IMPACT OF HOUSEHOLD WASTE ON THE ENVIRONMENT AND HUMAN HEALTH

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Annotation: Household waste has evolved into a core urban challenge, with increased quantities of waste being generated and with more complex material compositions, often containing toxic and hazardous elements. Critical systems theory understands cities as urban metabolisms, with different material and energy flows, highlighting the circularity in production, consumption, and discard. Waste pickers in low- and medium-income countries work on dumps and landfills, sifting through highly contaminated household waste and are exposed to health hazards. This paper discusses the risk factors, hazards, and vulnerabilities waste pickers are exposed to during collection and separation of recyclables, based on the review of literature on waste and environmental health and on findings from participatory research with waste pickers conducted in Brazil. We take a social and environmental justice perspective and identify the vulnerabilities and waste-borne hazards of household waste, associated with these workers, their communities, watersheds, and the environment. Household waste, although not always per se toxic or hazardous, can become a hazard if not collected or inadequately managed. Those communities where household waste is not collected or waste collection is insufficient are the most critical places. Informal and organized waste pickers, municipal or private waste collectors/workers, small waste traders and sometimes residents, particularly small children, may be considered vulnerable if exposed to waste-borne hazards. The results include recommendations to address household waste-borne hazards and vulnerabilities, according to waste workers involved in this research.

Keywords: Household waste, health risks, vulnerability, waste pickers, informal sector, waste management, recycling, low- and middle-income countries

Worldwide, municipal solid waste generation has increased significantly over recent decades and so has the range of toxic and hazardous materials within the waste stream [1–3]. If household waste is not adequately collected, separated, and treated, as is often the case in low- and medium-income countries, not only the toxic components but also all waste can potentially become hazardous, generating long term and cumulative environmental and human health impacts. The health of local communities, particularly low-income neighbor hoods, is not only affected by the accumulation of uncollected waste [4–6] but can also be compromised by waste management facilities, including dumps, landfills, and incinerators [7]. Without protective equipment and awareness on how to handle these potentially risky materials, household waste becomes hazardous and poses health risks to those handling garbage. Waste management infrastructure and services target the collection and transport of household waste, with the aim of maintaining and guaranteeing public health [8,9]. Waste management implies a wide range of distinct actors and different practices. Urban infrastructure and service provision is structured by the political economies and respective power relations that make up the city. Decisions over infrastructure and services are political and policymaking can involve various levels of democratic and participatory praxis, with variable outcomes [11] Currently, more than one-third of the global urban population lives in informal settlements [12,13], often poorly connected

to basic services [14]. In these neighbor hoods, open dumping of solid waste generates soil and water contamination as well as methane and other gas emissions, posing risks to human and environmental health [15]. Low-income residents are not passive about deteriorating socio-environmental conditions in their communities and create extensive informal sectors of waste pickers who collect and recycle household waste [16,17]. Driven both by the desire to maintain a healthy environment and by the need for jobs, residents initiate and support their own ability to provide and improve critical services, thus reducing the carbon footprint in their cities [18–21], recovering resources, improving the environmental conditions and health of low income residents. The informal waste sector creates many "low barrier" jobs needed for the poor [22]. Hazarous waste.Household hazardous waste is defined as the fraction of waste, originated from households, which contains corrosive, explosive, flammable, toxic, ignitable, or reactive ingredients and is difficult to dispose of or which put human health and the environment at risk because of its bio-chemical nature [5,40]. A major portion of municipal solid waste is household waste, of which 4 or more per cent [41,42] can be potentially harmful for both the environment and human health. For example, a significant proportion of water pollutants originate from the household waste stream [43]. In this paper, we consider household waste as hazardous if not properly collected or managed, both in urban and peri-urban settings, causing health and environmental hazards.

A range of health problems have been documented for waste workers which were caused by hazardous household waste or mismanaged household waste. Work-related disorders and injuries have been detected among the waste collectors around the world, such as respiratory problems, infectious diseases, gastrointestinal issues, muscle pain, fever, headache, fatigue, irritation of eyes and skins, mechanical trauma, pulmonary problems, chronic bronchitis, musculoskeletal damage and hearing loss, poor emotional well-being, and other specific types of injuries [26,44,45]. E-waste workers/collectors in Ghana are among the poorest and most vulnerable group in this country's urban population. Pollutants can leach from littered household waste into the ground, contaminating the soil. Improperly disposed batteries and fluorescent lamps pose significant threats to the environment as described for Brazil [49]. Heavy metal contamination in foodstuff, house dust, farm soil, and groundwater were found in an e-waste recycling area in China, where work processes are currently not regulated [50].Vulnerable place.Vulnerable places discussed here are communities, particularly those where household waste is not collected or where the collection is insufficient or neglected. Informal settlements face serious challenges due to improper waste management infrastructure, lack of collection services, and inadequate waste disposal [24,79,80]. There are large intra-city inequalities in low- and medium-income countries, related to waste disposal and collection services [81]. Sometimes waste is collected at the household level but then remains at transfer points without being evacuated from the neighborhood [82–84]. Both liquid and solid waste management practices in urban informal settlements can pose significant risks to the environment and human health [85]. Open drains regularly receive household waste which can contain hazardous substances, polluting the wider environment and affecting the health of the local population [81,86]. Often local authorities fail to provide frequent garbage collection services due to the government's low human and financial resource availability, high population density, and unplanned residential areas [87]. Waste disposed in the streets for many hours awaiting collection becomes a nuisance, forming foul-smells and leach ate from the waste pile, attracting

insects and rodents, which become vectors of diseases [85,88]. Improper disposal of waste creates and disseminates pathogens which can quickly spread among human and animal populations in the city. High-concentrated leach ate potentially causes environmental threats affecting ground water and surrounding environments [89]. There is also the risk of explosion and fire due to the production of methane gas on land filling sites [88].

Vulnerable environment. Informal dumping and uncollected household waste in watersheds gets carried into waterways by runoff water and often contaminates the local drinking water. A recent study shows that a maximum of 12.7 out of 275 million metric tons plastic waste enters the ocean, creating hazards for marine ecosystems [90], resulting in the cost of 13 billion USD/year for marine conservation initiatives [91]. Improper waste management practices contaminate the oceans and freshwater bodies in many parts of the world [85]. The vegetation near landfill sites is often damaged due to the replacement of oxygen by other gases produced in the root zones, causing the death of plants on the long term [85,92]. Research confirms that plants die due to various gas mixtures generated in typical landfill sites [93]. A range of hazardous pollutants (e.g. NO_x, SO_x, carbon dioxide, ozone) are emitted during waste collection processes, posing potential hazards to human health and the environment [94].

Land filling is the most common waste disposal method in low- and middle-income countries and most landfills are open or "controlled" dumps while few can be considered sanitary landfills. Landfills also emit various air contaminants. Landfill biogas, for example, contains approximately 48–56% methane; which, if not captured, contributes to the greenhouse gas effect, affecting our global climate [95]. The groundwater under or near dump sites is contaminated due to a range of hazardous and toxic wastes and their components concentrated in the leachate which is an aerobically fermented [96] and also due to the disposal of waste into the highly permeable alluvial sediments [97]. Additionally, high concentration of carbon dioxide and presence of vinyl chloride and other volatile hydrocarbons produced in dumps and landfill sites may cause groundwater pollution due to its high-solubility characteristics [91]. . Research shows that a high concentration of total dissolved solids, electrical conductivity, total alkalinity, chlorides, sodium, and lead are present in the groundwater samples near landfills, which are higher than the standard limits [99]. In the case of a high-income country like Canada, benzene, toluene, ethyl benzene, and *m-*, *p-*, *o*-xylene were also detected in the groundwater near former landfill sites in the eastern subarctic region [100]. Adverse effects on the environment such as groundwater contamination have been found due to the migration of chloride, manganese, and coli form bacteria from landfill sites. The coli form bacteria multiply when leachate enters in the oxygenated groundwater system. Some other groundwater contamination indicators include Cl, HCO_3, Cl/HCO_3, Zn, Na, NH_4, SEC, hardness, P, metals, NH_4, NO_3, TDS, SO_4, Fe, COD, Cr, Ni, Cu, CN, microorganisms [101]. The dispersion of toxic pollutions from municipal dumps and landfills through groundwater contamination compromises the quality of the surrounding environments.

Conclusion. In this paper, we have identified household waste-borne health risk factors and hazards and have discussed how these are affecting informal recyclers in low- and medium-income countries. We have particularly highlighted the perspectives of organized waste pickers who work in recycling cooperatives and associations. A literature review and empirical insights from research conducted in Brazil informs our discussion. Hazards linked to household waste affect the environment and particularly those who work with waste. Occupational health risks

of informal and organized recyclers have not been well documented and more research needs to be done to better understand the health impacts of household waste collection and separation and to address these risks. Not only does household waste contain hazardous materials and toxic substances, but the process of collection, separation, and transportation in itself can also pose severe health hazards and risks to those working with waste.Studies are needed to identify low-cost solutions, appropriate to specific geographic and political contexts to facilitate the work of waste pickers as service providers, as environmental stewards and waste educators in the community. There is a need to assess the costs of hospitalization or treatment due to diseases, cuts, injuries, or other accidents, evaluating the losses and health damage to waste pickers and community members.

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