PHTHALATES AND BISPHENOLS IN INDONESIA

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Country Situation Phthalates and Bisphenols in Indonesia

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SHORT SUMMARY

Bisphenol A (BPA) and phthalates remain among the most widely used industrial chemicals globally, commonly found in polycarbonate plastics, epoxy resins, PVC, and other polymers, used in water bottles, food containers, toys, packaging, cables, personal care products, and thermal-paper receipts (Manzoor et al., 2022). Growing scientific evidence since 2018 links exposure to BPA and phthalates with adverse health outcomes: epidemiological studies and meta-analyses show associations between BPA exposure and metabolic syndrome, obesity, type 2 diabetes, cardiovascular disease, and other metabolic disturbances; similar associations have been found for phthalate exposure (Liang et al., 2023; Smith & Jones, 2023). Mechanistic research indicates BPA promotes adipose-tissue inflammation and insulin resistance via immune-modulating pathways, supporting its obesogenic potential (Zhang et al., 2023).

For many populations, diet remains a major exposure pathway: recent systematic reviews document consistent migration of BPA, phthalates, and related compounds from plastic food packaging into foods and beverages under realistic storage conditions (Garcia-Rodriguez et al., 2024). This underscores how

everyday consumption of packaged foods may contribute substantially to internal chemical burden.

In Indonesia, characterized by high plastic use in single-use packaging, water containers, PVC-based products, and limited waste management, the potential for widespread exposure is high. Yet national-level biomonitoring and systematic assessment of BPA and phthalate contamination remain scarce. Given mounting global evidence and local vulnerability, this literature review seeks to compile the latest (post-2018) global and regional research on distribution, exposure pathways, environmental fate, and health implications of BPA and phthalates aiming to support sound risk assessment, informed policy development, and public awareness.

INTRODUCTION

Bisphenol A (BPA) is a widely used industrial compound, primarily employed as a monomer in the production of polycarbonate plastics and epoxy resins. These materials are ubiquitous in daily life, appearing in drinking water containers, canned food linings, thermal paper receipts, and various household and construction products. Phthalates, a group of plasticizers added to polyvinyl chloride (PVC) and other polymers, enhance flexibility and durability. They are commonly present in cables, vinyl flooring, toys, food packaging, personal care products, and medical devices (Manzoor et al., 2022; Tanzer et al., 2025). Because BPA and many phthalates are not chemically bound to the plastic matrix, they can leach or migrate throughout the product lifecycle, including during use, storage, heating, disposal, and recycling.

Global consumption of BPA and phthalates continues to rise, driven by growth in plastics, packaging, automotive, electronics, and construction industries. Millions of tons are produced annually, generating substantial economic value, even as certain high-risk phthalates face restrictions in some countries (Liang, Chen, Zhang, & Wang, 2023; Smith & Jones, 2023). Release of these chemicals occurs across production, usage, and disposal stages. International studies have documented BPA and phthalates in surface water, groundwater, sediments, indoor dust, and ambient air (Corrales et al., 2015; Net, Sempéré, Delmont, Paluselli, & Ouddane, 2015). Major contamination sources include manufacturing discharges, industrial and domestic runoff, degradation of post-consumer plastics, and migration from food and beverage packaging. Concentrations are generally higher in urban and industrial areas due to dense production and consumption activities.

In Indonesia, high plastic consumption exacerbates potential exposure. According to the Indonesian Aromatic and Plastic Olefin Association (INAPLAS), per-capita plastic consumption in 2019 was approximately 23 kilograms, amounting to over 6.2 million tons nationally (KLHK, 2020). Everyday products, including single-use plastics, polycarbonate water gallons, canned foods, toys, and thermal paper receipts, serve as direct exposure sources. While regulatory efforts exist including BPOM Regulation No. 20/2019, which sets a BPA migration limit of 0.6 mg/kg and restricts certain phthalates, and BPOM Regulation No. 6/2024 mandating BPA warning labels coverage and enforcement remain limited (Indonesia, 2019; Indonesia, 2024). Chemical content transparency is often lacking, and national biomonitoring data are scarce, leaving populations vulnerable to long-term exposure.

Environmental contamination in Indonesia is further influenced by limited waste management. Open dumping, burning, and informal recycling contribute to widespread chemical release into soil, air, and water. Studies in urban areas indicate BPA and phthalates are detectable in refill drinking water, groundwater, and sediments, though results vary depending on analytical methods and sampling sites (I

Nyoman Gede & Desak Gde Diah, 2018). The combination of dense population, rapid urbanization, and high plastic use poses substantial public health challenges.

From a toxicological perspective, BPA and phthalates are recognized as endocrine-disrupting chemicals (EDCs) that can interfere with hormonal systems. Recent studies link BPA and phthalate exposure to metabolic disorders, obesity, type 2 diabetes, cardiovascular disease, reproductive dysfunction, impaired child development, and neurobehavioral changes (Lin et al., 2023; Xiao et al., 2024; Zhang et al., 2023). Mechanistic research indicates BPA may promote inflammation in adipose tissue, impair insulin signaling, and disrupt endocrine homeostasis, while phthalates impact similar metabolic and reproductive pathways (Smith & Jones, 2023). Vulnerable populations, including pregnant women, infants, and children, are particularly susceptible, emphasizing the need for region-specific exposure assessment and health monitoring.

Given the growing global evidence and Indonesia-specific context, high plastic consumption, limited waste treatment capacity, emerging regulatory frameworks, and sparse biomonitoring, there is an urgent need to comprehensively assess the occurrence, sources, environmental distribution, and health impacts of BPA and phthalates. This literature review synthesizes post-2018 global and regional studies, integrating experimental chemical analysis and community-based citizen science led by ECOTON and Nexus3 Foundation, to provide a robust evidence base for risk assessment, policymaking, and public awareness in Indonesia (WHO & UNEP, 2012; Tanzer et al., 2025).

METHODS

To compile the national report on phthalates and bisphenols in Indonesia, we conducted a comprehensive scientific literature review. The review utilized multiple online databases, including Google Scholar, PubMed, ResearchGate, and Scopus, with keywords such as "BPA Indonesia," "bisphenol A Indonesia," "phthalates Indonesia," and "PVC plastic additives Indonesia" (ECOTON, 2025). Relevant government publications and regulations were also included, drawing from the National Food and Drugs Agency (BPOM), the Ministry of Environment and Forestry, and the Ministry of Industry, Indonesia. The initial search retrieved 18,000 titles related to BPA and 921 titles related to phthalates in Indonesia. Abstract screening focused on studies conducted within Indonesia, including environmental matrices, consumer products, and human exposure assessments. Following screening, 28 BPA studies and 11 phthalate studies were selected for inclusion in the review, forming the core of Chapter 5 in the national report (ECOTON, 2025)In addition to the literature review, direct experimental research was conducted in collaboration with the Wonjin Institute in South Korea during 2021–2025. This research included:

- Testing BPA content in thermal paper receipts, a common consumer exposure source (ECOTON, 2022).
- Analyzing phthalate content in erasers, representing exposure from everyday plastic products (ECOTON, 2022).
- Women Waste Workers Biomonitoring Project for Hazardous Chemicals Used in Plastics" Research Collaboration (Wonjin Institute for Occupational Environmental Health, ECOTON and Faculty of Medicine Airlangga University, 2025).

This mixed-methods approach combining systematic literature review, direct chemical analysis, and biomonitoring provides a comprehensive understanding of environmental and human exposure to BPA and phthalates in Indonesia. The inclusion of community-based sampling and engagement ensures that local contexts, exposure pathways, and vulnerable populations are adequately represented in the national report.

PRODUCTION AND USE OF PHTHALATES AND BISPHENOLS IN INDONESIA

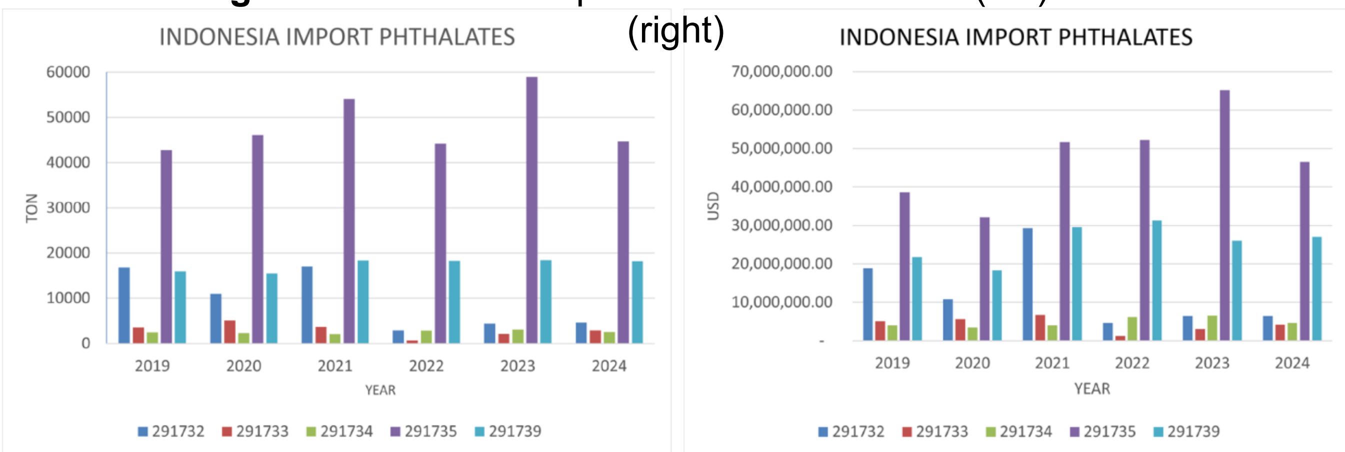
Publicly available national information on plastics production volumes, Bisphenol A (BPA), and phthalates in Indonesia is limited (Badan Pusat Statistik [BPS], n.d.; Ministry of Industry [Kemenperin], n.d.). No national databases (KLH, Kemenperin, BPS, or INAPLAS) provide detailed production statistics for these substances. However, the significant role of BPA and phthalates as primary additives in Indonesia's plastics industry is well established. High domestic plastic consumption estimated at 23 kg per capita in 2019 (Geyer, Jambeck, & Law, 2017) continues to drive demand for these chemical inputs, particularly for the production of polycarbonates, epoxy resins, and PVC-based products.

Due to the lack of publicly accessible national production data, this section relies on international trade data from UN Comtrade (2024), using relevant Harmonized System (HS) codes to approximate domestic flows of bisphenols and phthalates. The data below summarise the volume (tons) and value (USD) of imports and exports, providing an indication of Indonesia's dependence on global chemical supply chains.

Phthalates Trade (DEHP, DBP, BBP and others)

Phthalates are key plasticizers used in PVC and various polymer products. Their flows into Indonesia were assessed using HS codes (UN Comtrade, 2024): Phthalates imports exhibit substantial volume and value, confirming their essential role as plasticizers in Indonesia's PVC and polymer industries.

Figure 1. Indonesia Import Phthalates Volume (left) Value (right)



Phthalate imports are dominated by HS 291735, with volumes consistently above 40,000 tons per year, reaching a peak of nearly 60,000 tons in 2023. HS 291739 (other phthalates) is also high, ranging between 16,000 and 18,000 tons per year. These high volumes underscore the essential need for these plasticizers in creating flexible products such as cables, vinyl flooring, toys, and food packaging.

The corresponding value of HS 291735 imports also dominates, reaching a high of $65 million USD in 2023, underlining the high industrial demand. It should be noted that these imports include phthalates recognized as Endocrine-Disrupting Chemicals (EDCs), some of which (like DEHP, DBP, and BBP) are already regulated in Indonesia, particularly in children's toys.

Table 1. Indonesia imported phthalates period 2019-2024

YEAR	TOTAL TRADE VOLUME (Ton)	TOTAL TRADE VALUE (USD)	TRADE PARTNER
2019	81,694.90	$ 88,563,439.00	Japan, Malaysia, Rep. of Korea, Other Asia, nes, China, Viet Nam, Spain, China, Hong Kong SAR, India, Thailand, USA, Singapore, Germany, Italy, Netherlands, United Kingdom, Canada, Australia, Switzerland, Belgium, France, Sweden
2020	80,058.09	$ 70,258,350.00	Japan, Rep. of Korea, Other Asia, nes, Malaysia, China, China, Hong Kong SAR, Spain, Thailand, Viet Nam, India, Singapore, USA, Italy, Germany, Netherlands, Canada, Norway, Belgium, Sweden, Switzerland, United Kingdom
2021	95,363.79	$ 121,362,046.00	Japan, Rep. of Korea, Malaysia, Other Asia, nes, China, China, Hong Kong SAR, Thailand, Viet Nam, India, USA, Singapore, Spain, Dem. People's Rep. of Korea, Germany, Italy, United Kingdom, Netherlands, France, Australia, Canada, Austria
2022	69,104.74	$ 95,689,897.00	Japan, Rep. of Korea, China, Other Asia, nes, Thailand, Malaysia, China, Hong Kong SAR, India, Singapore, Netherlands, USA, Italy, Viet Nam, Germany, France, United Arab Emirates, Canada, Switzerland, Norway
2023	87,228.41	$ 107,309,291.00	Japan, Rep. of Korea, China, Other Asia, nes, Thailand, Malaysia, India, China, Hong Kong SAR, Netherlands, Singapore, USA, Italy, Germany, Australia, Canada, Switzerland, United Kingdom
2024	73,182.62	$ 88,750,606.00	Japan, China, Rep. of Korea, Other Asia, nes, Thailand, Malaysia, India, China, Hong Kong SAR, Singapore, USA, Viet Nam, Germany, Italy, Netherlands, Australia, Canada, United Kingdom, Belgium, France, Sweden

Figure 2. Indonesia Export Phthalates

Indonesia's phthalate exports, while significantly smaller than imports, are also dominated by HS 291735, indicating some level of domestic production activity. Exports of HS 291735 reached tens of thousands of tons in 2019 and 2021. These exports likely consist of domestically produced phthalates or phthalate-based plastic products for regional markets. The top five export destinations for Indonesian phthalates include India, Viet Nam, Saudi Arabia, Pakistan, and Bangladesh. Phthalates especially those under HS

291735, are the most widely consumed plastic additives in Indonesia by volume, underscoring dependence on imported plasticizers for domestic PVC production.

Bisphenols Trade

Trade data for bisphenols, analyzed using HS codes (primarily HS 290723 for Bisphenol A and HS 290729 for other Bisphenols), indicates the domestic industry's reliance on foreign sources for these crucial raw materials. The import volumes of Bisphenol A and other Bisphenols have remained stable and high, ranging from approximately 1,500 to 1,900 tons per year between 2019 and 2024. Imports were dominated by HS 290729 (other Bisphenols), which peaked at 1,100 tons in 2022. This high import volume is consistent with the primary uses of BPA in the production of polycarbonate for drinking water gallons and epoxy resin for food can linings.

Figure 3. Indonesia Import Bisphenol Volume (left) Value (right)

Concurrently, the value of bisphenol imports shows a significant upward trend, peaking in 2022 at over $12 million USD for HS 290729, reflecting rising costs or heightened demand for bisphenol raw materials in the global market.

Table 2. Indonesia imported bisphenols period 2019-2024

YEAR	TOTAL TRADE VOLUME (Ton)	TOTAL TRADE VALUE (USD)	TRADE PARTNER
2019	4,102.48	$ 11,722,711.00	Singapore, India, Germany, Japan, Jordan, Other Asia, nes, Rep. of Korea, USA, France, China, Malaysia, Spain, Switzerland, Saudi Arabia, Viet Nam, United Kingdom, Denmark
2020	1,826.48	$ 8,869,537.00	India, Singapore, Germany, Malaysia, Japan, Other Asia, nes, Rep. of Korea, USA, France, China, Spain, Denmark, Thailand, China, Hong Kong SAR, Switzerland, United Kingdom, Mexico
2021	1,189.64	$ 8,494,041.00	Singapore, India, Germany, Other Asia, nes, Jordan, Japan, Malaysia, Rep. of Korea, Thailand, China, Spain, USA, France, Denmark, Switzerland, Canada, Estonia
2022	1,143.88	$ 12,504,013.00	India, Germany, Other Asia, nes, Singapore, Japan, China, Jordan, France, Rep. of Korea, Malaysia, USA, Switzerland, United Kingdom, Canada
2023	1,047.39	$ 9,178,154.00	India, Other Asia, nes, Germany, Singapore, Japan, China, Rep. of Korea, USA, Jordan, Malaysia, France, Canada, Thailand, Australia, Italy
2024	1,058.84	$ 8,132,726.00	India, Other Asia, nes, Germany, China, Japan, Jordan, Rep. of Korea, Malaysia, USA, Singapore, France, Thailand, Netherlands, Australia, Brazil, Switzerland, Argentina, Belgium, Canada, Italy, Pakistan

Figure 4. Indonesia Export Bisphenols

Indonesia's bisphenol exports show significantly lower volumes than imports, suggesting that the majority of bisphenol entering the country is intended for domestic consumption rather than for re-export as raw materials. The top five export destinations for Indonesian bisphenols include Taiwan, Philippines, Nigeria, India, and the Russian Federation. Bisphenol A HS 290723 exports generally range from 200 to 900 tons per year, which may indicate small-scale domestic production or the export of BPA-derived products.

The analysis of international trade data reinforces the conclusion that Indonesia is a net importer of the main raw materials used in the production of phthalates and Bisphenols. This high volume of imports indicates a strong reliance on global supply to meet high domestic industrial demands. In terms of volume, Phthalate imports (with HS 291735 dominating) vastly exceed Bisphenol imports, confirming

Phthalates as the most widely consumed plastic additive in Indonesia, especially in PVC production. Overall, the substantial influx of both chemicals, which are recognized as Endocrine-Disrupting Chemicals (EDCs), ensures that exposure to these chemicals from daily consumer products, such as polycarbonate water gallons, food can linings, and PVC-based children's toys, will continue to be a significant public health issue in Indonesia.

REGULATORY CONTROLS IN INDONESIA

Phthalates

Indonesia has progressively developed regulatory controls on phthalates, beginning with import tariff classifications and evolving to chemical content monitoring in consumer products. Early regulations, including the Minister of Finance Regulations issued between 2011 and 2014, referenced phthalates only for tariff purposes and industrial raw material classification, without establishing safe usage limits (Kemenkeu, 2011–2014).

A major regulatory milestone occurred in 2013 with Ministry of Industry Regulation No. 55/M-IND/PER/11/2013, which set a maximum allowable concentration of 0.1% (1000 ppm) for several phthalates, including dibutyl phthalate (DBP), di(2-ethylhexyl) phthalate (DEHP), benzyl butyl phthalate (BBP), di-n-octyl phthalate (DNOP), diisononyl phthalate (DINP), and diisodecyl phthalate (DIDP) in children's toys (Kemenperin, 2013).

This regulation was subsequently strengthened through Indonesian National Standard (SNI) 8578:2018, which harmonized phthalate testing methods using GC-MS/LC in alignment with EN 71-3 and REACH Annex XVII (BSN, 2018). Building on this, Ministry of Trade Regulation No. 18/2019 expanded chemical-safety monitoring to additional consumer products, such as toys and textiles, thereby formally including phthalates in Health, Safety, Security, and Environmental (HSSE) testing (Kemendag, 2019).

Between 2020 and 2024, further updates clarified relevant HS Codes and strengthened laboratory testing requirements for key phthalates, including DINP, DIDP, and DEHP. Looking forward, the proposed Ministry of Trade Regulation No. 20/2025 aims to consolidate hazardous-substance controls, update testing parameters, and bring Indonesia's regulatory framework closer to global best practices (Kemendag, 2025 draft). Collectively, these measures indicate that Indonesia has established formal regulations for major phthalates (DBP, DEHP, BBP, DINP, DIDP, and DNOP) in consumer products, particularly children's toys, while gradually aligning testing standards with international frameworks. However, Indonesia should harmonize BPA and phthalate regulations across agencies and update migration limits to align with international scientific assessments, including EFSA's 2023 revision of the BPA TDI (Tolerable Daily Intake) (Ramírez, et al. 2023). Regulatory gaps for thermal paper, childcare products, cosmetics, and PVC piping need to be addressed through an integrated cross-ministerial framework to make a holistic changes

Bisphenols

Regulatory control of Bisphenol A (BPA) in Indonesia has evolved from general food safety provisions to more specific requirements for labeling and migration limits in consumer products. Before 2018, BPA was not explicitly regulated, and oversight was limited to general provisions such as Law No. 18/2012 on Food and regulations on food packaging symbols (Kemenperin, 2010; DG Agrochem, 2010). Key milestones include:

- 2017: Ministry of Health Regulation No. 62/2017 introduced "BPA-free" labeling for baby bottles, protecting vulnerable populations (Kemenkes, 2017).

- 2018–2019: BPOM Regulation No. 31/2018 and BPOM Regulation No. 20/2019 established labeling for processed foods and set a migration limit of 0.6 ppm for BPA in polycarbonate food packaging (BPOM, 2018; BPOM, 2019).
- 2021–2022: Testing showed that refillable gallon bottles often approached or exceeded the 0.6 ppm limit; a proposed BPA labeling regulation was delayed due to industry objections and competition concerns (BPOM, 2021).
- 2022–2023: Inter-ministerial discussions led to consensus on implementing "potentially contains BPA" labeling with a three-year transition period, informed by international developments, such as EFSA's reduction of the TDI from 4 µg/kg bw/day to 0.00004 µg/kg bw/day. The EU is lowering the migration limit to 0.05 ppm (EFSA, 2022).
- 2024: BPOM Regulation No. 6/2024 revised labeling rules, requiring warnings on polycarbonate gallon bottles: "Under certain conditions, polycarbonate packaging may release BPA into bottled drinking water" (BPOM, 2024).

The current regulations in Indonesia regarding bisphenol A (BPA) primarily focus on polycarbonate bottled water. These regulations include specific labeling requirements and establish a migration limit of 0.6 parts per million (ppm). However, this standard is considered outdated when compared to international guidelines. Additionally, the coverage of regulations for other food-contact materials and products for children is limited, and public awareness of these issues is generally low.

Transparency and Traceability

Indonesia has taken several steps toward improving chemical transparency in plastics, primarily through mandatory labeling of BPA-containing products (BPOM, 2024), HSSE testing requirements for phthalates and other chemicals in toys and textiles (Kemendag, 2019), and the adoption of SNI standards for testing and reporting (BSN, 2018). However, the country still lacks a comprehensive national database on chemical content in plastics accessible to consumers, and existing transparency mechanisms remain largely limited to industrial compliance and product labeling. Initiatives to align with global databases, such as IPEN's BPA report, Chemreg, and the Global Plastic Laws Database, have not yet been fully integrated into national policy (IPEN, 2021; Chemreg, 2024; Global Plastic Laws, 2024). Overall, Indonesia has established labeling and testing standards for phthalates and BPA, but it still lacks a fully transparent, publicly accessible tracking system for the use of chemicals in plastics. Therefore, a national chemical transparency system should be established, requiring all manufacturers and importers to disclose BPA and phthalate content across all plastic supply chains. This could serve as the fundamental for a future digital product passport which is very useful for product identification (Kühn et al., 2025)

KNOWN IMPACTS OF PHTHALATES/BISPHENOLS IN INDONESIA

Overall, Indonesian studies provide clear and compelling evidence of widespread exposure to phthalates and BPA across environmental media, consumer products, and human populations. Children, adolescents, and adults are consistently exposed through drinking water, food packaging, and personal care products, while major rivers, landfills, and urban groundwater have emerged as persistent environmental hotspots. Although some products show low or undetectable levels, multiple consumer goods and contaminated sites present measurable exposure risks. The findings below underscore an urgent need for continuous monitoring, stronger regulatory controls, and sustained public education to prevent long-term health impacts.

Phthalates

Several studies conducted in Indonesia over the past decade have documented the presence of phthalates across multiple environmental and consumer pathways, indicating widespread exposure and emerging public-health concerns.

- Water: In 2023, DEHP and BPA were analyzed in four bottled water samples from two popular brands in Makassar under sunlight and non-exposed conditions for six days. GC-MS analysis revealed no detectable levels of BPA or DEHP (Dwinanda Putra, Syamsir et al. 2023). In Kampung Daraulin, Citarum, DBP and BBP concentrations were 4.5 µg/L in groundwater and 22.18 µg/L in surface water, with a Hazard Index (HI) <1, indicating low health risk (Faathir Chalid and Nastiti 2025). However, 11 sites along the Citarum River showed higher total phthalate acid esters (PAEs) during the rainy season (79.18 ± 50.51 µg/L), with DBP up to 160.245 µg/L, resulting in a Risk Quotient (RQ) >1, indicating high ecotoxicological risk. One upstream site also showed a potential non-carcinogenic risk for toddlers (DBP contributed 80–89% of the total risk) (Wulan, Fahimah et al. 2025).
- Human biomonitoring: Urine samples from children in Indonesia, Thailand, and Saudi Arabia found the highest DEHP metabolite concentrations in Indonesian children, with HI >1 in 80% of cases, suggesting endocrine disruption risk (Lee, Pälmke et al. 2021). Comparative research across four Asian countries showed children in Indonesia and Bangladesh had higher phthalate exposure than those in Thailand and Korea, with DEHP as the main contributor (Jung, Jo et al. 2025). In adults, studies in South Tangerang found that MEP levels exceeding 131.91 µg/L were associated with type 2 diabetes mellitus (OR 3.75; CI 1.56–8.81) (Fauziah, Suhartono et al. 2023).
- Soil: Piyungan landfill soil samples contained DBP at all sites, with potential carcinogenic and non-carcinogenic hazards (Maharendra 2024).
- Adolescents: In Kediri, junior high school students had detectable levels of low- and high-molecular-weight phthalates in 100% of samples; DNA mutation frequency among obese adolescents was twice that of non-obese peers (Suwandani, Widjajanto et al.).
- Products: Phthalates were detected in personal care products among medical students at Andalas University (Dwinanda Putra, Syamsir et al. 2023).
- Groundwater: Ngaglik and Ngemplak studies detected DBP (0.0000107 mg/L), DAP (0.0001317 mg/L), and DCHP (0.0000832 mg/L) in 10 wells; RQ <1 and ECR <10^{-4}, indicating negligible non-carcinogenic and cancer risk (Marzuqah 2022).
- Analytical methods: DEHP in cooking oil showed LODs of 19.6 ng and LOQs of 65.5 ng using 5-min sonication and n-hexane extraction (Pusfitasari, Hendarsyah et al. 2017).
- Scoping review: DEHP is widely used and classified as Group 2B (possibly carcinogenic to humans), with human biomonitoring values of 0.02–8 mg/kg/day, lower than those of non-phthalate additives (100–1000 mg/kg/day) (Laelasari, Anwar et al. 2021).
- Levels of DEHP metabolites (such as MEHHP, MEOHP, and MEHP) in women waste workers were more than twice as high as those in the control group. Their concentrations were comparable to those reported in PVC factory workers and were twice as high as those found in plastic-recycling workers in China. (Wonjin Institute for Occupational Environmental Health, ECOTON, Airlangga University, 2025)

Bisphenol A (BPA)

Several studies in Indonesia have examined the presence of Bisphenol A (BPA) across water sources, consumer products, human biomonitoring, and experimental animal models, highlighting diverse exposure pathways and potential health concerns.

- Water: Mahakam River study (East Kalimantan) found BPA up to 652 ng/L in water and 952 ng/L in sediment, with urban/residential areas as primary sources (Hadibarata, Kristanti et al. 2020). Bengawan Solo and Brantas Rivers reported maximum concentrations of 1070 ng/L and 556 ng/L, respectively (Ismanto, Hadibarata et al. 2022). Yogyakarta groundwater wells showed BPA 0.27–3.55 mg/L (Sari and Yogana 2024).

- Consumer products: BPA migration has been detected in canned foods (Suryadi and Rasyid 2018; Sari and Yogana 2024), but is negligible in gallon water bottles and baby bottles (Dwijayanti, Munadi et al. 2023; Barus, Appa et al. 2025). Orthodontic adhesives released BPA over time with genotoxic effects (Winarta, Amtha et al. 2015).
- Humans: Urinary BPA in girls (age 9–14) in North Sumatra showed low detection, no correlation with menarche (Putri, Arto et al. 2024). Plasma BPA in 150 volunteers averaged 2.22 ± 9.91 ng/mL, higher in women, older individuals, and tap water consumers (Hayati, Hamzah et al. 2020).
- Animals: Drosophila studies revealed motor impairment and wing deformities (Ramadhan, Kharomah et al. 2025; Zahrah, Ramadhan et al. 2025). Rats exposed to BPA showed oxidative stress, liver damage, and DNA adduct formation (Dani, Rugian et al. 2022; Pradhany, Suarsana et al. 2022). Glucose metabolism studies linked BPA exposure to insulin resistance and β-cell dysfunction (Hayati, Hamzah et al. 2020; Kusnadi, Ardianto et al. 2025).
- In-silico and behavioral studies: BPA binds strongly to estrogen receptor β (ΔG = -7.70 kcal/mol), indicating estrogenic activity, classified as high-risk (Class III) (Herawati, Hidayat et al. 2022). A cross-sectional study in Bali showed household plastic use practices drive exposure, despite low knowledge (I Nyoman Gede and Desak Gde Diah 2018).
- Analytical methods: HPLC-UV, paper-based colorimetric sensors, and UV-Vis spectrophotometry validated for BPA detection in food and water with high sensitivity and precision (Aristiawan, Aryana et al. 2015; Fadillah, Guritno et al. 2024; Nurhafilah, Qodri et al. 2024).
- Urinary BPA levels in waste workers were 2.3 times higher than those in the control group, 10 times higher than Korean women, and 7 times higher than American women. (Wonjin Institute for Occupational Environmental Health, ECOTON, Airlangga University, 2025)

Vulnerable groups and high-exposure locations in Indonesia vary across age, behavior, and environmental conditions. Children and toddlers are the most susceptible, with studies showing DEHP exposure resulting in Hazard Index (HI) values above 1 in up to 80% of cases. Among adolescents, particularly those who are obese, phthalate exposure has been associated with higher DNA-mutation frequencies. Adults also face measurable risks, especially female university students who use multiple personal-care products and consumers of canned foods. Geographically, several locations have been identified as hotspots of BPA and phthalate contamination, including the Citarum, Mahakam, Bengawan Solo, and Brantas Rivers, as well as the Piyungan landfill and groundwater sources in Yogyakarta, Ngaglik, and Ngemplak. In contrast, some products, such as refillable gallon water bottles and polycarbonate baby bottles, generally show lower detected levels and are considered lower-risk within current studies.

NATIONAL ENDEAVORS TO PHASE OUT BISPHENOLS AND/OR PHTHALATES

Projects, Campaigns, and Challenges in Phasing Out Phthalates and Bisphenols

In Indonesia, public pressure to address chemical exposure has been most visible for Bisphenol A (BPA), where strong public concern, particularly over BPA migration from polycarbonate gallon bottles, triggered significant policy change. An online petition gathering tens of thousands of signatures, support from professional bodies such as IDAI and KPAI, and extensive national media coverage collectively pushed the Food and Drug Agency (BPOM) to issue Regulation No. 6 of 2024, mandating BPA warning labels and safe-storage instructions on polycarbonate gallon bottles (BPOM, 2024).

However, unlike BPA, there has been no major public campaign or national initiative to phase out phthalates. Existing measures remain fragmented across sectors, such as the Ministry of Industry

Regulation No. 55/M-IND/PER/11/2013, which restricts phthalates in children's toys to 0.1%, and BPOM Regulation No. 20/2019, which sets migration limits for BBP, DEHP, DBP, and combined DINP+DIDP in food packaging.

Despite phthalates being recognized as endocrine-disrupting chemicals (EDCs), national efforts toward labeling, transparency, or phase-out remain limited, and public mobilization continues to center almost exclusively on BPA (Sari & Yogana, 2024; Laelasari et al., 2021). Several structural challenges hinder broader progress. Regulatory gaps persist, with current policies focusing on technical limits rather than comprehensive phase-out strategies. Public awareness of phthalate-related health risks remains low, reducing societal pressure for stronger controls. Industrial resistance, especially from bottled-water and plastic-packaging manufacturers, continues due to anticipated cost implications and reputational concerns.

Scientific evidence is still limited, with few biomonitoring and exposure studies targeting vulnerable groups such as pregnant women, infants, and industrial workers. These issues are compounded by fragmented chemical-management systems, including the absence of a mandatory national inventory or positive/negative chemical list, which constrains coordinated national action (BPOM, 2024; Fauziah et al., 2023). Given the absence of nationwide initiatives addressing the phthalate risks, the government of Indonesia should launch a targeted public awareness and phase out campaigns similar to the BPA initiative. Priority should be given to DEHP, DBP, and BBP due to their strong endocrine-disrupting profiles and availability in children (Jung et al., 2025, Lee et al., 2021)

Conclusion and Recommendations

Given Indonesia's high plastic consumption, fragmented regulations, and measurable exposure among vulnerable groups (despite the very limited scientific findings especially in Indonesia for human health risks toward Phtalates and BPA)), the country urgently needs an integrated national strategy for endocrine-disrupting chemicals. Stronger regulatory alignment, systematic biomonitoring or human biomonitoring, improved chemical transparency, and enhanced capacity for laboratories are also included in this very particular substance. To strengthen public protection in Indonesia against exposure to Bisphenol A (BPA) and phthalates, coordinated action is needed across ministries, government agencies, academia, civil society, and the private sector. Key recommendations include:

Ministry of Environment

- Establish a national inventory system for plastic additives and endocrine-disrupting chemicals (EDCs), including bisphenols and phthalates, as part of the National Chemical Inventory and PRTR.
- Integrate BPA and phthalate monitoring into existing environmental quality programs, covering river water, sediments, air, and biota, especially in high-risk watersheds (Citarum, Brantas, Mahakam).
- Include these chemicals in the national list of priority hazardous substances within waste-management and pollution-control regulations to support gradual reduction and phase-out.

Food and Drug Supervisory Agency (BPOM)

- Expand current regulations by mandating "Phthalate-Free" labels for all food-contact materials, prioritizing products for children and pregnant women.
- Strengthen market surveillance for plastic-packaged foods, beverages, and refillable gallon water to ensure compliance with migration limits.

- Promote safer packaging materials through certification schemes and incentives for BPA- and phthalate-free manufacturing.
- Encourage voluntary phase-out commitments and require transparent labeling that discloses plastic composition at all stages of production and packaging.

Ministry of Industry

- Develop a national phase-out roadmap for high-risk phthalates (DEHP, DBP, BBP) in domestic manufacturing sectors.
- Revise relevant SNI standards for plastic products and children's toys to align with EU REACH and the ASEAN EDC Framework.
- Support SMEs in developing safer, bio-based alternatives, including natural or plant-derived plasticizers (citrates, phenolics, vegetable-oil derivatives).

Ministry of Health

- Integrate biomonitoring of BPA and phthalates into Riskesdas to generate baseline exposure data for women, children, and industrial workers.
- Conduct epidemiological studies linking EDC exposure with reproductive, metabolic, and developmental health outcomes.
- Strengthen risk-communication programs through Puskesmas, schools, and maternal-child health services to promote safer plastic use and raise awareness among vulnerable groups.

Academics and Research Institutions

- Establish a National Research Consortium on Endocrine Disruptors to coordinate exposure, toxicity, and alternatives research.
- Increase laboratory capacity through standardized methods, training, and inter-university collaboration.
- Promote open access to biomonitoring data to support evidence-based policymaking and transparency in chemical safety.

Private and Retail Sector

- Commit to phasing out BPA and phthalates across packaging and production lines through voluntary agreements and transparent labeling.
- Implement Extended Producer Responsibility (EPR) for safe plastic collection and recycling to prevent hazardous releases.
- Develop certification schemes for products labeled "Free from Endocrine-Disrupting Chemicals" in collaboration with BPOM and KLH.

Civil Society Organizations

- Expand public-awareness campaigns on BPA and phthalate risks through social media, exhibitions, and school-based education.
- Strengthen community-based monitoring (e.g., River Watch, Eco-Lab) of waterways and common household plastic products.
- Collaborate with professional organizations (IDI, IAKMI, KPAI) to advocate for stronger protections for children and pregnant women.

Public (Consumers and Households)

- Avoid heating or storing hot/oily food in plastic containers, and switch to safer alternatives such as glass or stainless steel.
- Choose products labeled BPA-free or phthalate-free, especially for infants, children, and pregnant women.
- Reduce the use of personal-care products with synthetic fragrances (common sources of phthalates) and maintain a clean home environment to reduce chemical-laden dust.
- Participate in community-based monitoring or awareness activities to increase public understanding of chemical risks.
- Support policy change by engaging with public campaigns and petitions that advocate for safer plastics and stronger chemical regulations.

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