-sectional surveys report weak, inconsistent associations between high environmental plastic usage and subjective neurocognitive symptoms, attention deficits and memory impairment. [31,32]

7) Immune and Inflammatory Responses

Multi-cohort observational studies demonstrate consistent statistical correlations between elevated microplastic exposure and elevated systemic pro-inflammatory cytokines: C-reactive protein (CRP), Interleukin-6 (IL-6) and Tumor Necrosis Factor-alpha (TNF-alpha).[33,34]

8) Oxidative Stress and Cellular Damage

Human biomonitoring shows positive correlations between microplastic exposure markers and oxidative stress biomarkers, specifically Malondialdehyde (MDA) and 8-hydroxy-2′-deoxyguanosine (8-OHdG). [35]

9) Genotoxicity

Direct clinical evidence of microplastic-induced DNA damage, chromosome aberrations or genetic mutations in general human populations is currently lacking.[36,37]

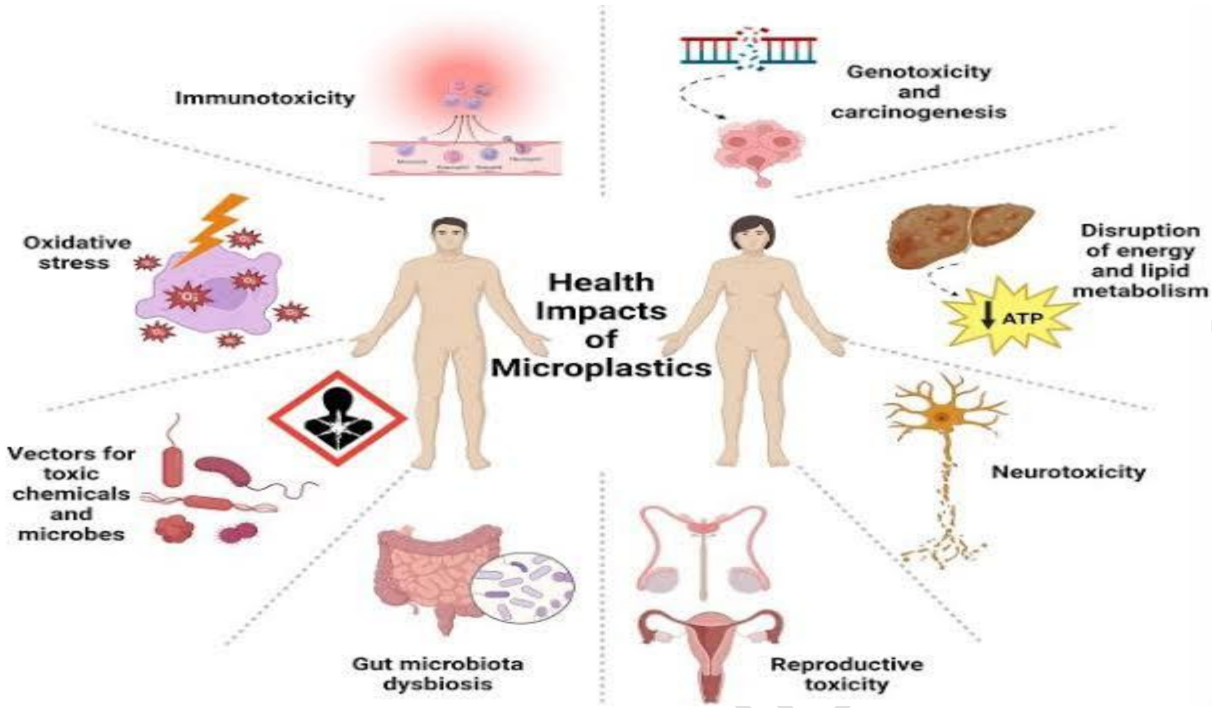

Fig No. 3 Showing health effects of microplastics

This emerging environmental-health challenge has relevance for preventive medicine. Ayurveda gives primary importance to preservation of health through *Swasthavritta*. The Ayurvedic objective of maintaining health is classically expressed as *Swasthasya Swasthya Rakshanam*, emphasizing preservation of the health of healthy individuals.[38] Appropriate *Ahara*, *Dincharya*, *Ritucharya* and *Sadvritta* are important components of preventive health. [39] These principles are elaborated across the classical Ayurvedic literature, including the *Charaka Samhita*, *Sushruta Samhita* and *Ashtanga Hridaya*. [38,40-41]

The contemporary problem of microplastic exposure therefore provides an opportunity to examine whether Ayurvedic preventive principles can be applied to an emerging environmental contaminant. These principles may provide a conceptual framework for exposure reduction and health promotion.

MATERIALS AND METHODS

This article is developed as a structured narrative review integrating contemporary environmental-health literature with classical Ayurvedic preventive principles. Relevant Ayurvedic concepts were examined from *Charaka Samhita*, *Sushruta Samhita* and *Ashtanga Hridaya*, with emphasis on *Ahara*, *Dincharya*, *Riucharya*, and *Sadvritta.* [39-41] Contemporary evidence was identified from PubMed-indexed biomedical literature, peer-reviewed scientific publications and authoritative reports from WHO and EFSA.

RESULTS

A) Microplastic exposure preventive approaches

Human exposure to MPs is principally associated with ingestion and inhalation. Food may become contaminated during production, processing, packaging, transportation or preparation. Drinking water can contain plastic particles originating from environmental contamination, water systems or plastic containers. Airborne microfibers may originate from synthetic textiles, household dust, industrial processes and environmental fragmentation. [1,2]

Table 4. Major human exposure preventive approach [42]

Exposure pathway	Potential preventive approach
Ingestion	Reduce unnecessary plastic-food contact, hygienic food preparation, prefer safer reusable materials where feasible
Inhalation	Household dust control, adequate ventilation, occupational controls.
Drinking water	Use appropriately treated drinking water, reduce unnecessary dependence on single-use plastic bottles
Food-contact materials	Avoid unnecessary heating/storage of food in unsuitable plastic materials
Dermal exposure	Occupational/environmental hygiene
Occupational exposure	Engineering controls, respiratory protection and workplace hygiene

B) Preventive perspectives through Ayurveda

Ayurveda places preservation of health at the foundation of its therapeutic philosophy. *Achraya Charaka* describes the objective of Ayurveda as preservation of the health of healthy individuals and alleviation of disease in the sick.[38] This principle provides a strong conceptual foundation for addressing environmental exposures before clinically apparent disease develops.

1) *Ahara* and food-contact practices:

Ahara is central to Ayurvedic health preservation. Classical texts emphasize appropriate quantity, quality, compatibility and method of food consumption.[38,39] In the context of MPs exposure, the most scientifically defensible application is to adopt food practices that may reduce unnecessary contact with plastic materials.

a. Minimizing Unnecessary Plastic Contact with Food

Ayurveda prioritizes *Ahara Shuddhi* as the primary fuel for *Prana* and the protection of *Agni*. Consuming food that has been compromised by physical contact with synthetic, non-biodegradable chemicals introduces *Kritrima Visha* and *Dushivisha* into the gastrointestinal tract. Over time, this slow exposure vitiates the bodily tissues (*Dhatus*), leading to systemic inflammation and chronic ailments. Cutting off the exposure pathway of everyday essentials such as milk, packaged snacks and prepared meals, that frequently harbor micro-polymers. [43,44]

b. Avoiding Unnecessary Heating of Food in Inappropriate Plastic Containers

The application of external heat to food inside inappropriate synthetic vessels transforms wholesome, life-sustaining nutrition into *Viruddha-Ahara* and generates *Ama Visha*. This severely impairs *Jatharagni*, leading to the chronic accumulation of toxic residue within the *Srotas*, which manifests over time as metabolic and tissue-level disorders. Thermal stress on plastic polymers dramatically accelerates their depolymerization, structural fragmentation and physical degradation. This causes a exponential spike in the release of sub-micron fragments, nanoplastics and highly toxic additives directly into hot food. Avoiding microwave heating or pouring hot food into plastic containers is crucial to prevent the direct ingestion of billions of chemical particles. [3]

c. Reducing Prolonged Storage of Food in Disposable Plastic Packaging

Food should ideally be consumed fresh to maintain its vital life force and high *Sattvic* quality. Prolonged storage in artificial materials degrades the natural properties of food, rendering it *Paryushita* (stale food). Storing food long-term in plastic packaging slowly infuse the food, quietly accumulating in the tissues without immediate toxic symptoms, only to manifest as chronic disease years later when systemic immunity is compromised. Disposable plastic packaging, often made from low-density polyethylene (LDPE) or polystyrene (PS), is highly susceptible to weathering, light exposure and mechanical stress over time. Prolonged contact provides a continuous timeline for polymer breakdown and additive leaching. Reducing storage time in disposable plastics limits the bio-persistent plastic load transferred into our daily diet. [45]

d. Using Suitable Reusable Food-Storage Materials

Classical texts recommend storing water and food in natural vessels such as *Mrittika* (Soil), *Tamra* (copper) or stainless steel according to their thermodynamic and healing properties. For instance, copper is a natural *Lekhana* material that purifies fluids, cleanses the circulatory channels and balances *Kapha*, while clay provides alkalizing and cooling benefits.[43] Transitioning to inert, non-polymeric, reusable storage materials completely eliminates the source-to-food transfer pathway of synthetic particles. Glass, ceramics and stable food-grade metals do not fragment, undergo micro-abrasion or leach chemical endocrine disruptors under typical storage temperatures, directly supporting the ecological and public health "5R" framework (Reduce, Reuse, Recover, Recycle, Re-invest). [45]

e. Washing Fresh Produce Appropriately

This is a vital component of *Shaucha* (personal and dietary hygiene) and *Ahara Pariksha* (food inspection and purification). Thoroughly washing fruits and vegetables dislodges external physical impurities before they can enter the body and disturb internal homeostasis. [43] Modern agricultural practices heavily rely on plastic mulch films, sewage sludge fertilizers and plastic irrigation piping, which release high concentrations of micro- and nanoplastics into the soil.

Plants can actively take up sub-micron plastics through their water transport systems, translocating these particles into roots, stems, leaves and edible fruits. Washing fresh produce under running water or using mild saline washes removes soil-adhered microplastics, atmospheric plastic fallout and surface-bound plasticizer residues from the skin of the produce.[44]

2) *Dinacharya* :

Dinacharya promotes regularity in daily activities, personal hygiene, physical activity, sleep and other health-supportive behaviors. *Ashtanga Hridaya* describes daily regimen as part of maintaining physiological balance. [41]

a. Regular Household Cleaning and Dust Control

Indoor household dust is a primary sink for airborne MPs and nanoplastics (NPs), capturing highly persistent synthetic microfibers and fragments shed continuously from indoor carpets, synthetic upholstery and home electronics.[8] Upon inhalation, these particulates escape standard respiratory clearance mechanisms, deposit deep within pulmonary tissues and blocks the *Pranavaha Srotas*. This aggravates *Vata* and *Kapha* doshas and predisposing the individual to respiratory conditions such as *Kasa* and *Shwasa*. [44] To counteract this, Implementing regular, systematic dust-control measures such as wet-dusting, HEPA-filter vacuuming, classical sanitation with daily *Dhupana* by using natural anti-toxic and antimicrobial agents like *Guggulu*, *Neem* and *Vacha* is a vital primary prevention strategy to lower the daily inhalation burden. [3,45]

b. Appropriate Ventilation

Exposure to airborne synthetic fibers is often significantly higher in indoor environments than outdoors due to enclosed air volumes and the continuous shedding of polymers from clothes and synthetic home furnishings.[10] If these airborne particles are not expelled leading to deep alveolar deposition. [15] Ensuring adequate, consistent natural cross-ventilation or utilizing high-efficiency mechanical air exchange diluted indoor microfiber concentration. This practice represents *Vayu Shuddhi*, which is a key clinical countermeasure to prevent *Janapadodhwamsa*. Opening windows and doors, particularly during the early morning hours, allows the natural flow of fresh and life-sustaining *Prana Vayu*. This effectively decreases the cumulative inhalation exposure risk for occupants. [3]

c. Hand Hygiene Before Food Preparation and Eating

Human skin especially on the hands acts as a continuous collector for microscopic plastic fragments, synthetic chemical residues and industrial plasticizers transferred from touching everyday synthetic packaging, electronic devices and consumer goods.[10] When food is handled, prepared or consumed, these hand-adhered particles are transferred directly to the food, facilitating direct oral ingestion, which is the most statistically significant pathway for systemic plastic exposure.[10] Ayurvedic texts strictly mandate *Hasta-Pada-Mukha Prakshalana* immediately prior to taking *Ahara*. Rigorous hand hygiene using plastic-free soaps before preparing or consuming meals is a highly effective, low-cost barrier that disrupts this hand-to-mouth transfer. [3,44]

d. Appropriate Laundering and Management of Synthetic Textiles

Domestic laundering of synthetic garments (such as polyester, nylon and acrylic) releases millions of micro-polymeric fibers per wash cycle into household wastewater.[6] These microfibers slip through standard municipal treatment plant filters, polluting aquatic ecosystems, bioaccumulating within the marine food chain and ultimately returning to human diets through contaminated seafood.[10] Ayurveda advocates wearing clean, fresh, light clothing made exclusively from natural, plant-based fibers like *Karpasa* or *Kshauma*, which are highly breathable and biocompatible. Conversely, wearing synthetic fabrics as dressing that trap sweat, block skin pores and aggravate *Pitta* and *Kapha* doshas. Modern public health interventions include washing clothes at lower temperatures, installing specialized microfiber-catching filters on washing machine drain hoses, using liquid detergents to minimize physical fabric friction and transitioning to natural, biodegradable textiles i.e. cotton, wool, linen. [45]

e. Regular Physical Activity and Adequate Sleep as Components of General Health Promotion

General health promotion utilizes lifestyle medicine to optimize endogenous clearance systems and strengthen immune defenses against environmental toxic loads. Regular physical activity enhances cardiovascular circulation and gastrointestinal motility, facilitating the natural excretion of ingested particulates.[10] Regular *Vyayama* kindles *Agni*, improves *Sroto-Shodhana* and promotes *Swedana*, which actively excretes deep-seated latent toxins through feces and sweat. Adequate, timely, deep and restorative sleep pacifies *Vata* and *Pitta* doshas, enables the body's internal self-healing mechanisms to repair cellular wear, counter oxidative stress and maintain immunity against chronic low-grade toxic exposures.

3) *Ritucharya* :

Ritucharya recommends seasonal modification of diet and lifestyle according to environmental and physiological changes. The transition of seasons governs *Chaya*, *Prakopa* and *Prshama* of the *Doshas* within the body.[39] When seasonal transitions begin to destabilize the *Doshas*, Swasthavritta schedules proactive, preventative purification therapies i.e. *Shodhana* to safely expel accumulated environmental residues and ensures that the body's physical channels are regularly cleansed, helping to maintain physical purity and prevent chronic environmental illnesses.

Table 5. **Seasonal Regimen for Microplastic Mitigation**

Sr. No.	Seasons	Environmental MNPs Stressors	Traditional Regimen

1.	***Grishma & Sharad***	High temperatures and UV index accelerate plastic fragmentation. Heat increases chemical plasticizer (phthalate/BPA) leaching into bottled water	-Store water exclusively in *Mrittika* or *Tamra* vessels. -Consume cooling, light and *Sattvic* food. -Strictly avoid heating or storing food in plastic.
2.	***Varsha***	Stormwater runoff washes microplastics and toxic heavy-metal additives into aquatic systems. High microbial biofilm formation on suspended plastics.	-Consume *Shruta-Sheeta Jala*. -Emphasize *Deepana-Pachana* herbs -Perform mild, seasonal purification.
3.	***Shishira & Hemanta***	Dry windy weather suspends airborne microfibers indoors.	-Practice daily Nasya. -Maintain wet-cleaning of surfaces. -Perform physical activity and *Abhyanga* with suitable medicated oil.

4) *Sadvritta*, behavioural modification and environmental health :

Sadvritta emphasizes disciplined conduct, personal responsibility, social behavior and maintenance of mental and social well-being. [38]

a. Responsible Waste Segregation

Municipal solid waste management relies on household waste segregation as a primary public health barrier, which include under *Sadvritta* i.e. daily regimen of social hygiene. When plastic waste is mixed with organic waste, it is discarded in municipal landfills or enters natural ecosystems where it persists for over 400 years. Over time, these macroplastics undergo weathering and disintegrate into highly transportable microplastics and nanoplastics (MNPs). Segregating waste at the source prevents plastic from contaminating terrestrial and aquatic systems, facilitating efficient recycling and reducing the environmental pool of secondary MNPs. [46]

b. Prevention of Littering

Littering directly introduces large volumes of consumer plastics into the biosphere through stormwater runoff, winds and aquatic channels. Inadequate disposal of plastics poses a severe threat to soil, air and waterways, eventually leading to ecological accumulation and food chain infiltration.[48] Once littered, these plastics undergo mechanical fragmentation and UV-induced degradation, turning into persistent environmental contaminants. A primary public health goal is to curb littering to stop the physical spread of synthetic polymers and prevent their breakdown into micro-fibers and micro-fragments that contaminate essential resources.[49]

c. Reduction of Unnecessary Single-Use Plastics

Single-use plastics such as plastic-bottled water, disposable straws, single-use bags and plastic food wraps are major contributors to global plastic waste streams. Human exposure occurs continuously because these single-use items fragment easily, introducing microplastics directly into drinking water, food packaging and processed consumables. [43] Modern public health policy advocates for the complete reduction of single-use plastics as the highest priority of the 5R responsibility framework (Reduce, Reuse, Recover, Recycle and Re-invest) to minimize plastic exposure at its source. Traditional Ayurvedic lifestyle also models rely on vessels made of *Mrittika* (soil), *Tamra* (copper) or plant leaves (such as *Patravali* plates) for handling meals to prevents the introduction of artificial elements to body. [50]

d. Responsible Consumption

Responsible consumption involves modifying individual purchasing and usage habits, such as bringing reusable shopping bags, avoiding bottled water, upcycling glass containers and buying in bulk to reduce packaging waste. This concept is a direct extension of *Ahara Matra* (eating in proper measure) and *Samyak Vihara* (regulated, mindful lifestyle). Studies show that while a majority of the population holds positive attitudes toward reducing plastic waste, only a small fraction (approximately 10%) consistently adopts these protective behaviors in their daily lives. Bridging this "awareness-practice gap" through conscious, responsible household choices is crucial to lower the demand for manufactured polymers and reduce personal exposure to plastic-related hazards.[51]

e. Participation in Community Environmental-Health Initiatives

Addressing ubiquitous environmental contaminants like microplastics requires collective, community-level action that goes beyond individual behavioral modifications. [47] Participating in community-led cleanups, protecting water bodies and supporting public sanitation are core duties of Sadvritta, helps to build stronger local circular economies, improves waste management infrastructure and creates a clean living environment.

f. Health Education Concerning Plastic Exposure

Knowledge, Attitude and Practice (KAP) evaluations demonstrate that general public awareness of plastic pollution does not necessarily translate into an understanding of microplastic exposure routes and its subclinical health implications. Empowering the public with the practical principles of Ayurveda focusing on *Dinacharya*, *Ritucharya*, and *Ahara* enables individuals to make conscious, protective choices that preserve their metabolic fire and support long-term well-being. Educating young people by incorporating environmental health and microplastic issues into school and university curricula is a highly effective way to foster lifelong preventive behaviors. [43]

Targeted health education campaigns are needed to bridge this scientific knowledge gap, translate positive public concern into sustainable household practices and support stronger environmental policies. Educating young people by incorporating environmental health and microplastic issues into school and university curricula is a highly effective way to foster lifelong preventive behaviors. [52]

In Ayurveda, intellectual error or conscious mistakes i.e. *Pragya-paradha* are recognized as the root cause of all physical and mental suffering. [47] *Pragya-paradha* occurs when an individual, despite knowing the ultimate benefits of wholesome living, chooses unwholesome paths due to a lack of deep understanding, leading to health issues. Delivering clear, accessible health education acts as the primary preventive shield against *Pragya-paradha.* Empowering the public with the practical principles of Ayurveda focusing on *Ahara, Dinacharya*, *Ritucharya* and *Sadvritta* enables individuals to make conscious, protective choices that preserve their metabolic fire and support long-term well-being.

DISCUSSION

Microplastics are increasingly recognized as ubiquitous environmental contaminants, with ingestion and inhalation being major routes of human exposure. Their detection in human biological samples has raised concerns regarding possible respiratory, gastrointestinal and systemic effects. Experimental evidence suggests that MPs may induce oxidative stress, inflammation, epithelial injury and cellular dysfunction. However, human evidence remains limited, heterogeneous and causality has not yet been firmly established.[14-21]

From an Ayurvedic perspective, prevention primarily emphasizes appropriate *Ahara*, *Dinacharya*, *Ritucharya* and *Sadvritta*.[38] These principles may be relevant to microplastic prevention through practical measures such as improving food and water quality, minimizing unnecessary plastic contact, maintaining hygiene and adopting environmentally responsible behaviours. Such applications should be regarded as preventive and exposure-reduction strategies rather than proven methods of microplastic elimination.

Overall, Ayurveda provides a valuable preventive framework for reducing environmental exposure and promoting physiological resilience but specific interventions require rigorous experimental and clinical validation. An evidence-based integration of Ayurveda with modern environmental-health research may help develop scientifically credible strategies for addressing the emerging health challenge of microplastic exposure.

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