

The global risks of increasing reliance on bottled water

The rapid growth of bottled water use in low- and middle-income countries, and its normalization as a daily source of drinking water, does not provide a pathway to universal access. Generous and sustained investment in centralized and community utilities remains the most viable means for achieving safe water access for all.

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In 2015, the world adopted 17 Sustainable Development Goals (SDGs) intended to “end poverty, protect the planet and ensure prosperity for all”. The first target of SDG6 is: “By 2030, achieve universal and equitable access to safe and affordable drinking water for all.” Today, approximately two billion people lack access to microbiologically safe drinking water^{1,2}.

The Joint Monitoring Programme for Water Supply and Sanitation (JMP), a collaboration between the World Health Organization and United Nations Children’s Fund, defines drinking water as “water used for drinking, cooking, food preparation and personal hygiene”¹. This broad definition is critical, as the faecal–oral disease transmission route cannot be reliably interrupted via safe water consumption alone.

Economically developed countries have achieved near-universal access to drinking water through publicly owned or regulated water utilities, but the expansion of safe piped water in most low- and middle-income countries (LMICs) has been slow. Bottled water is now the fastest growing form of access to ostensibly safe drinking water in LMICs. We argue that the normalization of this form of drinking-water access threatens to exacerbate disparities in safe water access and undermine progress towards SDG6.

Rising bottled water use worldwide

We define bottled water (also called packaged water) to include single-use bottles, 1–5-litre bottles sold by retailers, and large ~5–19-litre reusable bottles. Over the last decade, 6 of the top 10 bottled-water-consuming nations have been LMICs (Brazil, China, India, Indonesia, Mexico and Thailand). Their consumption of bottled water has increased by 174%, compared to a 26% increase for the high-income countries (HICs) in this group over the same period (Fig. 1) (corresponding population growth was 8.7%

and 5.2%, respectively; see Supplementary Information). These data are for bottled water only. In many LMICs, the use of sachet water (water sold in small plastic bags) is also increasing rapidly³.

In HICs, where bottled water is heavily marketed as a healthier alternative to municipal water, or as a lifestyle product, safety and convenience are the primary reported reasons for its consumption^{4,5}. Packaging and marketing represent a major part of the production costs for multinational beverage companies, and smaller LMIC-based companies benefit from this advertising. The (limited) data indicate that convenience and perceived quality are also leading motivators of bottled water use in LMICs^{3,6}.

Marketing aside, bottled water use in many LMICs is a rational response to the lack of publicly provided safe drinking water. Even in LMICs where piped water supply is expanding (Fig. 2), it remains unsafe in many settings², and/or is perceived to be unsafe. Indeed, a 2016 cover story in the *Bottled Water Reporter* (the magazine of the International Bottled Water Association) declared that: “Bottled water serves as at least a partial **solution to the problem** of often-unsafe water found in many economically developing countries” (emphasis in the original)⁷.

The slow provision of piped water to underserved populations, the intermittently supplied low-quality water provided to served populations, and the rapid growth of bottled water have led some to argue that the increasing reliance on bottled water in LMICs should be accepted as a ‘partial solution’ towards SDG6. Attendant to this acceptance are calls to better regulate, rather than ignore, the growing LMIC market for packaged water⁸ — a position that appears to have garnered the support of the JMP. In 2017, the JMP reversed its long-standing position on bottled water and now accepts it as an ‘improved’ source (that is, potentially safe), which it will

classify using three service levels (‘limited’, ‘basic’ or ‘safely managed’)¹.

Expectations, affordability and health

The normalization of bottled water as an everyday form of drinking water has significant social implications. Many high-income households in LMICs already rely exclusively on bottled water. This elite-led approach diminishes top-down demand for safe piped water (while reinforcing status-associated perceptions of bottled water). Poor service provision from utilities also erodes bottom-up expectations. As overall demand — both top-down and bottom-up — decreases, so too does the overall expectation that utilities will, or can, provide safe piped water. At the end of this chain lies a resignation of sorts that is already apparent in many urban areas of LMICs such as Mexico⁹: piped water (when available) is to be used for domestic purposes and (possibly) cooking, with little expectation from consumers or providers that it will be safe to drink.

Consumers frequently believe that bottled water is safer than tap water. In most HICs, however, testing and standards are usually more rigorous, frequent and transparent for utility-supplied piped water⁵. Therefore, there is little reason to assume that bottled water is of higher quality than well-regulated municipal water. The limited data from LMICs indicate that although bottled water is safer than piped water on average, it is also frequently contaminated^{2,8}.

Affordability is another consideration. Bottled water costs hundreds (and even thousands) of times more per litre than treated piped water. When water is expensive relative to household incomes, its use is typically rationed. A study in Ghana, for example, found that ~63% of households bought sachet water, but only ~8.4% always drank sachet water³. Bottled water in low-income households is usually used for drinking, rarely for cooking, and almost never for personal hygiene. As the

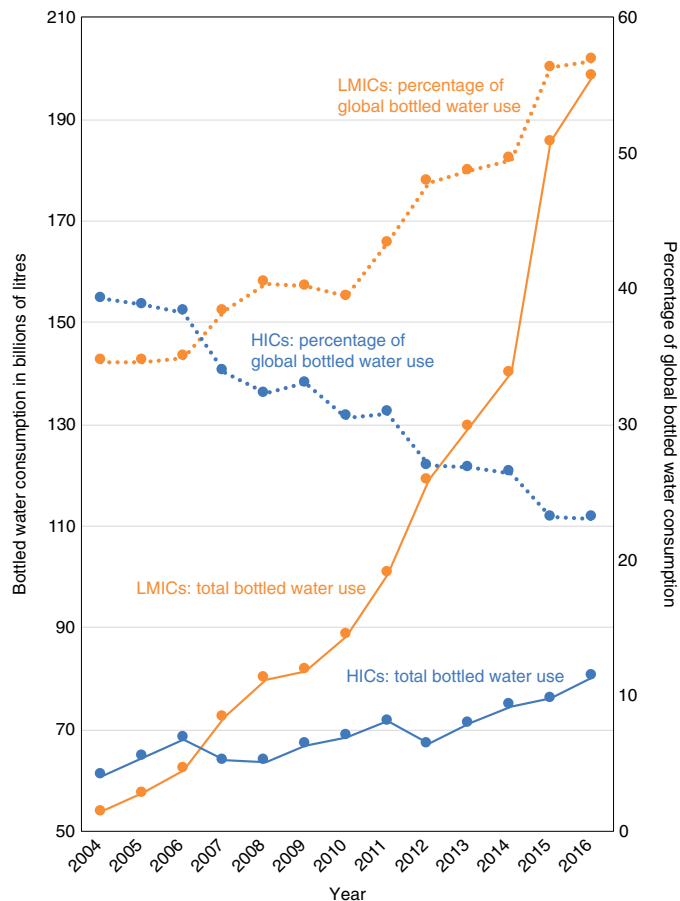


Fig. 1 | Bottled water consumption trends in the top 10 bottled-water-consuming countries from 2004–2016. Total consumption (primary y axis, solid lines) and as a percentage of global consumption (secondary y axis, dashed lines) by country income classification. In 2016, bottled water consumption in the top 10 bottled-water-consuming countries accounted for ~80% of the global total. Data for calculations taken from bottled water consumption statistics reported in multiple issues of the *Bottled Water Reporter* (see Supplementary Information for details).

JMP recognizes, however, consistent use of safe water for drinking, hygiene and food preparation is necessary for good health. A reliance on bottled water therefore forces low-income households to consume less than optimal quantities, or to pay a high proportion of their incomes for drinking water, or both. It is reasonable to expect that the growing reliance on bottled water in LMICs will therefore exacerbate disparities in access to safe water and, potentially, associated health outcomes.

The environmental health implications of bottled water consumption are also significant. Globally, most of the 480 billion plastic beverage bottles sold in 2016 were for drinking water, and most of these bottles (including the recyclable ones) ended up in landfills and the world's oceans^{3,10}. Bottled water production and transportation also contribute significantly to climate change emissions, generating 180 times more CO₂ emissions per litre than tap water

in HIC settings (0.162 versus 0.0009 kg CO₂ l⁻¹, respectively)¹¹.

Towards safe water for all

Thus far, regulated utilities have offered the world's best hope for expanding affordable access to safe drinking water for all. From the perspectives of improving public health¹² and alleviating poverty¹³, there is compelling evidence to support investments in universal safe water access. Governments should therefore expect to shoulder some of the costs of safe water provision for the collective well-being of their citizens.

We are not suggesting that bottled water is problematic in all circumstances (when safe, it is certainly preferable to contaminated piped water). We do suggest that the growth and normalization of bottled water use in LMICs is eroding expectations that utilities will (or can) provide or expand access to safe piped water supply.

The partial commodification of drinking-water provision may produce a dynamic similar to that of privatized healthcare and education in many LMICs. In such cases, low-quality public services and low public expectations drive even the poor to seek privately run services of uncertain quality. In this context, normalization is troubling and may inadvertently reinforce the 'failure of the state' narrative that the bottled water industry already invokes to promote its products. This possibility is ironic, given that no country has achieved universal access to safe drinking water without state-run or state-regulated utilities.

In the short- to medium-term, therefore, LMIC governments should evaluate non-tap options that could expand safe water access¹⁴. With regard to microbiological contaminants, the promotion of lower-cost options, such as boiling with electric kettles (where feasible)⁶ or subsidized ceramic filters (where suitable)¹⁵, may be beneficial. Community-scale kiosk models, from which disinfected municipal water is delivered at low or no cost in reusable 19-litre bottles, are more sustainable and affordable than commercially sold bottled water¹⁴. Where population densities are low, or the spatial layout of neighbourhoods is challenging, a regulated version of this last option may provide an imperfect but viable long-term form of safe water access.

We have argued that the increasing reliance on bottled water in LMICs does not provide a pathway to safe and affordable drinking water for all. Therefore, if LMICs are to eventually meet and maintain SDG6, we cannot collectively concede to the 'failure of the state' narrative. Rather, we recommend that the international development community and LMIC governments accept that full-cost recovery from a low-income customer base is not realistic, and that they actively invest in regulated utilities or community-scale models as the most sustainable options for delivering universal safe water access. This will take time, of course. Consumer confidence in the safety of utility-supplied water should be fortified along the way with water quality reports and, perhaps, 'marketing' messages. These recommendations are not new, but they bear repeating in an era of explosive growth in, and de facto normalization of, market-driven approaches to 'safe water for all'. In the meantime, non-tap treatment options that are known to be effective and affordable, but that may achieve only partial uptake, should be subsidized and more aggressively promoted. If, on the other hand, governments and development agencies allow the bottled water sector to continue

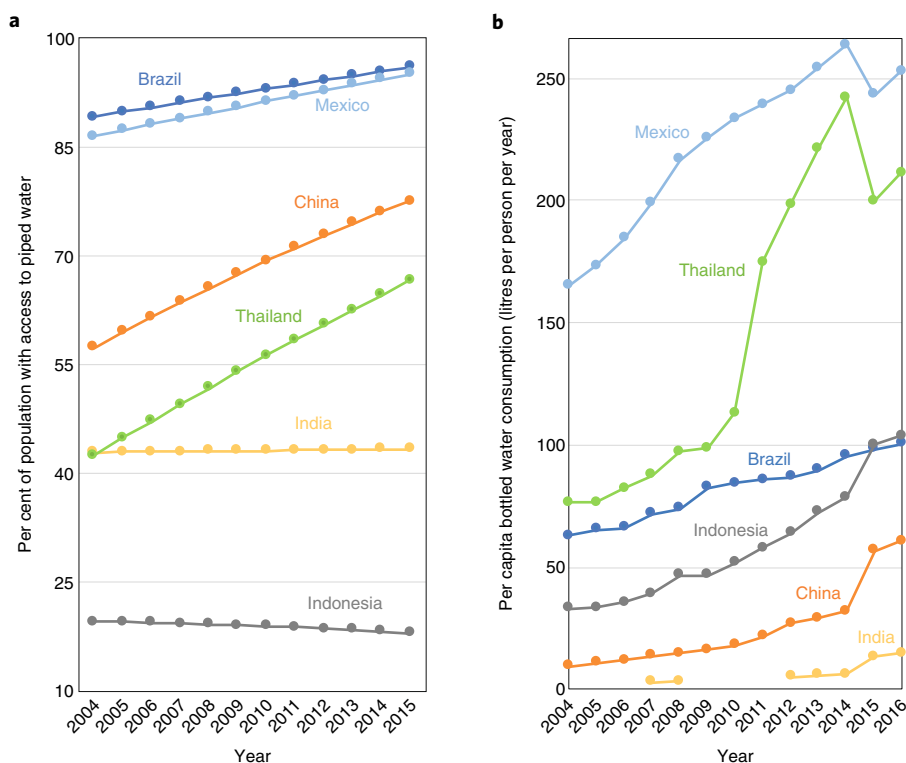


Fig. 2 | LMICs among the top 10 bottled-water-consuming countries. a, b, Trends for the LMICs among the top 10 bottled-water-consuming countries from 2004–2015/2016: percentage of the population with piped water access (**a**) and per capita consumption of bottled water (**b**). The JMP data on access to piped water supply do not account for water quality. Per capita consumption trends were derived from statistics reported in multiple issues of the *Bottled Water Reporter*; it is unclear whether the 2014–2015 decreases observed for Mexico and Thailand represent actual reductions in consumption or are the result of discrepancies in the underlying data. Data for calculations taken from the *Bottled Water Reporter*, World Bank and JMP (see Supplementary Information for details).

meeting the rising demand for safe water in LMICs, then access will indeed expand by 2030, but it will not be reliably safe or universally affordable. The SDG for drinking water is a public commitment, and

history is clear: public commitments need public investment.

Data availability. All data generated or analysed during this study are included

in this published article and the Supplementary Information.

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Additional information

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