

Microplastics in Drinking Water Systems under Hot-Climatic Conditions: Evidence, Risks, and Policy Implications

A Comprehensive Review

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1. INTRODUCTION

- Microplastics (MPs, <5 mm) are increasingly detected in drinking water worldwide, with hot and arid regions facing unique amplification pathways.
- High temperatures (>40 °C), intense UV radiation, desalination dependence, polymer-based infrastructure, and high bottled water use increase the risk of MP contamination.
- This review synthesizes current evidence on MP occurrence, thermal degradation, health implications, and policy responses, with emphasis on GCC countries and Qatar.

KEY TAKE-HOME MESSAGE

Hot-climate conditions accelerate polymer degradation and MP release, creating multiplicative exposure pathways in drinking water systems. Robust monitoring, resilient infrastructure, and climate-adapted policies are urgently needed.

2. METHODS

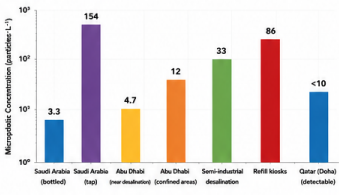
A systematic literature search was performed in Web of Science, Scopus, PubMed, and Google Scholar (up to March 2026).

- Records identified **n = 1,254**
- After screening **n = 224**
- Studies included **n = 224**
- Focus areas: Occurrence, Sources, Thermal Stress, Health Risks, and Policy

Studies included peer-reviewed articles reporting MP concentrations in drinking water (or related sources), thermal degradation behavior, infrastructure/packaging sources, and health/policy implications.

3. RESULTS

3.1 Microplastic Occurrence in Hot-Climatic Drinking Water



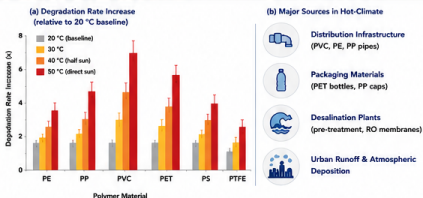
Reported concentrations vary widely depending on analytical methods, size cutoffs, and water sources. Data synthesized from multiple studies (Table 1).

3.2 Microplastic Concentrations in Drinking Water from Hot-Climatic Regions

Region / Source	Concentration (particles L ⁻¹)	Size Range	Dominant Polymers	Key Reference
Saudi Arabia (bottled)	19 – 1,154	<20 µm	PE, PP, PET	Almalm et al. (2021)
Saudi Arabia (tap)	1.9 – 4.7	25 – 500 µm	PE, PP	Almalm et al. (2021)
Abu Dhabi (near desalination)	3.3 ± 3.0	>300 µm	PA-66, CA, PET, ABS	Hashmi et al. (2026)
Abu Dhabi (confined area)	8.5 ± 5.5	>300 µm	ABS, CA, PET, LDPE	Hashmi et al. (2026)
Semi-industrial desalination	88 – 180	Various	PE, PP, PVC	Rigi et al. (2026)
Refill kiosks	11 – 860	Various	Mixed	Pérez-Guevara et al. (2022)
Qatar (Doha)	Detectable	<10 µm	PET, HDPE, PP	Al-Ani et al. (2025)

Note: Data from Abu Dhabi represent marine/surface-water environments near desalination-related areas and should not be interpreted as direct drinking-water concentrations.

3.3 Thermal Degradation and Source Contribution



Data synthesized from Khan et al. (2024), Zhang et al. (2024), and Li et al. (2024).

3.4 Human Exposure and Health Implications

Potential Exposure Pathways

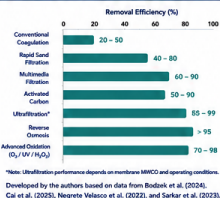
- Ingestion (drinking water)
- Inhalation (aerosolization)
- Dermal contact (during handling)

Potential Health Effects (Evidence to date)

- Chemical leaching of additives (e.g., phthalates, BPA)
- Endocrine disruption
- Oxidative stress & inflammation
- Potential microbial influence enhancement
- Cellular and reproductive toxicity (in vitro / animal studies)

Evidence is still emerging, and long-term epidemiological data for humans are limited.

3.5 Removal of Microplastics in Drinking Water Treatment



3.6 Exposure Framework in Hot-Climatic Countries

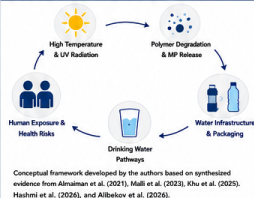


Table 3. Estimated Annual Microplastic Intake via Drinking Water in Hot-Climatic Conditions

Population Group	Daily Water Consumption (L)	MP Concentration (particles L ⁻¹)	Daily Intake (particles-day ⁻¹)	Annual Intake (particles-year ⁻¹)	Assumptions
Adult (70 kg)	3	30	90	32,850	2.5x Higher than temperate regions
Child (20 kg)	1.5	30	45	16,425	
Bottled Water Consumer	2	80	160	58,400	High-end bottled water scenario

These estimates should be interpreted cautiously, as they are extrapolated from available international datasets and assumptions regarding hot-climate water consumption patterns. They have not yet been validated through comprehensive drinking water monitoring studies in Qatar or other GCC countries.

5. CONCLUSION

Hot-climate drinking water systems face amplified microplastic risks due to thermal degradation, infrastructure characteristics, and high bottled water use. Current regional data remain limited, highlighting the need for dedicated monitoring in Qatar and the GCC to support risk-based policy and resilient water system design.

ACKNOWLEDGMENT

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