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Rethinking bottled water in public health discourse

Amit Abraham ,[1] Sohaila Cheema ,[1] Karima Chaabna ,[1] Albert B Lowenfels ,[2] Ravinder Mamtani [1]

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[1]Institute for Population Health, Weill Cornell Medicine - Qatar, Doha, Qatar
[2]Department of Surgery and Department of Family Medicine, New York Medical College, Valhalla, New York, USA

Correspondence to
Dr Amit Abraham; ama2006@qatar-med.cornell.edu

INTRODUCTION

The plastic bottled water (BW) industry is experiencing rapid growth, with data indicating that approximately one million bottles are purchased every minute.[1] This trend is projected to continue, with experts forecasting a substantial increase in BW consumption in the years ahead,[2] despite the well-documented adverse effects of contaminated BW on human health[3] and the environment.[4] While the necessity of BW is undeniable for nearly two billion individuals globally who lack access to safe drinking water, the escalating demand in other sectors is largely driven by convenience, portability, perceived nutritional advantages, mistrust of tap water quality and personal taste preferences.[5] Due to poor waste management strategies, low-income and middle-income countries account for most of plastic waste today, a significant amount of which is waste from BW.[6] Further, Asia produces over 80% of global plastic waste emitted to the oceans.[6] However, the excessive consumption of disposable BW presents a significant challenge, necessitating immediate and concerted efforts to mitigate its adverse effects. These include a range of issues impacting public health, environmental integrity and the broader goal of sustainable development. Addressing these concerns is critical for maintaining ecological balance and ensuring long-term health safety.

Given the intricate interplay between regulatory frameworks, public health ramifications and environmental sustainability, this article contributes to the pivotal discourse of rethinking BW in public health. What regulatory standards and monitoring systems, if any, exist? What are the social, political, financial and environmental considerations that influence the use of BW? What role do stakeholders such as policymakers, governments and individuals play in making informed decisions about the use of BW? How will concerted efforts impact public health and ecosystem sustainability? The subsequent sections endeavour to dissect these dynamics.

SUMMARY BOX

- ⇒ The use of plastic bottles for the consumption of beverages, including water, exacts an immense toll on human and planetary health, from leaching of toxic substances to degradation of ecosystems and increasing greenhouse gas emissions.
- ⇒ Despite these significant health and environmental costs, the consumption of water in plastic bottles has markedly risen on a global scale.
- ⇒ Misunderstandings about the safety and potential risks of bottled and tap water persist. Launching public awareness campaigns aimed at dispelling these common misconceptions is essential.
- ⇒ There are regions where drinking water is contaminated; however, tap water is generally safe, inexpensive, convenient and eco-friendly in high-income and upper-middle-income countries that adhere to rigorous safety standards. Low-income and middle-income countries must invest in infrastructure and safe tap water availability.
- ⇒ Bottled water regulations are often more relaxed than tap water; therefore, regulators must implement stronger measures to ensure safety and quality.

Disparities in regulation: contrasting standards for tap and BW safety

Tap water in high-income and upper-middle-income countries often exceeds BW in safety,[7] yet this fact remains unknown to many. Surprisingly, up to two-thirds of BW in the USA is repackaged tap water.[7] This finding becomes more impactful when considering the rigorous standards that tap water in high-income countries must meet, which far outstrip those for BW, particularly regarding chemical leaching from plastic containers.[5 8]

In the USA, this disparity in regulation becomes even more evident. The Environmental Protection Agency ensures tap water's safety, enforcing a regime of comprehensive testing for a broad spectrum of potential contaminants. This level

of scrutiny means that any deviation from the standards necessitates immediate reporting, with a requirement to detect contaminants swiftly within 24 hours.[8] Contrastingly, the realm of BW, governed by the Food and Drug Administration, paints a different picture. BW manufacturers face no obligation to disclose the presence of microbial or chemical contaminants.[8] They do not need to demonstrate that their products meet specific quality standards or adhere to stringent inspection protocols.[8] This striking difference in regulatory approaches raises important questions about our perceptions and choices regarding water consumption. Table 1 compares the regulatory standards and the implications of the use of bottled and tap water on human and planetary health, within the context of the United Nation's Sustainable Development Goals, which provide a blueprint for all countries to promote sustainable prosperity for all.

Pervasive plastic contamination of BW: human health implications and concerns

Plastic contamination is ubiquitous in BW, with reports suggesting a wide-ranging presence spanning from 10% to 78% of BW samples.[9] The list of these contaminants includes microplastics, phthalates, alkylphenols, polychlorinated biphenyls, polyfluoroalkyl substances and bisphenol A (BPA).[10] Studies indicate that microplastic contamination is associated with oxidative stress, immune dysregulation and potential obesogenic effects through alteration of lipid metabolism.[11] Such contaminants are frequently classified as endocrine disruptors, interfering with the normal functioning of reproductive hormones, thyroid hormones and glucocorticoid receptors, especially during critical embryonic stages.[10] BPA is a notorious player in this mix. Its exposure has been tied to a range of later-life health issues like hypertension, cardiovascular disease, diabetes and obesity.[12] In a recent study, patients with microplastics/nanoplastics in carotid plaque specimens were at higher risk of myocardial infarctions, strokes or death in the subsequent 34 months, compared with those who did not have microplastics/nanoplastics in carotid plaque (HR: 4.53; p<0.0001).[13] While there are short-term safety thresholds, the long-term effects of these contaminants remain largely unknown.[14] The storage conditions of BW significantly increase the risk of plastic contaminants leaching. Specifically, prolonged storage, exposure to high temperatures and sunlight can lead to harmful chemicals like BPA and phthalates seeping into the water.[14] Studies have established a connection between these contaminants and health issues, including gastrointestinal and neurological problems, in individuals consuming such contaminated water.[3] In sum, the prevalent contamination with microplastics, endocrine disruptors and other hazardous substances belies the clean image that BW projects (table 1). This narrative paints a concerning picture of BW—a product often chosen for its perceived purity and safety.

Planetary health implications of plastic BW: urgent action for sustainability

The utilisation of plastic bottles has significant implications for environmental health. Ranking as the second most prevalent ocean pollutant, plastic bottles make up 11.9% of all plastic waste, surpassed only by plastic bags.[6] Globally, a mere 9% of these bottles undergo recycling, with notable disparities among countries.[6] This low recycling rate is attributed to various factors, including the incorporation of colourants and additives, contamination from consumer use (eg, food stains), limitations in recyclability, complexities in recycling processes and the cheaper cost of producing new plastics than recycling.[6] Consequently, most plastic waste ends up in landfills or incinerators, leading to potential soil and water contamination and compromising air quality in the vicinity. The dilemma deepens with high-income nations outsourcing their plastic waste to lower-income and middle-income countries, raising concerns about social and environmental justice,[4] exacerbating the environmental burden on these nations and creating an uneven distribution of environmental responsibility. The BW industry emerges as a notable contributor to the plastic waste crisis, by promoting BW as a healthier option and exploiting common water resources for financial gain.[7]

The process of extracting raw materials and manufacturing plastic bottles significantly contributes to greenhouse gas emissions, due to non-renewable resources and intensive energy consumption,[4] and can directly impact microbial and animal species.[15 16] Plastic litter, microplastics and plastic contaminants such as BPA can be ingested by plankton and animals, thus entering the food chain.[16–18] There are also changes to natural habitats such as soil and sediment contamination, marine accumulation and nutrient cycling.[17] As with human health, the long-term direct and indirect environmental consequences of plastic are difficult to discern in such complex biological and ecological systems.[17] Because many human communities rely on these natural systems for food security and livelihoods, any effects felt on the environment will reverberate in human populations as well (table 1).

Each of these factors—the unsustainable reliance on landfills, the outsourcing of waste, the marketing strategies of the BW industry and the environmentally costly production of plastic bottles—intertwines to create a scenario where short-term convenience and economic gain are pitted against long-term environmental health and sustainability.

Taste preferences for BW

One reason consumers may favour bottled over tap water is the belief that it offers a superior taste or smell.[19] However, it is important to consider some critical points. First, some BW brands enhance their products with flavours, chilling or carbonation, targeting specific taste preferences.[19–21] This suggests that the perceived superior taste of some BW may be more a result of added chemical compounds rather than the

Table 1 Summary of the pros and cons of tap and bottled water (BW)

Characteristic	Who is impacted?	Tap water	BW	Relevant Sustainable Development Goals (SDGs)*
Regulations and safety				
Regulatory standards[7 8]	Consumer Society	High standards†	Varies between countries	SDG 3—Ensure healthy lives and pr omote well-being for all at all ages.
Accountability[7 8]		Reporting required†	No reporting required	
Liability[7 8]		Local government/authorities	Corporate/profit-driven	SDG 6—Ensure availability and sustainable management of water and sanitation for all.
				SDG 10—Reduce inequality within and among countries.
Human and planetary health impacts				
Infectious disease risk[7 8]	Consumer Society Environment	Low‡	Low	SDG 3—Ensure healthy lives and promote well-being for all at all ages.
Presence of plastic contaminants (eg, BPA, PCBs, PFAS, etc)[10 11]		Low	High	SDG 11—Make cities and human settlements inclusive, safe, resilient, and sustainable.
Environmental impacts (sustainability; pollution; carbon footprint)[4 6]		Low§	High	SDG 13—Take urgent action to combat climate change and its impacts.
				SDG 14—Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.
Miscellaneous				
Costs[5]	Consumer Society	Inexpensive	Comparatively expensive	SDG 16—Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable and include institutions at all levels.
Convenience[5]		Readily available	Portable and convenient	

*The United Nation's Sustainable Development Goals aim to promote sustainable growth. The content of this publication has not been approved by the United Nations and does not reflect the views of the United Nations or its officials or member states.
†In high-income nations.
‡Not the case in some low-income countries.
§Desalination can have a negative ecological impact.
BPA, bisphenol A; PCBs, polychlorinated biphenyls; PFAS, polyfluoroalkyl substances.

natural quality of the water itself. Second, research has suggested that many individuals cannot differentiate between tap water and BW in blind tests, challenging the notion that BW is inherently tastier.[21 22] This evidence calls into question the validity of taste as a sole determinant in the preference for BW. Third, the absence of flavour or odour is not a reliable indicator of water purity. Transparent, odourless water can still harbour contaminants and bacteria.[20] Conversely, certain minerals like sulfur can give water a distinctive taste that many might find unpleasant, yet these minerals do not necessarily compromise water quality or safety.[20] Finally, it is essential to recognise that taste perception is not static but can evolve with time and experience, reinforcing the notion that taste alone should not be the decisive factor in water choice.

Economics of BW

While estimates vary by country and region, BW can cost several times that of tap water.[22 23] The amount of water consumed in the entire lifecycle of a litre of BW varies between 17 and 35 L.[7] Further, the total energy required to produce BW may exceed that of tap water by a factor of 2000,[7 23] not including the energy required for disposal (table 1). While putting a numerical value on the bill that is due for use of BW may be difficult, the costs far outweigh the benefits.

Attempts to promote the use of tap water

Given that regulated tap water is recognised for being safe, cost-effective and environmentally sustainable, there has been an international push towards endorsing tap water as the preferred choice. Some areas within Australia, Canada, Hong Kong and the USA have completely banned commercialisation of BW for the public.[5] They have also focused on raising awareness about the safety of tap water and encouraging its consumption in restaurants and bars.[5] In addition, some countries have highlighted the sustainability of tap water compared with BW, actively installing drinking fountains, providing refilling stations and distributing free reusable bottles in public spaces to facilitate access.[5] Other initiatives are driven by non-governmental organisations and individuals striving to encourage tap water consumption through awareness campaigns and creating online maps indicating locations with access to tap water.[5] Complementing these efforts, a personal strategy gaining traction involves using water filters at home, enhancing the potability of tap water, thereby making it a more attractive option for daily use. Collectively, the accumulated evidence underscores the critical role of government interventions and educational campaigns in shifting public perception and behaviour. These campaigns should highlight the environmental stewardship and health benefits of choosing tap water, effectively driving a cultural change towards more sustainable consumption practices.

CONCLUSION

The reliance on BW incurs significant health, financial and environmental costs, calling for an urgent re-evaluation of its widespread use. Governments must urgently confront these issues and shift towards sustainable alternatives to single-use plastic bottles in the interest of both human and global health. There is a pressing need for low-income and middle-income countries to invest in making safe drinking water accessible. To achieve this, public awareness campaigns are essential in this transition. They can generate demand and push governments to make policy changes and can create governmental accountability for provision of clean and potable water. They should provide clear evidence-based information about tap water's advantages, correct false beliefs and respond to worries about health risks and the taste and smell of tap water. Additionally, they should also highlight the substantial financial savings associated with tap water and provide practical incentives motivating individuals to choose tap water over bottled options. By prioritising tap water consumption, we can collectively address the multifaceted challenges posed by BW and embrace tap water as a cornerstone of environmental responsibility and public health.

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ORCID iDs
Amit Abraham http://orcid.org/0000-0002-9696-8598
Sohaila Cheema http://orcid.org/0000-0002-5874-4059
Karima Chaabna http://orcid.org/0000-0002-1443-207X
Albert B Lowenfels http://orcid.org/0000-0003-3631-4530
Ravinder Mamtani http://orcid.org/0000-0001-8507-281X

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