Children and digital dumpsites

E-waste exposure and child health

SUMMARY FOR POLICY-MAKERS

World Health Organization

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Smaller hands, cheaper labour: the crisis of e-waste and children's health

Introduction

In 2019, some 53.6 million tonnes of e-waste were generated worldwide, a 21% increase over the past five years. Global e-waste generation is projected to grow to 74.7 million tonnes by 2030 (Figure 1) *(1)*.

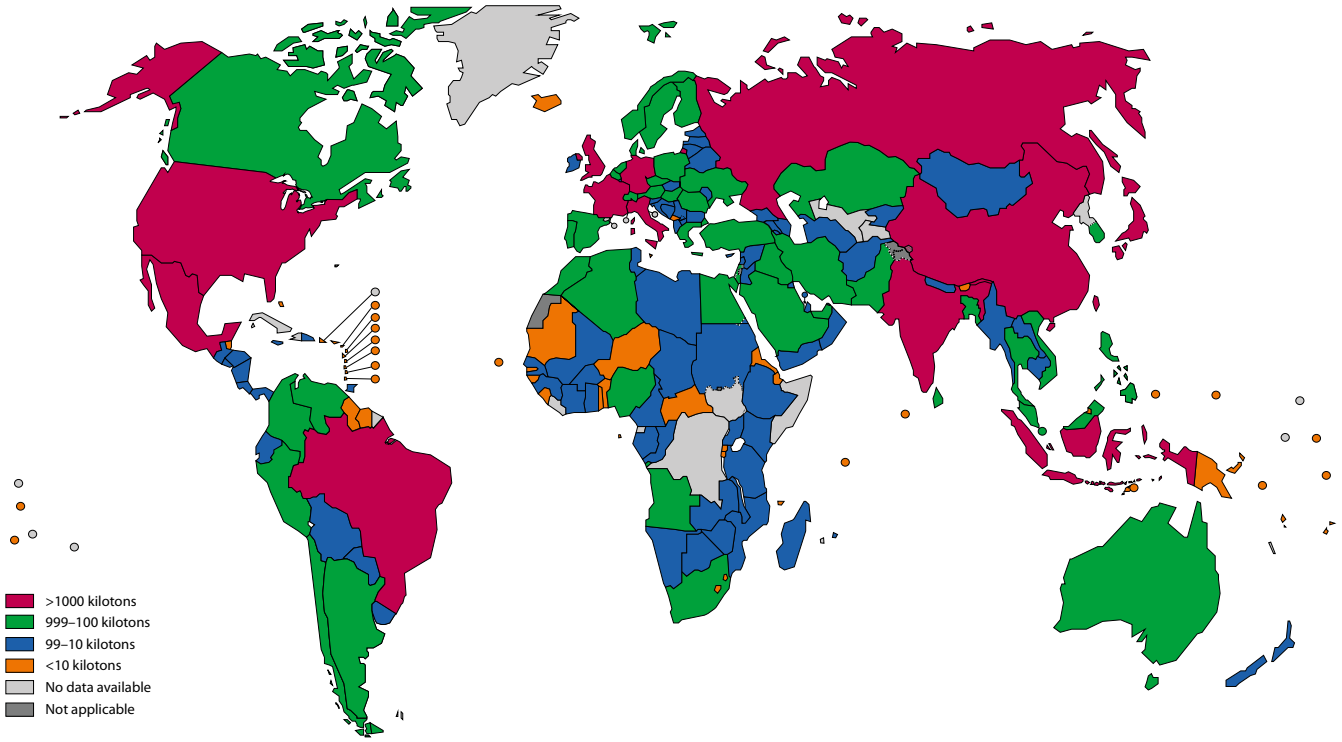
Meanwhile, an estimated 152 million children aged 5–17 years are involved in child labour, including 18 million children (11.9%) in the industrial sector, which includes waste processing. Some 73 million children worldwide engage in hazardous labour, with unknown numbers in the informal waste recycling sector *(2)*.

In terms of women, it is estimated that between 2.9 million and 12.9 million women are involved in the informal waste sector, including an unknown number of women of childbearing age *(3)*.

By endangering tens of millions of children and women of childbearing age, improper disposal of e-waste threatens the health and abilities of future generations.

The problem is most severe where impoverished city dwellers work in or live near informal dumps and landfills. These unmonitored sites in low- and middle-income countries receive a large share of global e-waste. E-waste is commonly defined as "electrical or electronic equipment which is waste, including all components, subassemblies and consumables, which are part of the equipment at the time the equipment becomes waste" *(4)*.

Ineffective waste management of mobile phones, computers and appliances has led to a global crisis of e-waste health risks.



Source: Global E-waste Monitor *(1)*.

Fig. 1
E-waste generated by country, 2019

These e-waste volumes are spiralling as use of cell phones, smart phones and computers grows exponentially, and devices are replaced rather than repaired. Large electrical appliances, such as washing machines and refrigerators, were once known as "durable goods" as they were built to last, but the reverse is now often the case. Both small and large appliances are often designed in ways that make repairs difficult, instead encouraging more frequent device replacement, adding to the growing e-waste stream.

By 2030, global employment in waste management is expected to grow by 70%, or another 45 million jobs *(5)*.

This growing waste stream contains valuable materials such as gold, silver, palladium, platinum, cobalt, and copper, as well as bulkier materials such as iron and aluminium. Informal scavenging for e-waste in unmanaged landfills has become a common income source for low-income communities nearby.

Reprocessing increases risks and impacts

Informal processing of e-waste extracts valuable metals through open burning, heating or acid leaching (using cyanide salt, nitric acid or mercury). These reclamation efforts can expose children and workers to mercury, lead, cadmium, and other by-products of plastics and metal processing.

Only 17.4% of e-waste produced in 2019 reached formal management or recycling systems. The rest was disposed of in illegal landfills, domestically or internationally, or was recycled by informal workers. This waste stream's growth is driven by consumer habits in some developed countries, where the average mobile phone is replaced as often as every two years (Figure 2) *(1)*.

Children and digital dumpsites: e-waste exposure and child health – the main report of which this document is a summary – builds on the World Health Organization (WHO) Initiative on E-waste and Child Health, extensively updating a 2013 systematic review on emerging issues and health impacts *(6)*. Its four sections concern e-waste settings and exposure pathways, exposure impacts on children's health and development, action and policy agendas, and WHO's leadership role. Key messages from each section of the full report are briefly presented here.

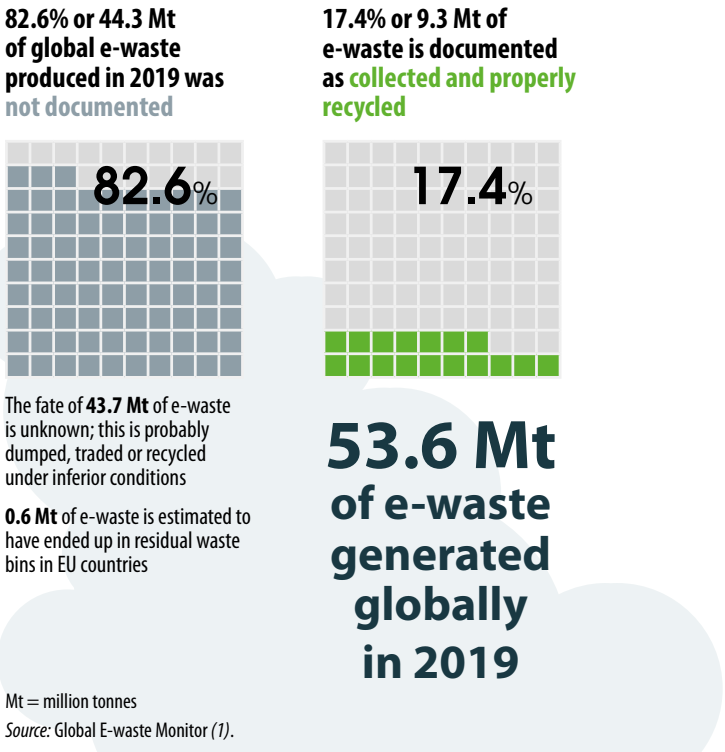


Fig. 2
Proportion of e-waste treated in accordance with best available technology

1. E-waste settings, trends and exposure pathways

E-waste workers and their families are exposed to toxicants through multiple pathways, including ingestion of food, water, soil and dust, inhalation of aerosol gases and particles and dermal exposure. Children face additional risks from breast milk and transplacental exposure.

Primitive recycling processes typically lack safety measures and personal protective equipment. Both severe environmental contamination and human health risks are associated with e-waste sites.

Hazardous mixtures of e-waste toxicants circulate in many forms. Dismantling, heating and open burning emit airborne particulate matter (PM) and leach by-products into soil and water sources. Among such released chemicals known to harm children are heavy metals, dioxins, furans, polychlorinated biphenyls (PCBs), brominated compounds and polycyclic aromatic hydrocarbons (PAHs).

These substances can pollute the air, dust, water and soil, and can volatilize from contaminated ground. Workers inhale and ingest hazardous dust, and their skin, shoes and clothes can carry it into communities and homes (Figure 3).

Multiple sources of e-waste toxicants put children and their families at risk in communities near informal e-waste sites. Various air pollutants from burning metals, plastics and contaminants also settle as residues on crops, market foods and other surfaces.

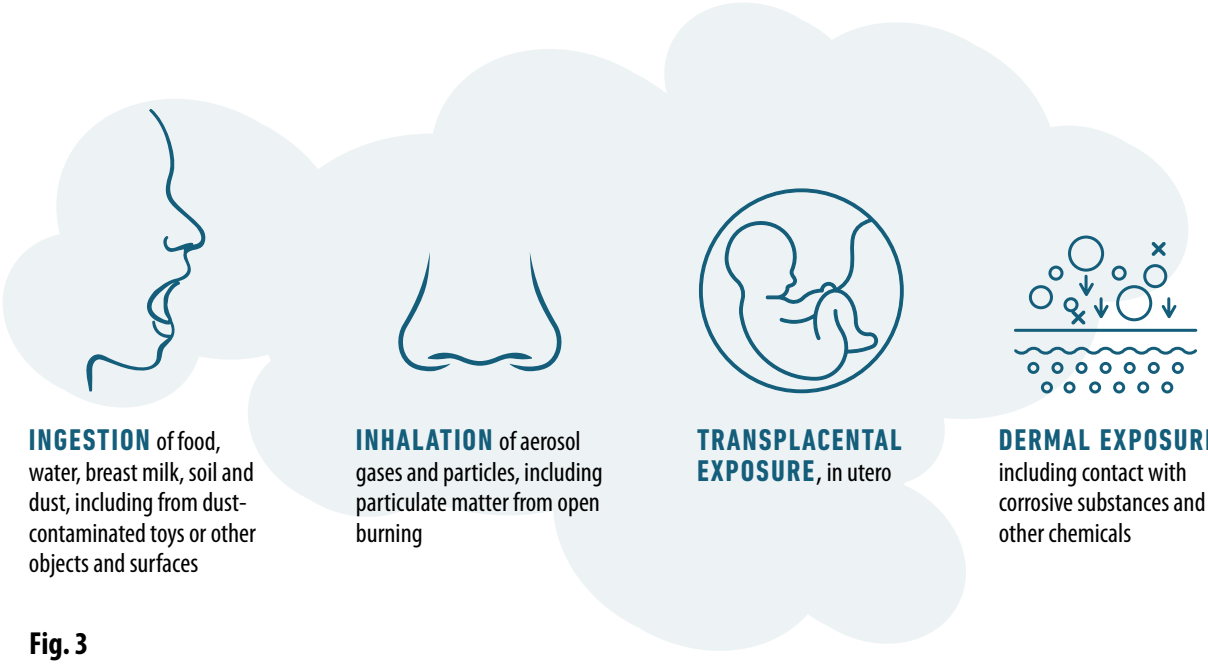


Fig. 3
Physiological routes of exposure

Even in cities with organized waste management systems, e-waste is often discarded alongside other solid waste, ending up in landfills. Such discarded e-waste can leach toxicants into aquifers and drinking-water supplies *(3)*.

Most at risk: children, adolescents, pregnant women and fetuses

Children and pregnant women working in or living near informal e-waste disposal and processing sites are among those most vulnerable to hazardous chemicals. Children are disproportionately at risk due to their still developing organs and immune systems, as well as their rapid growth and developmental vulnerabilities.

For instance, children absorb more pollutants because they breathe more rapidly and ingest more food and water relative to their size than adults. They are also less able than adults to metabolize and eliminate hazardous substances from their bodies. Their smaller bodies are thus impacted by exposure to proportionately lower volumes of toxicants than those that might be deemed safe for adults.

Children's behaviour also makes them more vulnerable to injuries from and hazardous exposure to e-waste. Small children spend more time close to the floor, crawling and playing in dust or dirt. They engage in hand-to-mouth and object-to-mouth behaviours much more often than adults, increasing their relative intake of contaminated dust or soil *(7)*.

As they develop physically and cognitively through infancy, childhood and adolescence, children's risk behaviours change, and they face different injury issues. Adolescents may be more accident and injury prone, while girls who become pregnant face greater risks, as do their fetuses. For pregnant girls and women working or living near e-waste sites, exposure to toxicants even at very low levels can impact pregnancy health. Such exposure may also result in long-term impacts on the health of newborns in childhood or in adult life *(3)*.

2. Health and development impacts

E-waste exposure has been linked to a variety of adverse health outcomes, including impaired neurological and behavioural development, negative birth outcomes and immune system impacts.

This chapter considers which hazards pose the most substantial risks, as well as their multiple and combined threats to children's health (see Box 1 on the emerging issue of COVID-19). Prenatal and childhood exposure to e-waste toxicants are associated with:

- impaired neurological and behavioural development;
- negative birth outcomes;
- lung function and respiratory effects (including cough, wheeze and asthma);
- impaired thyroid function;
- changes in cardiovascular system function;
- DNA damage;
- immune system impacts (including greater vulnerability to infection, reduced immunization response and higher rates of allergies and autoimmune diseases);
- increased risks of chronic disease later in life (including cancer and cardiovascular disease).

Box 1
Infectious disease and e-waste

The COVID-19 pandemic, which began shortly after this review was completed, has heightened awareness of infectious disease risks facing many sectors. Informal waste workers, including women and children, face greater risks of infectious disease exposure due to worksite safety and sanitation issues. While the *Children and digital dumpsites* report highlights noncommunicable health risks from e-waste exposure to chemicals, metals and other toxicants, the infectious threats of informal waste sites to children and pregnant women deserve further exploration, especially in light of the pandemic and increased awareness of infectious disease risks in community settings and workplaces more broadly.

Chemicals most closely linked to health impacts

The most significant e-waste recycling health risks are due to exposure to a number of the 10 chemicals recognized by WHO as of major public health concern *(8)*. These include heavy metals such as lead, cadmium and mercury; persistent organic pollutants such as dioxins; and fine particles emitted through e-waste combustion. $PM_{2.5}$ is a commonly used indicator of the most health-harmful fine particles, referring to those with a diameter of less than 2.5 micrometres (see Table 1 for more details on the suspected human health effects that have been associated with chemicals found in e-waste).

However, more than 1000 harmful substances have been identified that are either components of e-waste or are used in informal e-waste processing *(9)*. Notable among these are compounds that are used in fabricating electronic components, or that are produced as a result of waste burning or metals extraction. These include PCBs, polybrominated diphenyl ethers (PBDEs), per- and polyfluoroalkyl substances (PFAS), phthalate esters, organophosphate flame retardants (PFRs), and bisphenols. Combustion of e-waste materials to extract metals also makes e-waste sites frequent sources of intense air pollution contaminated by toxic mixes of such harmful particulates, including heavy metals and industrial chemicals and compounds.

Table 1
Suspected human health effects of individual chemicals found in e-waste

Health effects	Chemical component of e-waste suspected to cause human health effects
Carcinogenic (cancer causing)	PCBs, dioxins, PAHs, PFOA, cadmium, arsenic, beryllium, chromium
Endocrine disruption	PBDEs, PCBs, dioxins, manganese, phthalates, bisphenols
Fetal growth and development (low birth weight, low head circumference, intrauterine growth restriction)	PBDEs, PCBs, dioxins, PFAS, PAHs, lead, cadmium, arsenic, chromium
Neurodevelopment and cognitive function (IQ deficits)	PBDEs, PCBs, PAHs, lead, mercury, cadmium, manganese
Behavioural effects (shortened attention span, reduced ability to deal with frustration, hyperactivity, antisocial behaviour, depression)	Lead, PCBs, dioxins, PAHs
Reproductive effects	PBDEs, PCBs, dioxins, PFAS, lead, chromium, mercury, phthalates, bisphenols
Metabolic diseases	PBDEs, dioxins
Bone damage	Cadmium
Liver damage	Nickel, iron, cadmium
Lung damage	PAHs, cadmium, arsenic, lithium
Kidney damage	Lead, cadmium, mercury
Cardiovascular	Dioxins, mercury, arsenic
Immune system suppression	PCBs, dioxins
Immune system stimulation, promoting allergy and autoimmunity	Lead, nickel, mercury, chromium, gold

PAHs: polycyclic aromatic hydrocarbons; PBDEs: polybrominated diphenyl ethers: PCBs: polychlorinated biphenyls; PFAS: per- and polyfluoroalkyl substances; PFOA: perfluorooctanoic acid.
Source: Children and digital dumpsites *(3)*.

3. E-waste and health action and policy agenda

Action to protect human and environmental health from the hazards of e-waste needs to happen at global, regional, national and local levels. The health sector can play a role at all levels by providing leadership, conducting research, lobbying policy-makers and engaging communities.

Global and regional actions

Several international conventions, including the Basel, Rotterdam and Stockholm Conventions, prohibit the commercial use and transboundary movement of certain hazardous substances. These conventions cover many chemicals that are found in e-waste. Regional agreements, such as the Waigani and Bamako Conventions, ban the transboundary movement and demand improvement in regional control and management of hazardous wastes, including e-waste.

Vast amounts of e-waste are transported from the United States, Canada, Australia, Europe, Japan and the Republic of Korea to African, Asian and South American countries.

In response to the health threats posed by informal waste disposal, United Nations (UN) agencies and programmes and independent experts have called for stronger action on improperly recycled e-waste.

Better recycling also presents opportunities for increased income and decreased demand for new materials. In 2019, up to US$ 57 billion in raw materials could have been recovered if e-waste had been recycled optimally *(1)*.

Extracting resources from e-waste supports climate mitigation goals and produces less carbon dioxide (CO_2) than mining for the same materials *(10)*.

Overarching goals to stimulate effective and binding action by e-waste importers, exporters and governments include:

- **ensuring health and safety of e-waste workers and communities** with systems that train and protect workers, monitor exposure and health outcomes, and make protecting children the highest policy priority;
- **enforcing sound environmental health practices** for disposal, recapture and reuse of materials;
- **shifting toward a circular economy** by manufacturing more durable electronic and electrical equipment, using safer and less toxic materials, and encouraging sustainable consumption to reduce e-waste;
- **managing e-waste by prioritizing health and environmental protection** throughout the life cycle, with reference to the Basel Convention, appropriate regional conventions and the Sustainable Development Goals (SDGs) on waste management;
- **eliminating child labour and incorporating adult e-waste workers into the formal economy with decent conditions** across the value chain of collection, processing and recycling, and resale by transitioning informal workers to the formal economy.

The health sector can provide leadership and advocacy on e-waste initiatives and contribute to multisectoral action by reaching out to other sectors to demand that health concerns be made central to e-waste policies. Opportunities for leadership and collaboration include:

- **regional and national capacity-building for health-based assessment of e-waste policies and regulations,** particularly regarding children's health;
- **raising awareness of e-waste health risks** and encouraging responsible recycling with policy-makers, communities, waste workers and their families;
- **building health sector capacity to diagnose, monitor and prevent toxic exposure** within primary health care services, especially for children and women;
- **pursuing better data and further research about women and children involved with e-waste,** as well as studies about implementation and effectiveness of protective measures. Box 2 details some of the most pressing research needs.

Box 2
Research priorities

Health effects

- Long-term, prospective cohort studies are necessary to study the long-term effects of exposure to e-waste in both children and adults.
- Given the unique mixtures of chemicals in e-waste, additional studies on exposure to chemical mixtures are needed.
- Additional research on emerging health outcomes of concern should be conducted.
- Additional studies of health outcomes should be done in expanding e-waste areas in Africa, Asia and the Americas.
- As new and updated electronics are produced, research needs to focus on the additional exposure and environmental burdens that these items may add to the health of e-waste workers.

Interventions

- Document the effectiveness of awareness-raising, risk reduction interventions and prevention strategies and share this information.
- Conduct further research on environmental remediation technologies.
- Conduct research to develop more easily recyclable technologies with less toxic components.

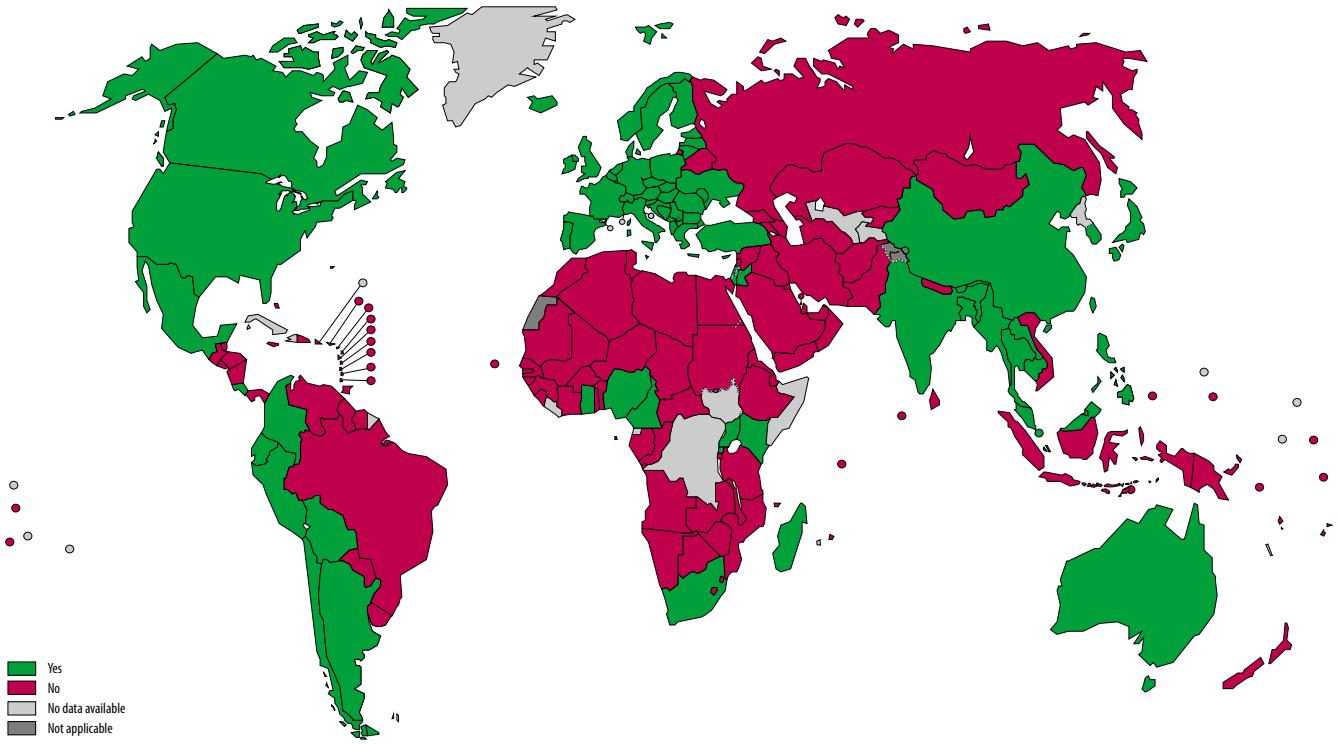
National level: multisectoral collaboration to assess and recommend solutions

At the national level, the health sector can build capacity to assess e-waste hazards, estimate related health costs, and propose contextualized solutions. Policies to encourage safe and efficient recycling can also prevent e-waste-related injuries and other health effects. In 2019, 78 countries, covering 71% of the world's population, had a policy, legislation or regulation in place governing e-waste (Figure 4) *(1)*.

Health systems can set up programmes at primary care clinics to monitor toxic exposure among children and women. Reporting toxic exposure greatly enhances the ability of authorities to effectively target interventions.

While millions of women and children face e-waste toxicant exposure, these workers remain largely invisible in labour market statistics. As waste workers are represented only in the broader category of industrial workers, monitoring informal waste workers and e-waste workers within labour surveys would make these workers more visible.

Only multisectoral action can build informed e-waste policies. Governments need to study this workforce's exposure and related health impacts, and to test and implement solutions that put e-waste management on a clean development track. More sustainable and health-focused e-waste policies that stimulate transition to a circular waste economy can promote healthier communities while yielding economic benefits.



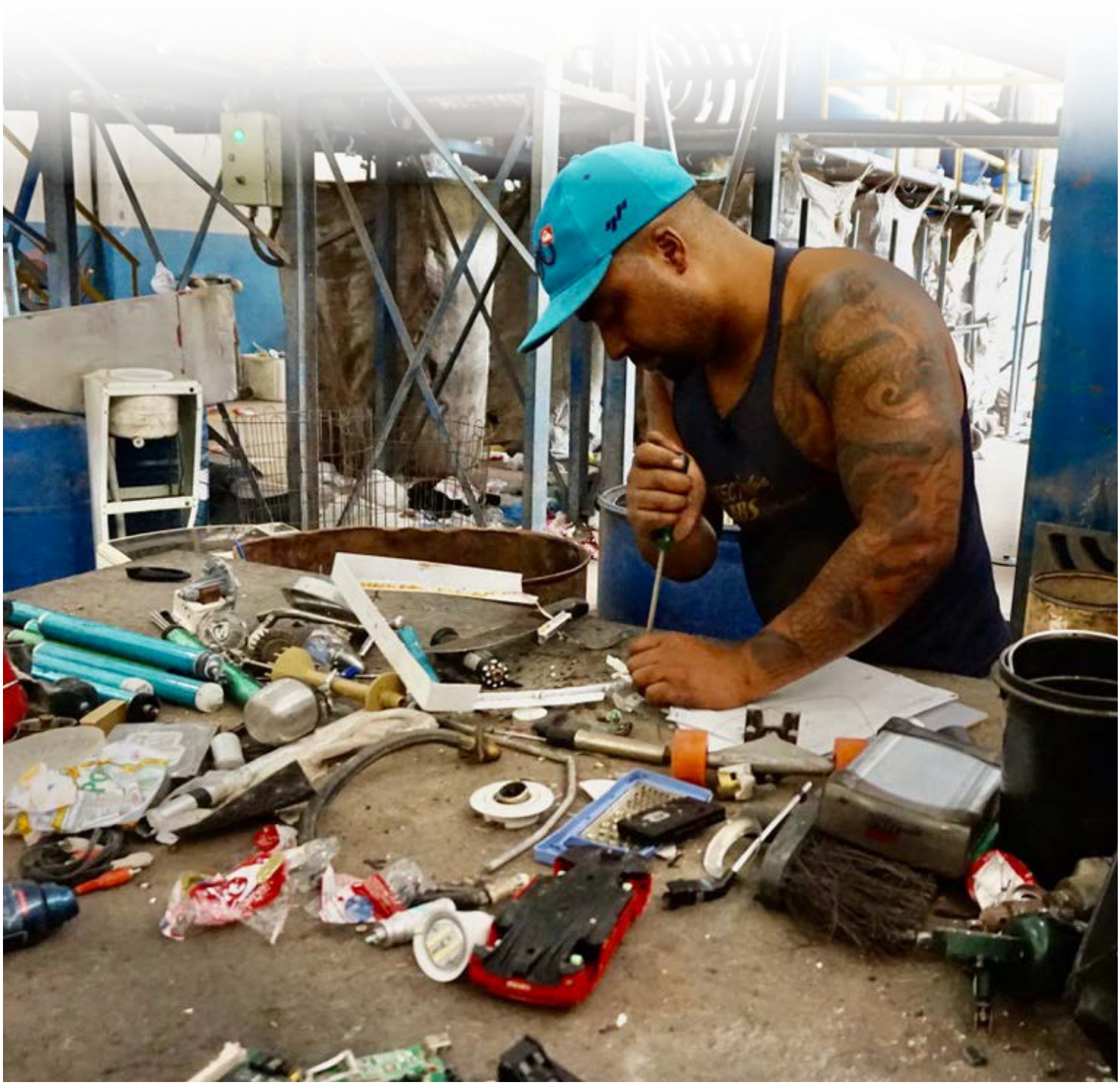
Source: : Global E-waste Monitor *(1)*.

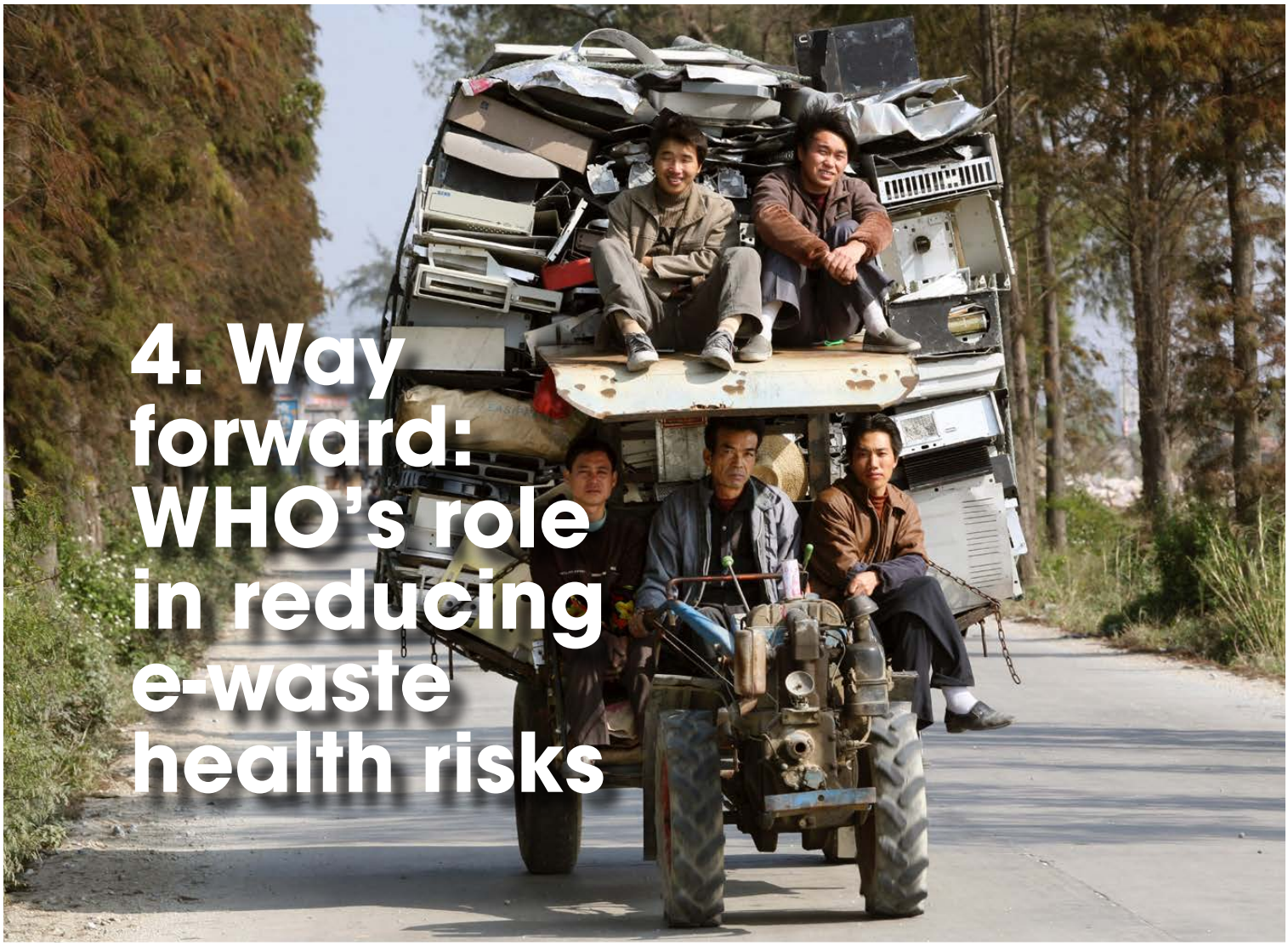
Fig. 4
Countries with national e-waste legislation, policy or regulation in place, 2019

Local training to recognize and address exposure risks

At the local level, health professionals need to be aware of the health risks of e-waste and need training and equipment to detect and test for toxicant exposure in workers. They also need training in methods to reduce risks and treat exposure impacts among children, adolescents and women.

Health care providers can also raise awareness in their communities about e-waste risks while promoting local solutions at the community level and improved occupational health practices to reduce harmful exposure.





4. Way forward: WHO's role in reducing e-waste health risks

WHO is working with other UN agencies, governments and communities across the world to spread awareness of the dangers of e-waste and to support the development of targeted policies, research and interventions.

The WHO Initiative on E-waste and Child Health was launched in 2013 after the WHO Working Meeting on E-waste and Child Health. The Geneva Declaration on E-waste and Children's Health *(11)* set as goals:

- increased access to the evidence and knowledge base;
- greater awareness about health impacts, particularly in children, and solutions for e-waste management;
- improved health sector capacity to identify risks, track progress and promote e-waste policies that protect children through exposure reduction;
- promotion of e-waste exposure monitoring;
- multisectoral collaboration to implement policies reducing e-waste exposure;
- facilitation of research about e-waste and health;
- development and testing of country-based pilot initiatives to reduce e-waste health risks.

WHO is working with international experts and its collaborating centres on children's environmental health. It is compiling relevant research and building health professionals' skills using the WHO training package on

children's environmental health, including an e-waste training module *(12)*. WHO is also collaborating with other UN and international agencies on a massive open online course *(13)* and contributes to UN efforts to spread awareness of e-waste through collaboration with other agencies to produce reports such as the *Global E-waste Monitor 2020 (1)*.

WHO recently joined the E-Waste Coalition, which is working globally to support governments in addressing e-waste issues across health, environment, climate and development agendas *(10)*. The goals of the E-waste Coalition include:

- supporting countries to manage and reduce e-waste volumes and implement appropriate policies and practical measures;
- creating inter-organizational cooperation and adding value to existing programmes;
- increasing awareness and engagement across global, regional, national and local levels;
- supporting the development of a circular economy;
- preventing illegal e-waste trafficking;
- promoting opportunities for non-State actors to be involved in e-waste solutions.

Recent World Health Assembly resolutions on health sector action on chemicals, wastes and air pollution specify that WHO and the health sector should report on and implement actions related to toxic waste and waste burning. Box 3 presents the World Health Assembly resolutions and decisions most relevant to e-waste.

At regional and local levels, WHO is helping to develop frameworks to protect child health from e-waste exposure in Latin America and Africa. The pilot projects include collaboration with a range of local communities, governments and UN agencies. These pilot projects aim to promote local advocacy and collaboration with communities and build the capacity of primary health systems to address risks by monitoring e-waste exposure and measuring the success of interventions. The pilot projects are designing frameworks that can be adapted and replicated in different countries and settings.

Box 3
World Health Assembly resolutions and decisions related to e-waste

Resolution WHA63.25: Improvement of health through safe and environmentally sound waste management

Resolution WHA68.8: Health and the environment: addressing the health impact of air pollution

Resolution WHA69.4 and decision WHA70(23): The role of the health sector in the Strategic Approach to International Chemicals Management towards the 2020 goal and beyond

Decision WHA72(9): WHO global strategy on health, environment and climate change: the transformation needed to improve lives and well-being sustainably through healthy environments.

Links to SDGs: climate and health agendas

Extracting resources from electrical and electronic waste using safe extraction technologies reduces health risks while producing less CO_2 than mining the same materials, thus benefiting the environment and reducing climate emissions.

The most recent *Global E-waste Monitor* found that refrigerators and air-conditioners recycled in substandard conditions in 2019

Box 4
SDG targets related to e-waste

The environment is embedded in the integrated SDGs and their targets, a number of which reflect the importance of tackling the devastating impacts of e-waste on children around the world.

SDG 3 – Ensure healthy lives and promote well-being for all at all ages, including the reduction of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.

SDG 8 – Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, which includes promoting decent job creation, formalization of small- and medium-sized enterprises, eradication of forced and child labour and promotion of safe and secure working environments.

SDG 11 – Make cities inclusive, safe, resilient and sustainable, including by reducing the adverse environmental impacts of cities through attention to air pollution and municipal and other waste management.

SDG 12 – Ensure sustainable consumption and production patterns, including through environmentally sound management of chemicals and all wastes throughout their life cycle and reducing waste generation through prevention, reduction, repair, recycling and reuse.

produced an estimated 98 million tonnes of CO_2 equivalents. In contrast, the 17.4% of appropriately recycled e-waste saved as much as 15 million tonnes of CO_2 equivalents from being released into the environment in 2019 *(1)*. Along with the carbon savings, sound recycling processes can reduce or eliminate the random release of many other chemicals that can harm humans and the environment. The safe management of e-waste will also contribute to the achievement of multiple SDGs (Box 4).

Recognizing the potential co-benefits, the WHO Global Strategy on Health, Environment and Climate Change calls for population-based, intersectoral approaches, as other sectors have greater ability to make upstream changes that reduce risks to health *(14)*.

Collaboration between the private sector and national ministries of health, labour, industry and environment is essential to promote interventions across the value chain. Examples of such collaboration include redesigning equipment to reduce toxicants and seeking to prevent occupational and community exposure through safer e-waste management.

A rights-based approach to child health

Exposure to toxic chemicals and heavy metals unquestionably impacts children's rights. According to the Convention on the Rights of the Child, States are duty bound to ensure, to the maximum extent possible, the survival and development of the child *(15)*.

Chronic exposure to e-waste and its toxic components violates children's rights. For many children, lack of access to an appropriate justice system or an effective remedy further violates their human rights.

Efforts that should be taken by Member States to respect, protect and fulfil child rights are not limited to addressing violations that occur within their territory or jurisdiction.

Member States have human rights obligations regarding export of their e-waste.

The report concludes by noting that businesses must respect children's human rights that are infringed by the unsound management of e-waste. Whether involved directly or indirectly in e-waste production and use, or linked to the disposal or export of electronic waste, businesses are obligated to prevent children from being exposed to toxins from their products and activities. From the electronics and recycling industries to investors and legal professionals, all involved sectors have a responsibility to respect these rights.

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Photos

Children break apart CRT (cathode ray tube) monitors to salvage metal from inside at Agbogbloshie dump.

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Plastic from e-waste is piled high at Agbogbloshie dump.

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Filipino boys gather recyclable materials, mostly e-waste.

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A woman carries her baby through an electronic waste site, Ghana.

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A drinks vendor and e-waste workers watch as waste is burned in Agbogbloshie, Ghana.

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Young girl selling small bags of water to workers at an e-waste dump in Ghana.

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Working with e-waste and repair at the Cooperative Cidade Limpa in Santo André, Brazil.

© Jutta Gutberlet

Workers transport a large stack of old computers on a small tractor in China.

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Children and digital dumpsites

E-waste exposure and child health

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