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Overlapping vulnerabilities in workers of the electronics recycling industry formal sector: A commentary

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Abstract

Vulnerabilities in workers performing electronics recycling (e-recycling) in the informal sector worldwide have been well documented. However, the growing e-recycling industry in the formal sector still brings many challenges to protect the health of workers and their environment. This commentary aims to draw attention to the overlooked vulnerabilities faced by the workers of the e-recycling industry formal sector in high-income countries and discuss the potential impact on health inequalities experienced by these workers. Expanding the definition of vulnerability, not limited to the biological susceptibility to chemical and physical exposures, the demographic

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AUTHOR CONTRIBUTIONS

Ceballos and Flynn conceptualized the idea for this commentary; Ceballos, Cote, Bakhiyi, and Gravel contributed to the acquisition and summary of key content for the manuscript; all authors contributed to the drafting and review of the manuscript; Labrèche as a senior author revised manuscript critically for important intellectual content; Ceballos and Cote contributed equally to the writing and revisions of the manuscript; and all authors participated in the final approval of the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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characteristics of workers in the e-recycling formal sector often reveal social groups known to be disadvantaged regarding occupational exposures and health effects, including young workers, immigrant or ethnic minorities, and workers with mental or physical health issues or disabilities. Overlapping structural vulnerabilities of the e-recycling industry stem from its newness, its working conditions, its conditions of employment, and the sociodemographic characteristics of its workforce. This phenomenon in high-income countries is not restricted to the e-recycling industry alone. It is rather a symptom of more generalized macro socioeconomical phenomena. The present challenges are in line with the new gig and green economies and changes in the global market, and their consequences on the solid waste sector. Continued efforts to strengthen the inclusion of social aspects of health into the complex interaction of the structural vulnerabilities met by e-recycling workers will be essential to anticipate and prevent health issues in this essential but still emerging workforce.

Keywords

electronics recycling; e-waste; formal sector; vulnerable populations; workers

1 | INTRODUCTION

1.1 | Electronic waste and the electronics recycling industry

Worldwide, amounts of electronic and electrical equipment waste, better known as electronic waste or e-waste, are increasing alarmingly. In 2020, it was estimated that there were 53.6 million tonnes of e-waste in the world, with only 17.4% appropriately recycled.[1] Electronics recycling, or e-recycling, is performed in large proportions informally[2] and increasing proportions, formally, in numerous countries. The term “informal e-recycling” refers to recycling operations in e-waste sites that are not monitored or regulated by the government, and “formal e-recycling” refers to licensed and permitted facilities that process e-waste with some level of industrial hygiene, worker protection, and pollution controls, as described by Ceballos and Dong.[3]

The health challenges in handling e-waste arise from the emission of dust and other chemical hazards such as toxic metals—including lead and cadmium—and organic chemical compounds, such as polybrominated flame retardants and polychlorinated biphenyl compounds.[4] Chemical hazards have been reported as a reproductive and developmental health issue, especially for sensitive populations such as children and pregnant women living in the vicinity of e-recycling sites or involved in e-recycling jobs in the informal sector in different Asian and African countries.[5,6] Particularly as many in the informal e-recycling workforce are workers of low socioeconomic status.[7,8]

Management of e-waste in developed countries is primarily provided by electronics recyclers or e-recycling facilities, as well as by direct disposal in the solid waste streams, winding up in landfills or incinerators.[9] However, even in well-equipped environmentally-certified e-recycling facilities, there are exposures to toxic materials associated with the typical processes of sorting, dismantling, and shredding.[3,4] Precarious conditions in the e-recycling informal sector have been the subject of much scientific inquiry. A few years ago,

a thoughtful commentary was published[10] on the sensitive populations exposed to e-recycling chemical pollution, focused on the effects derived from the informal e-recycling sector worldwide. In particular, children and women were deemed as most sensitive, with an emphasis on those of low socioeconomic status, and advocating that these populations had not yet been sufficiently studied. The need for addressing the coexistence of social, economic, environmental, and physical conditions in the informal e-recycling sector, as well as the inevitable effects that green growth policies have in informal economies, have been highlighted;[10] however, such documentation in the formal sector is only emerging.

This commentary aims to draw attention to the overlooked vulnerabilities faced by workers of the e-recycling industry formal sector of high-income countries and to discuss the potential impact on health inequalities experienced by these workers.

1.2 | Workplace structural vulnerabilities

Overall, social vulnerability refers to a combination of economic, social, and symbolic factors concerning social norms and codes, that imposes asymmetrical power relationships in society along axes such as race and ethnicity, class, sex/gender, and place of birth, as well as affecting the living and working conditions of an individual or community.[11,12] Even if race and ethnicity are widely used social determinants of health, there are a lot of misconceptions about what is meant by these terms. Both terms are social constructions, but “race” is based on biological assumptions/utilization of presumably physical differences, while “ethnicity” is based on self-perception and social or cultural attributions. Race and ethnicity are thus mentioned herein as social constructs that are often applied in such a way as to generate social cleavages and discrimination.

A vast array of studies shows that workers are exposed to different health hazards depending on their position in society despite equality in law.[13] This suggests that broader forces may be at work, making certain sections of the workforce more vulnerable.[14] Structural vulnerability means that various levels—social structures, laws regarding employment and inclusive practices, construction of social identity, etc—may interact to shape a worker’s personal OHS experience. This social vulnerability layers on to structural disadvantages such as work intensification and the transition from standard employment relationships to atypical, precarious forms of employment (eg, being temporary or casual, lacking benefits and control over the labor process, low income, etc).[15,16] Difficult migration and social inclusion pathways can add to this complex picture of workers’ vulnerable situations.[17,18]

Workers in situations of vulnerability are disproportionately employed by small businesses in industries and jobs that expose them to high levels of biological, chemical, musculoskeletal, and psychosocial hazards.[19-22] They also may not fully know their rights and responsibilities regarding their occupational health and safety or how to exercise them.[23] Even when they do know their rights, they can be trapped in situations where they overlook safety measures or fail to report an incident to maintain production levels, especially for fear of reprisals.[15,24,25]

For instance, immigrant or racial/ethnic minority workers are commonly referred to as vulnerable workers because they frequently find themselves disproportionately in precarious

jobs.[19,21,26-28] They can be overqualified[24] and may face language or cultural barriers that make them less likely to seek compensation and medical assistance.[29,30]

2 | DISCUSSION

2.1 | Vulnerabilities in the formal sector of the e-recycling industry

Risks associated with exposure to chemical, musculoskeletal, and other hazards are increased by social factors such as the high proportion of small businesses in the e-recycling industry, the reliance on precarious employment arrangements, and the overrepresentation of workers from socially marginalized populations such as immigrants, racial/ethnic minorities, incarcerated persons, and the physically or mentally disabled.[31,32] This phenomenon of workers in situations of vulnerability has recently been observed in the United States,[3,33,34] Canada,[31] and Great Britain.[35,36] In the United States, the e-recycling industry workforce is commonly low-income, low-education, not fluent in English, multiethnic, predominantly young, and sometimes incarcerated, or suffering from physical or mental health issues or disabilities. Many facilities typical of the industry are small to medium-size businesses, which results in low rates of health insurance, and lack of workers' health surveillance. Moreover, there are limited health and safety controls and training. This is compounded with the challenges incurred by common seasonal or precarious employment arrangements, which are necessary to accommodate fluctuating labor needs in response to the variable influx of e-waste—typically, higher rates of e-waste are recycled during the summer months. Further, workers may inadvertently bring contaminants home from work, such as lead, which can result in hazardous secondary exposures to family members, including developing children.[37]

In Canada, the e-recycling workforce is similar to that of the United States.[31,32] Near urban areas, workers can turn out to be more multiethnic and over-educated, to come from work agencies or to have physical or psychological disabilities. The workforce in sub-urban and rural areas tends, however, to comprise lower-educated individuals or to consist of workers in social rehabilitation programs. Inadequate exposure control measures, as well as insufficient training, are key issues that arise in several instances.

A review conducted by Searl and Crawford[36] on occupational issues in the waste processing industries in Great Britain, including the e-recycling industry, highlighted that a significant fraction of waste workers not only may come from employment (or temporary work) agencies, but also may have low social status, including low education, and poor English second language skills. Given their temporary status, which promotes work mobility within Great Britain, agency workers may not always benefit from adequate training, personal protective equipment, as well as proper supervision, up-to-date risk assessment, or systematic health monitoring. These precarious employment arrangements can also dilute responsibilities for workplace health and safety protections.[38]

2.2 | Overlapping structural vulnerabilities of e-recycling work

E-recycling workers are often exposed to well-known risks which have been the traditional domain of occupational safety and health (OSH), such as musculoskeletal and chemical

hazards. However, asymmetrical power relationships resulting from various social factors like those described above can increase the risk associated with exposure for some workers as well as restrict their ability to mitigate those risks. This socially constructed work environment creates structural vulnerabilities for these workers, impacting the distribution of risks, therefore, also impacting the distribution of injuries, illnesses, and ultimately of health. Categories of structural vulnerabilities that need to be considered when examining the social context of e-recycling workers in the formal sector are presented in Figure 1. These situations can be categorized, for simplicity, into four broad groups that are intrinsically related: (a) new industry, (b) work conditions, (c) employment arrangement, and (d) sociodemographic factors of the workforce.

(1) New industry—Exposure to hazardous conditions in e-recycling is further complicated by the fact that the formal e-recycling industry is fairly recent, dating back to the last three decades.[39] This new industry is facing palpable challenges. Solid waste streams in the e-recycling industry continue to change, evolving from consisting largely of cathode ray tube (CRT) TVs to now cell phones and novel small electronics.[1,40] A rapidly growing volume of the e-waste stream is partly due to the functional or subjective obsolescence of electronics and advancements in technology.[4] There is also economic and legal instability in the industry, as lawsuits and bankruptcies are commonplace.[41,42] Furthermore, several e-waste import bans have disrupted the dynamics of both the solid waste industry, as a whole, and the global trade, such as is the case with the ban on e-waste imports in China since 2018.[43] All these industry challenges make the individual e-recycling facilities and their processing demands extremely volatile, affecting, in turn, the stability of the workforce. The business realities are often so urgent and changing rapidly that strengthening environmental, health, and safety controls may not always be a priority. Furthermore, the challenges of adapting controls to new and changing processes are often complex, even for experts in the OSH field. The many competing demands in this new industry can result in difficulty anticipating new workplace hazards that could derive from new streams of e-waste or the modification of existing procedures during e-waste processing. This is particularly challenging for small businesses, which often have limited health and safety resources[23] to keep up with a constant adaptation of procedures and job hazard analyses.

(2) Work conditions—E-recycling is an industry that exposes workers to hazards traditionally known by OSH to be detrimental to health. For example, working conditions that affect workers' health and safety include how the industry struggles to manage exposures to legislated hazards such as lead and cadmium,[3] even for outdated occupational legislation such as that for lead, which does not protect health.[44] The industry also faces new documented hazards—for instance, worker exposure to flame retardants from electronic devices being processed.[31,45] Further, the traditional occupational hygiene approach is to regulate one chemical at a time; however, these workers are exposed to a mixture of chemicals, making more challenging the protection of health. In addition to workers being exposed to chemical mixtures, workers are exposed to a wide array of ever-changing electronic products; which makes it virtually impossible to train workers on exactly what they are being exposed to and when. Lastly, chemical hazards do not occur in isolation to

many physical and safety hazards such as noise, nonergonomic workstations, cuts and lacerations, slips, crushing, and electrical hazards, among others.[46,47] In this context, psychosocial stressors may also be included as an aspect exacerbating hazardous work conditions, for example, excessive workload, conflicting demands, and lack of role clarity. Hazardous conditions in this industry are then further complicated with the limited controls typical of the work in small businesses.[23]

(3) Employment arrangements—An additional problematic factor for worker safety in e-recycling is the high prevalence of nonstandard work arrangements. The increased risks of occupational accidents and diseases among temporary agency workers in general, either migrant or not, as well as the little guidance provided on good health and safety practices in their jobs have been underlined by the International Labour Organization.[48] Poorly aware of inherent hazards and risks related to their tasks, temporary agency workers in recycling summer jobs may be particularly at risk for injuries or overexposure to the several contaminants released in their workplace environment.

In Québec, Canada, it has been reported that the frequency of occupational injuries among these staffing agency workers, including e-recycling industry workers, is higher than that of other workers. Moreover, as immigrant workers tend to turn to employment agencies to foster their labor market integration in Canada, they experience rather harsh working conditions, including the most laborious and dangerous task assignments (ie, outsourcing of hazardous work), as well as marginalization by the permanent workers in the recycling plants.[49]

(4) Sociodemographic factors—In the formal e-recycling industry, there is an overrepresentation of workers from socially marginalized groups within society such as racial/ethnic minorities, prisoners, disabled, etc. These workers may face additional challenges to staying safe at work by their marginalized position within society. For example, workers may not have access to information or equipment that will keep them safe, may feel less able to exert their rights to a safe workplace, and they may be overrepresented in dangerous jobs and tasks at work.[50]

A particular category of concern is that of incarcerated individuals. Hence, some studies conducted in several federal prisons in the United States have shown prisoner-workers' overexposure to lead and cadmium, particularly during CRT processing.[51,52] Health and safety issues were raised, including insufficient training and protective measures, as well as inadequate work practices and job hazard assessment. These e-recycling programs in US federal prisons have been considered by the US Department of Justice as in violation of health, safety, and environmental laws and regulations.[53] Six prison e-recycling sites were shut down in 2016 but eleven remain in operation as of September 2019.[54] Other examples include individuals doing community time, as well as formerly incarcerated people being part of the formal e-recycling workforce, such as in facilities run by the Green Non-Profit Organization in the United Kingdom,[55] or in private e-recycling companies that have specific training and employment programs for ex-convicts.[56] Sometimes facilities are strategically located close to prisons to more easily access this population into their workforce.

2.3 | Overlapping structural vulnerabilities and implications for health

Developing an understanding of how each of the social structures confers vulnerability on workers in the formal e-recycling industry is imperative in developing a robust and holistic approach to their OSH. However, these social structures do not appear or act in isolation; they are components of the complex social context of work. Workers are often simultaneously affected by multiple structural vulnerabilities.[28,57]

Overlapping structural vulnerability results in what Sylvie Gravel and Dubé[58] have termed "cumulative precarity." For example, in the United States, immigrants and racial/ethnic minorities are concentrated in the most peripheral and exploitative contingent jobs.[59,60] A recent review pointed at how social and structural vulnerabilities at work increase the risk of contaminants being brought back home as well. Indeed, workers are often not only experiencing high exposures at work but also poor safeguards when leaving work, and poor housing conditions at home which compound the problem for their families.[61] Although little work has been done to understand how these overlapping structural vulnerabilities contribute to differential exposure and susceptibility to workplace hazards in the formal e-recycling industry, in particular, emerging efforts in other industries can help guide this understanding.

A report explored how three structural vulnerabilities—being young, working in small businesses, and being foreign-born—overlapped in the US construction industry.[62] Researchers found that immigrant workers younger than 25 years of age were overrepresented in small construction firms and had elevated rates of occupational injuries. In a follow-up study, Cunningham et al[23] found that small construction firms were less likely to employ supervisors who spoke the same language as their foreign-born workers and immigrant workers in small construction firms were less likely to receive safety training.

2.4 | Research needs and recommendations

The simultaneous occurrence of many of the structural vulnerabilities in the formal e-recycling industry will need to be addressed to reach health equity within its workforce. Research on overlapping structural vulnerability and cumulative vulnerability in the e-recycling industry faces two principal challenges: (a) rooting OSH in its social context requires a paradigm shift from a biomedical to a biosocial approach to workplace health and safety[63] and (b) data sources that operationalize worker vulnerability are scattered and often do not include data regarding work arrangements, race/ethnicity, place of birth, business size, or other relevant social variables.[64-66]

Understanding the health of workers has largely developed into a technical, applied field guided by the biomedical approach to health.[67] The biopsychosocial approach is advocated in the general field of medicine since the 1970s.[68] Such a shift has already been undertaken in the field of occupational rehabilitation since the late 1990s, based on previous work such as that of Mosey[69] and Engel[68] In that sense, OHS might be seen as a latecomer in this needed transition to a broader approach. As a result, "traditional" professionals and researchers need to appropriate the theoretical viewpoint and gain practical experience to address or to take into account the social aspects of health and safety of workers. This

implies no clear distinction between environmental and occupational health, as many of the factors that create the structural vulnerabilities in these worker populations are societal problems that go beyond the realm of occupational health and merge into larger public health questions.[70,71] In this perspective, interdisciplinary research should be a priority, just as a de-compartmentalization of scientific disciplines would be relevant and appropriate in this emerging sector. Health inequities are then viewed from a macro socioeconomical perspective that identifies many of the situations of vulnerability, experienced by individuals who belong to disadvantaged groups in society, and that commonly affect persons working also in disadvantageous conditions.[72] There is indeed, a growing awareness that OSH professionals need to do a better job to include these social factors in occupational health.[22]

Any effort to address situations of vulnerability to protect occupational health, and more broadly public health in the long-term, need to be tailored for the OSH field in general as well as specifically for the e-recycling industry. Recommendations in science and training of new professionals in public health, in particular, should include a better understanding of social aspects related to OSH by closely collaborating with the social sciences as well as integrating social perspectives on health and safety into traditional OSH or public health curriculum, as described by Peckham et al.[67]

Recommendations for improving data systems to inform public health may include developing the capacity to capture data on not just health outcomes but also on precariousness and vulnerabilities and other social variables. This will help to increase a robust understanding of overlapping structural vulnerabilities in the formal e-recycling industry. In this regard, waving more clearly e-waste and health into broader discussions on topics such as sustainability and climate change, which attract a lot of attention in the environmental health field, may be beneficial. Health data systems already being developed for tracking the health of marginalized populations for other purposes may be possibly leveraged in the future to connect aspects of workers' health linked to specific workplaces.

Besides data systems, a perennial challenge of the formal e-recycling industry is the variable and growing inflow of e-waste and resulting levels of toxic exposures to which workers are often subjected. Some facilities in the United States have started to automate and enclose the most polluting processes,[73] which holds promise. However, this is a costly endeavor, and special thoughts and investments on prevention are necessary to evaluate the effectiveness and expand access to this new technology, with special considerations for small businesses.

Curbing exposures and mitigating OHS issues in the formal e-recycling industry will require a continuum of changing safeguards and checkpoints. Many e-recycling facilities have environmental management certifications such as ISO-14001:2004 (now replaced by ISO 14001:2015). These certifications generally include a provision for respecting regulations pertaining to OSH, compliance that should be done even without the certification. However, given the overlapping vulnerabilities identified above, specific OHS certifications should also be required for e-recycling industries, such as the OHSAS-18001:2007, an international standard that provides a framework to identify, control, and decrease OHS risks. Of note, industry certifications such as e-Stewards and R2 provide another layer of standards with guidelines related to both environmental and occupational health tailored for this industry in

the United States as well as internationally, and many facilities are adopting them. However, these industry guidelines are generally not enforceable or sufficient in curbing all of the issues described. Coordination of efforts with different government agencies or programs to strengthen mitigation of hazards may be needed to efficaciously curb exposures and mitigate OHS issues.

3 | CONCLUSION

Workers in situations of vulnerability, over and above biological vulnerabilities, in the e-recycling industry of high-income countries often include people from groups known to be more at risk from exposures and health effects, such as young workers, immigrant or racial/ethnic minorities, incarcerated individuals, and workers with physical or mental health issues or disabilities. The challenges of workers from disadvantaged groups are compounded by the fact that the formal e-recycling industry is still relatively new—with constantly evolving e-waste streams and workplace risks—that relies heavily on precarious employment to supply fluctuating production demands. However, this phenomenon in high-income countries is not isolated to the e-recycling industry alone but is rather a symptom of more generalized phenomena of challenges in line with the new gig and green economy and changes in the global market, and how this impacts specifically the solid waste sector. Continued efforts to strengthen the inclusion of social aspects of health into the complex interaction of structural vulnerabilities in e-recycling workers will be crucial to anticipate and prevent health issues in this essential but still emerging workforce, not only in high-income countries but also worldwide.

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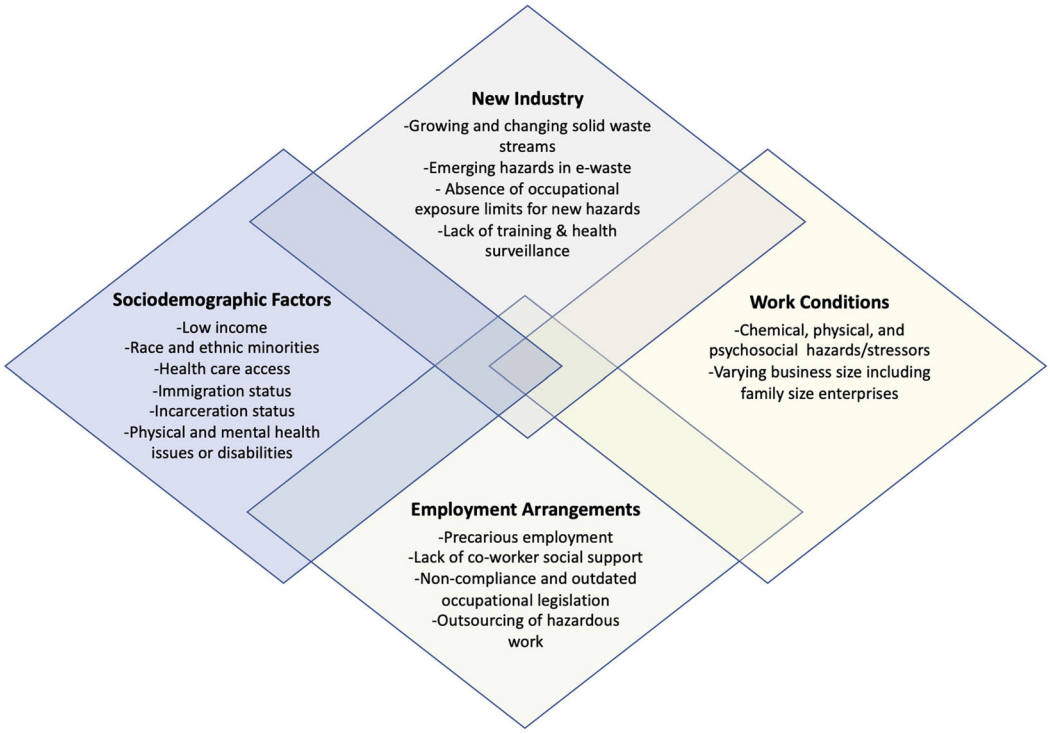

FIGURE 1.
Overlapping vulnerabilities in workers of the e-recycling industry formal sector