Review

The effects of handling solid waste on the wellbeing of informal and organized recyclers: a review of the literature

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Previous research has identified health issues in the formal, regulated solid waste collection sector, located primarily in the global North. Conversely, less information is available with regard to the health predicaments of informal, unaffiliated, and organized recyclers operating in regions of the global South. Estimated at 15 million people operating globally, informal recyclers perform a vital public service while working individually or within cooperatives.[1] This review assesses, discusses, and compiles the physical and emotional health issues of individuals who are operating in this stigmatized sector. The study highlights the self-assessed and observed health risks. Findings were coded into a number of reacquiring themes: chemical hazards, infection, musculoskeletal damage, mechanical trauma, emotional vulnerabilities, and environmental contamination. The review showcases the encouraging significance of working as a member in a recycling cooperative as a means of alleviating health issues. The findings suggest the need for further qualitative research with informal recyclers and solid waste policy enforcement with public, commercial, and industrial cooperation in source separation.

Keywords: informal recycling, occupational health, health perceptions, risks, policy, cooperatives, literature review, solid waste

Introduction

Informal recycling, a ubiquitous activity, is defined as individuals collecting, separating, classifying, and selling solid waste as a means of subsistence or supplementation of income. The solid waste is recovered from residential, commercial, and industrial sectors. The occupational title is linguistically diverse, identified colloquially in Brazil as *catadores* or *carrinheiros*, in Argentina as *cartoneros* or *recuperadores urbanos*, as Binners in North America, or as *Zabaleen* in Egypt. Consequently, the term 'informal recycler' used in this review will generalize all individuals involved in the informal solid waste recovery sector, which employs an estimated 15 million individuals.[1] Solid waste, viewed as a salient resource, can subsequently be extracted as a source of income and as a means of sustaining a livelihood. This livelihood is operated as an unregulated public service that is performed under precarious or hazardous working conditions. Hence, solid waste, which would typically accrue in landfills or be incinerated, is commoditized, creating further use as a recycled or reused good. The people involved in the activity construct their livelihood on resource recovery, mostly unassisted and without adequate health protection measures in place. However, some recyclers in countries such as Brazil and Argentina mobilize to form cooperatives. The cooperatives allow collection, separation, and commercialization of the materials recovered from the solid waste stream in an organized and equitable fashion.

The knowledge that solid waste may pose a serious risk to both the environment and human health is well known.[2] Investigations from Denmark have demonstrated how sanitation workers in the regulated sector of waste management were 5.6 times more likely to incur a workplace injury and were 1.5 times more inclined to contract a waste-related occupational disease in comparison to the national average.[3,4] A subsequent study in Canada demonstrated how employees in formal recycling plants reported higher job-related illnesses and injuries more often than other sectors.[5] As a result of these inherent risks associated with the regulated waste-management sector in high-income countries, there has been discourse with regard to the unregulated informal recycling and solid waste management sectors.

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Owing to the demonstrated formal waste-management risks, ethnographic studies have established the process of defining health and occupational risks associated with informal recycling. A majority of these studies have applied mixed-method approaches, utilizing standardized surveys, invoking perceptions through interviews and focus groups, using researcher observation, or comparing national referents. The studies with informal recyclers and health have been completed worldwide, particularly in Brazil,[6] Vietnam,[7] the Philippines,[8] Argentina,[9,10] and South Asia.[11,12] Further research in global North regions have yielded similar results, such as in the United States[13] and Canada.[14] Only a few investigations, such as in India[15] and Brazil,[16,17] have performed quantitative analytic approaches using national and regional census information and community referent groups in order to determine reoccurring health problems of informal recyclers based on comparisons of individuals in similar socioeconomic status.

Objective

This article summarizes the literature on the subject of informal recycling and the reported health risks—both observed and perceived—by the recyclers themselves. There has been some research undertaken to determine the overall health and occupational risks of informal recycling. However, this research bridges a 20-year divide of knowledge that has never been systematically brought together. Hunt[18] published a brief review, yet there has been much data accumulated since, particularly emanating from Latin America. This literature review is an accumulation of existing studies, followed by a collection of the nascent work being developed by researchers particularly in the South.

Methods

The qualitative and systematic review included a search of the online electronic databases Academic Search Elite, EBSCO, and SCIENCEDIRECT. Each database was searched from its inception through January 2011. University library searches were utilized to further access books, journals, and media. The review consists of articles published in peer-reviewed English, Spanish, and Portuguese journals. Key words used in the search included but were not limited to: waste pickers, scavenger, recycler, informal waste, recycling, perceived health, risks, occupational health, policy, hazards, and environment. Relevant references from the bibliographies of identified papers were analyzed. There are numerous articles with regard to the health of sanitation workers in regulated sectors in low-, mid-, and high-income nations. Only a few of these articles were chosen to exemplify the above-average risk of regulated waste-management workers. The articles chosen were deemed to be the leading works in their field. This report does not discuss specific epidemiological and toxicological diseases associated with informal recycling, as it would go beyond the scope of this review. Last, the paper includes some original insights and research that have been carried out by both authors of this article.

Results

Berthier, as cited by Medina,[19] revealed that informal recyclers at one dumpsite in Mexico City were reported to have a life expectancy of merely 39 years. An ensuing study in India found that children involved in informal recycling had a 2.5 times higher potential of morbidity than the national average.[3] A 1981 study performed by Environmental Quality International of the Zabaleen exemplified the mortality rate of infants at a rate of 240 deaths per 1,000 live births when the national average at the time was 98 deaths per 1,000 live births.[3] Furthermore, in Vietnam, 51% of recyclers rated their health as poor, or worse than what they considered typical of the national average.[7] The lifespan of the informal recyclers, risk of childhood death, larger-than-average infant mortality rate, and perception of being unhealthier than nonrecyclers raises a salient concern with regard to occupational health issues surrounding informal recycling: Is the drastically shortened lifespan—the injuries, accidents, deaths—a direct outcome of the informal occupation or is it a result of the variables of inhabiting a marginalized socioeconomic living standard?

Attempting to identify and remove the occupational health risks from hazards associated with living in marginal or impoverished socioeconomic conditions is an arduous task as there may be an inordinate amount of variables that affect the health of informal recyclers. Gutberlet[21] demonstrates that many of the recyclers live under precarious housing conditions, often without reliable water or sewage access. In da Silva *et al.*,[22] it was found that the majority of recyclers lived in substandard housing, having little or no running water, and at times were lacking electricity. Recyclers may spend the night on the streets guarding collected waste, thus exposed to adverse weather conditions.[23] More so, the period of time between direct contact and manifestation of a disease, or other chronic illness, may be unknown or, if known, may be classified wrongly.[24] These points of contention bring forth credibility and bias quandaries associated with research and demonstrates how operating with a control group is not without its own set of problems. Nevertheless, the studies reviewed conclusively reveal that informal waste collection does negatively affect wellbeing. These findings were demonstrated through observation and self-assessment.

A few studies included in this review are presented in Table 1. These studies were chosen to demonstrate the immense global breadth of informal recycling and the health implications. These and other samples have been reviewed and classified into six subthemes that will be addressed: chemical hazards, infection, ergonomic and musculoskeletal damage, mechanical-trauma, emotional wellbeing and vulnerabilities, and environmental contamination. Evidently, a number of themes coalesce, but for sake of organization and convenience, they have been left in the most relevant category. Finally, this report addresses the benefits of operating within a cooperative when recycling and will conclude with recommendations for alleviating hazards.

Chemical Hazards

Chemical exposure is associated with physiological poisoning and dermatitis injuries, such as burns and respiratory illnesses. The injuries include sudden or long-term exposure to toxic chemical substances. Industrial, pharmaceutical, and hospital waste may or may not be regulated in a number of countries. Hence, these toxic chemicals can differ widely according to their composition and region. Furthermore, protective measures, such as safety equipment and governmental policy vary greatly. High levels of lead have been found in the blood of recyclers working in landfills, leading researchers to associate their work with increased bioaccumulation.[8,12] Lead and dioxin related-compounds were discovered in higher concentration within the breast milk of women neighboring landfills of recycler communities.[25,26] In addition to lead, mercury and cadmium are of serious concern.[27] While collecting, informal recyclers may occupy landfills or city streets where, in addition to unknown chemical solvents, they may be inhaling burning waste or vehicle and heavy machinery emissions. There have been numerous documented self-reported respiratory ailments, such as decreased lung function, lung infections, and eye irritation, as a result of diesel fuel exhaust and burning waste.[28,29] The constant exposure to exhaust is thought to be correlated with a higher level of bronchitis reported by recyclers,[6] as well as headaches and nausea.[25]

An example of failed policy with regard to chemical waste mismanagement is the Goiânia accident. In 1987, radioactive poisoning occurred in Goiânia, Brazil, when recyclers dismantled nuclear medicine equipment used in a hospital, which was carelessly discarded as waste. The recyclers took this material home to be sorted and dismantled, allowing radiation to leak and infect themselves, their families, and their friends. The event lead to four deaths and radioactive contamination of 249 other individuals.[30] In addition to radioactive hospital waste, pharmaceutical rejects may be illegally disposed of in landfills or left in the streets to be picked or sorted through by children.[31] In some countries, such as Brazil, recyclers work directly on landfills, collecting recyclable and recoverable materials. These landfills may contain hazardous hospital waste. Recyclers can occasionally make more money buying and selling these pharmaceuticals. Such medical waste is concurrently a catalyst for infection.

Table 1 A sample of studies on the health, hazards, and vulnerabilities of informal recyclers

Author(s) (publishing year)	Country	Sample of additional researchers working in the region	Method	(*n*)	Associated symptoms and other findings
Parizeau (2011)[10]	Argentina	Martin *et al.* (2007)[9]	Surveys Interviews	397 30	Traffic accidents, broken bones, cuts from glass and metals found in the trash, tiredness and fatigue, burns, aches and pains, breathing problems, circulatory problems, diseases and infections.
Gutberlet & Baeder (2008)[6]	Brazil	Velloso *et al.* (1997/1998),[63,66] Porto *et al.* (2004),[32] da Silva *et al.* (2006a/2006b),[16/17] Sousa & Mendes (2006),[45] Santos (2008),[41] Tremblay & Gutberlet (2010)[46]	Surveys	47	Self-reported body pain and soreness in back, legs, shoulders, and arms, lacerations to the hands, along with ulcers, high blood pressure, influenza, and bronchitis
Hunt (1996)[11]	India	Sarkar (2003),[12] Kunisue *et al.*, (2004),[26] Ray *et al.* (2004),[29] Parveen & Faisal (2005)[15]	Interviews	100	Worm infestation, upper respiratory tract infection, lymph node enlargement, suspected tuberculosis, xerophthalmia, and dental caries
Nguyen *et al.* (2003)[7]	Vietnam	Gunn & Ostos (1992),[31] Suplido & Ong (2000)[8]	Interviews	41	Back pain, coughs, headaches, stomachaches, sore muscles, and rashes; nearly all respondents suffered cuts to hands, feet, and limbs
Rendleman & Feldstein (1997)[13]	USA	Lavoie (2005),[5] Tremblay (2007),[67] Gutberlet *et al.* (2009)[14]	Surveys	96	Lacerations, infections, needle sticks, and blunt trauma

Infection

Pathological waste may be generated by the improper disposal of medical waste, solid household waste, human waste, and decaying organic matter. Typically working without adequate protection, recyclers inadvertently come into contact with a variety of biological by-products of waste. These biological hazards can be classified by contamination via viruses, fungi, protozoa, and other bacteria. Infections may occur by direct contact with biological pathogens, such as hepatitis-B. Mishandling solid waste, such as medical waste and syringes, is one of the higher perceived occupational threats for the informal recycler.[9] Notwithstanding, there is limited knowledge of long-term data with regard to infections and correlation with occupation, lifestyle, and precarious living conditions. An example of this was the research conducted in the United States that encountered one confirmed case of hepatitis-B and a potential case of HIV thought to have been contracted by an accidental needle stick.[13] Determining whether the virus was acquired through informal recycling or lifestyle is the unknown factor.

In Metro Manila's main dump site, 974 children were examined, 24% of which had chronic cough, 25% wheezing, and 19% a shortness of breath.[3] At the same dump site 10 years earlier, out of 750 informal recyclers, 70% had upper-respiratory ailments.[3] These respiratory diseases include tuberculosis, pneumonia, asthma, and bronchitis.[32] A similar study in Managua, Nicaragua, demonstrated that waste-picking children exhibited a decrease in lung function and wheezing due to a higher exposure to particulates.[33] Kennedy *et al.*[34] discovered that individuals working in bottle return stores were exhibiting similar respiratory ailments. They found that there was measurable inhalable particulate matter, including fungus and endotoxins (toxic substances released from the cell wall when Gram-negative bacteria are damaged or destroyed). The study concluded that these ailments, which showed signs of nasal infections and acute chest symptoms, were associated with endotoxins derived from decaying waste growing in bottles, which is consistent with other studies.[33,35] These toxic reactions are thought to be caused by endotoxins and substances excreted by Gram-positive and Gram-negative bacteria.[24] The study by Kennedy *et al.*[33] reiterates the perceived risks from biological contamination, as modelled by other studies which cite respiratory ailments as being a leading complaint perceived by informal recyclers.[6,7]

Microorganisms and organic dust present other pathogens, such as bacteria, yeasts, protozoa, and intestinal diseases such as worms, flukes, and viruses.[36] *Toxoplasmagondii*, a parasite that may lead to severe infection during pregnancy, is typically acquired through food contamination. The parasite antibodies were discovered in recyclers operating in Durango City, Mexico.[37] Diseases such as typhoid fever, tuberculosis, dysentery, poliomyelitis, malaria, and various skin disorders have been identified in Manila in informal recycling communities.[19] Economic hardship occasionally pushes recyclers to consume recovered food, risking stomach infections and parasites.[9,22,32,38] Food poisoning may cause diarrhoea, parasite infection, and nausea. Furthermore, stomach infections are common, as recyclers inadvertently come into contact with human and animal excreta.[6,7,12,28] One such study found that the incidence of acute diarrhoea was 10 times greater in informal recyclers than in the general population.[3] In stool samples taken from children working in Manila, it was confirmed that 98% had parasites, either Trichuris trichiura, Ascaris lumbricoides, or both.[3] Furthermore, proximity and contact with flies as a consequence of infestation led to a higher correlation of diarrhoea in children.[39] Other diseases, such as plague and leptospirosis may be present from the exposure of rodent urine.[3,6,40–42] Helminths, such as schistosomiasis were prevalent in Egyptian recyclers.[42] In Colombia, recyclers perceived themselves as having a higher proportion of infectious diseases, such as acute diarrhoea and respiratory infections, than neighboring populations.[28] In addition to infection, recyclers must be weary of the physical toll inflicted upon their musculoskeletal system.

Ergonometric and Musculoskeletal Damage

Ergonometric injuries consist of musculoskeletal illness, the direct result of repeatedly moving and lifting heavy objects, such as carts and bags filled with solid waste. These issues may lead to sprains, fatigue, muscle pain, and back problems. In Brazil, a study demonstrated how informal recyclers are prone to squatting, vibration, awkward postures, and repetitive movements.[16] Frequent kneeling occurs while sorting and collecting solid waste and is thus associated with lower-extremity pain.[16] In the regulated sector of waste management, heavy lifting leads to higher rates of back and shoulder pain, lumbar disc prolapse, disorders of the neck, tendon disease, and increased pulmonary ventilation.[34] Formal solid waste workers in Brazil report injuries that are consistent with the informal workers, such as cuts, sprains, or breaks to the lower limbs, followed by upper limbs, including the hands and the spine.[43] All informal recyclers interviewed in the studies by Gutberlet and Baeder[6] and Nguyen *et al.*[7] reported some sort of pain or discomfort in the limbs and back. Further reports from a US study on formal sanitation workers revealed that arthritis was four times more common in sanitation workers than in general laborers,[3] which coincides with self-assessed

reports from informal recyclers in Brazil.[14] Da Silva *et al.*[16] prepared a quantitative analytic approach using a comparison study between informal recyclers and a control group from the same socioeconomic standing. They found that back pain incidents were similar to individuals from the same population, but still higher than that of the general population. Children working on a waste disposal site in Nicaragua complained of upper- and lower-extremity pain that was correlated to them jumping onto moving dump trucks as they proceeded to the landfill.[27] Long days, repetitive movements, heavy lifting and loading present itself as short-term pain and discomfort. However, what is currently unknown, is the long-term musculoskeletal physical effects on the body over a lifetime of such manual labor. In addition to ergonometric risks, recyclers deal with mechanical accidents on a daily basis.

Mechanical Trauma

These hazards to informal recyclers consist of cuts, blunt trauma, fractures, falls, lacerations, and traffic accidents.[6,10,32,34,41] Recyclers work at all hours of the day, collecting in the streets or at landfills. In Buenos Aires, the majority of the recyclers operate in the evening, thus putting them at risk of working in the streets while it is dark. Traffic accidents were demonstrated as being high as a perceived risk for informal recyclers in both Argentina and Brazil.[6,9,44] Pursuing this further, informal recyclers, who work around landfills, are exposed to high risks of accidents during their work. In Vietnam, for example, it was cited that the community knew of two recyclers who had been buried accidently in the landfill that year and that another individual had been killed in an accident with a garbage truck.[7] Recyclers at dump sites in Brazil furthered these concerns with knowledge of injured and killed recyclers.[45] Frequent accidents caused by trucks and tractors are reported by the local recyclers, which are constantly moving the waste deposits at the landfill *Gramacho*, which serves the metropolitan region of Rio de Janeiro.[46] Similarly, 17% of the recyclers in Vietnam mentioned being involved in either a minor or major collision with garbage trucks.[7] The perceived and real threat of vehicular accidents is justified.

Recyclers often prefer to work barehanded, as it allows for greater tactility, to quickly sort paper and plastics. They tend to tear open bags of waste or dig quickly through bins in order to find specific items, such as cardboard, paper, aluminium cans, or plastics. This task is risky as the waste may contain broken glass, construction materials, or hospital waste, such as syringes. In tropical areas, informal recyclers may wear shorts and T-shirts, thus having little to no protection for their arms or legs.[47] At times, recyclers acquire discarded gloves from hospitals, which they wash and then reuse in a futile attempt to remove the risk of chemical burns and infection.[40,48] In Brazil, recyclers occasionally wear gloves, but complain that they are still useless to needle punctures or cuts from glass.[49] Indeed, a lack of safety equipment leads to a common occurrence of lacerations to the hands, arms, and legs.[6] Small cooperatives, that may be operating on micro credit in combination with inadequate local government resources, have difficulty providing employees gloves, masks, or other safety-related equipment. Moreover, studies inquired as to how waste pickers deal with injuries, typically lacerations. Martin *et al.*[9] discovered in Buenos Aires, that recyclers were unwilling to seek professional medical care, even if it was free of charge, and in some cases, when asked, the response was that they did not know where the nearest health care provider was located. Only 32% of the recyclers in Colombia went to see the doctor when they were ill, citing lack of health coverage as the issue.[28] Further answers ranged from doing nothing about the injury, finding rags in the trash to wrap around cuts, using lemon juice, or licking at the wound.[7] In Portland, medical records confirmed that the majority of recyclers arriving with lacerations had cuts in such poor states that medical officials were often unable to stitch them.[13]

Regardless of high- or low-income countries, the informal recyclers appear to wait too long before seeking medical help thus increasing the likelihood of infection.[9,13,14] In light of this, studies in South Asia exemplified how health waste was picked and then sold to informal medical practices. Recyclers who were injured collecting medical waste, and who could not afford suitable medical care, would go to unscrupulous doctors who employ used medical equipment, pharmaceuticals, and syringes.[50] Although informal recyclers may have access to health care, it may be impossible to receive the care, as at times, they are requested to take work off, which is not fiscally feasible when living on day to day pay.[51] Undoubtedly, the issue of medical care can be deemed a social issue, a lack of knowledge of hazards, and an absence of medical opportunities.

Emotional Wellbeing

Social issues encompass malnourishment, undernourishment, low education, high birth rates, physical and emotional abuse, no training of basic health care and first aid, a lack of access to health care facilities, and precarious living arrangements. Furthermore, access to clean sources of water and sanitation for informal recyclers can be as much of a problem in the global North as in the global South.[13,14,52] Social stigma and marginalization create unnecessary stress. The public

may perceive the informal recyclers in a variety of ways; some assist the recyclers by pre-sorting their materials from the garbage or by providing food, while others socially exclude and marginalize them.[9] The insecurity, coupled with social exclusion, perceived shame, and humiliation, leads to a higher self-assessed degree of vulnerability.[9,44,49] Constant occupational threats, such as being robbed, harassed, or bullied, are mentioned as problems by informal recyclers.[14,52] Admittedly, the precariousness of work, the stigmatization, and the lack of financial security can lead to stress.[45] Recyclers in Guatemala reported avoiding health clinics and hospitals when injured or sick for fear of discrimination.[53] Granted, stigmatization may form a self-fulfilling prophecy with the self-perception of recyclers. When inquired in Kathmandu, Nepal, 73% of informal recyclers revealed that they would not wash their hands with soap upon returning home after work and that 65% would not change out of their work clothes.[3] These examples highlight that the social stigma attached to working in a dirty job and the self-perceived reiteration continue to the home, where people lose the sense of dignity that comes with being clean.

Kennedy *et al.*[33] identified additional factors of high psychosocial stress of recycling and sorting, which they deemed to have been contributing to fatigue, nausea, and headaches. Stress-related symptoms, such as ulcers, high blood pressure, and stomach problems were self-assessed by informal recyclers.[6,12] In Brazil, the majority of recyclers did not perceive a major health change between their previous and current activity; yet, 31% cited specific health issues, such as recurring high blood pressure and ulcers, that had commenced since becoming a recycler.[6] A subsequent study in Brazil demonstrates that patterns of minor psychiatric disorders occurred 44.7% more in recyclers than within the average neighborhood referent group, signaling signs of depression and anxiety.[17] Consequently, this was hypothesized to be because of constant injuries and monotonous work.[17] Recyclers in Buenos Aires self-reported depression, anxiety, and nervousness in the prior year.[10]

As mentioned, recyclers may consume food from the waste, risking infection. Further nutrition issues are addressed as social problems. According to Sarkar,[12] malnutrition, infant growth retardation, and anaemia are more prevalent in individuals and families who work in informal recycling; however, this study is not conclusive because control group studies in similar low-income areas were not conducted. Oppositely, improper nutrition can also lead to obesity, as demonstrated in BMI comparisons with recyclers in Colombia.[28] Recyclers living in communities near landfills, or collecting in the streets, may at times, need to bring their children along due to a lack of social support. Therefore, it is not uncommon to witness young toddlers to pre-teen children working with or alongside their guardians.[31] It is known that intensive working environments and heavy lifting at a young age can have life-long negative effects on general health[54] or may have growth-stunting effects.[31] Positively, the act of informal recycling removes and challenges the waste stream that would typically allow waste to be deposited, buried, or incinerated. This aspect of recovering resources makes informal recyclers important players in the global challenge of environmental stewardship, addressing consumption, and raising awareness on recycling. However, certain parts of the environment can be affected by informal waste collecting, depending on how the materials are collected, sorted, and transported.

Environmental Contamination

Admittedly, by now, one can agree that solid waste and informal recovery have direct negative effects on the physical and emotional health of those who work in the recovery of those materials. Nevertheless, the long-term effects of working with solid waste in certain environments may affect not only individual health, but also the environmental health of the surrounding community. Mishandling waste allows the waste stream to propagate into other areas, such as in the previously mentioned Goiânia accident. It may degrade environmental conditions, clogging sewers, creating stagnant water, and thus producing breeding grounds for pathogenic organisms, facilitating the spread of diseases vectors such as dengue.[3,39,55] As waste is collected, it is sorted in situ, or in specific sorting areas, such as depots, recycling centers, cooperatives, or even in homes. Recyclers may move collected waste to be sorted, leaving it placed on river banks or in vacant lots, thus risking human health and further degrading the environment.[1] As is the case with rural to urban migration or populations of unemployed or underemployed individuals, they often lack the resources to buy property and may become illegal squatters in areas close to landfills or marginalized areas with waste disposal.[56] Therefore, waste may inadvertently be brought into the community or homes of the recyclers, creating potential health implications. Indeed, waste is transported, along with all negative aspects of it, such as chemical and biological pathogens, and therefore needs specific care when handled and transported.

Moreover, incorrect storage of organic waste can create dangerous molds, toxins, and gases, such as methane,[3] which can put these locations (often households or organizations, such as cooperatives) in danger. Animals, such as livestock, birds, or rats, may feed on waste at landfills or informal dump sites,

thus potentially transmitting diseases, such as trichinosis and taeniasis, which is spread by pigs.[3] Insects, such as ants and lice, compete with rats, snakes, dogs, and vultures for scrap and territory at dump sites.[53] Hence, untreated and unregulated waste-streams have the potential to create and continue to spread infectious diseases to informal recyclers and their immediate community.[36] The possibility of hazardous impacts from landfills in high- and low-income countries has repeatedly become a matter for scrutiny. Findings that demonstrate the spread of increased risks of adverse health issues, such as certain cancers, from landfills have been discredited through biases and numerous confounding factors regarding variables, thus the absolute danger of living in the vicinity of a landfill is still disputed.[57] However, there is generally verified literature that points to self-reported symptoms of headaches and general fatigue of individuals living near landfills.[57] Likewise, at a landfill in Rio de Janeiro, only 27.4% of the recyclers believed that the landfill generates environmental problems for the surrounding communities and workers.[32] In summary, terminal diseases, such as cancer, have long latency periods. As a result of this, it would be extremely difficult to correlate various types of cancer with periods of time when individuals have worked or lived near landfills, especially in lower-income areas. Further research in toxicological and epidemiologic studies are necessary.[57]

Health and the Cooperative

A number of initiatives worldwide have led to the self-organization of informal recyclers. Forming cooperatives, recyclers are able to create advantageous situations, legitimatizing and formalizing their employment, empowering their members with decision making, and generating greater selling power with direct negotiations with the industries. The various networks of organized recyclers, as they have been formed in Latin America, have created a conjoined voice for the recyclers when discussing policy matters with local and regional governments. Furthermore, cooperatives strengthen the organizational base of the recyclers, opening up discourse between groups and individuals in other regions, thus facilitating knowledge transfer and mobilization on a wider scale; generating awareness, and providing areas for educational training.[6,58] The cooperative, although not a means or end-product to alleviating all health issues, can be perceived as an organic process that creates both place and space for the informal recyclers.

Repressing the informal sector to address the occupational health implications of informal recycling is not a viable resolution. By legitimizing the employment, cooperatives allow a tangible space to be constructed or rented. This space can then be used to bring collected solid waste for sorting and resale. Da Silva *et al.*[22] found that 86% of the recyclers were sorting and separating the solid waste in their homes. The cooperative thus inhibits the solid waste from propagating into the environment, and curbs illegal dumping.[19] It allows the waste to be in a controlled state, allowing preventative measures to be implemented, thus diminishing potential injuries.[6] Furthermore, working together in a cooperative can reduce overexhaustion and overworking, which are factors in musculoskeletal damage, stress, anxiety, and depression.

The cooperative can allow easier access to legal protection and health care.[19] A case in point is the recycling cooperative *El* Movimiento *de Trabajadores Excluidos* (Movement of Excluded Workers, MTE). This cooperative was formalized as a secondary means of solid waste collection and recycling in a number of neighborhoods in Buenos Aires. As part of Argentina's workers union, it currently has access to *Obras Sociales*, a social security network that allows extended health insurance. Cooperative members are also provided durable uniforms with reflective strips, and are able to register with the city, thus accessing free gloves and vaccinations, such as tetanus. Whether or not they choose to wear the items provided is up to them. This program is open to all informal recyclers in Buenos Aires. By February 2004, the city had vaccinated 12,000 informal recyclers for tetanus and hepatitis.[51] Thus, the formation of a cooperative, working alongside the government, can progressively move the informal employment into the formal sector.[22] Creating cooperatives is typically done under organic grassroots situations. It is a difficult process. The activity of informal recyclers has been noted as being individualistic,[59] and therefore, creating cooperatives is not without its set of challenges. Nonetheless, there have been numerous successful cooperatives, such as the aforementioned MTE in Buenos Aires, and scores of others in Brazil, Colombia, and throughout Latin America. A Brazilian researcher, Yunes,[60] worked alongside the cooperative COOPERMYRE in Brazil. Together, Yunes and the members of the cooperative developed a framework that would assist in alleviating risks and injuries while working.[60] Evidently, the creation and use of cooperatives and associations create a working environment that fosters emotional and financial support for their members.

Conclusion

Further research is necessary in utilizing more adequate methods that can move to alleviate the majority of preventable accidents and illnesses associated with

the unaffiliated informal recycler. As mentioned by Wilson *et al.*,[61] there needs to be additional data collection on accidents and vulnerabilities in order to make a significant contribution to the health of the workers. Wilson *et al.*[61] notes that most studies suffer from methodological flaws, and that studies with control groups have difficulty linking the data to the population understudy and the referent group.

As demonstrated, the informal recycler is exposed to a wide variety of hazards. The chronic diseases typically associated with operating in these situations arise, but the time frame used for a study makes it difficult to determine if the recyclers were affected through occupational conditions or if the disease was acquired due to the genetics, lifestyle, or lack of medical access. Hence, these studies have difficulties in defining these effects of long-term exposure, and as a consequence, diseases may also be wrongly classified.[8,24] However, there is an opportunity to further research some risk aversion methods, such as the role a cooperative plays in the self-reported health and injuries of an informal recycler. The environment of organized recyclers (cooperatives or associations) has not yet been studied sufficiently in terms of the health implications and risks for the workers.

Moreover, early detection of musculoskeletal disorders, childhood labor, hearing loss, respiratory illnesses, and gastrointestinal diseases must be addressed[65] to understand long-term issues. Sanitation workers in Rio de Janeiro refer to work-related injuries as an issue from the process itself and the lack of training, equipment, and preventative measures.[63,66] Most recyclers cite ergonometric issues with lifting and carrying waste. More participatory studies can be done to determine further perceptions of hazards and risks and grasp a better understanding of the problems and future solutions. Furthermore, addressing poor working conditions, the lack of recognition for their profession, and the fatigue from long days will create more knowledge on how profession affects the informal recycler physically and emotionally.[45]

Emphasizing the importance of workplace health promotion in worker-run cooperatives and collectives is imperative.[68] The creation of cooperatives and associations by informal recyclers has proven to be effective in alleviating hazards. The cooperatives build to legitimize the work as a public service, allowing social programs, such as extended health care and child care, to be funded. Not only does this method assist in limiting the physical strain on the recyclers, it is seen to be emotionally beneficial to self-esteem through empowerment and capacity building. Rather than merely looking at risks and vulnerabilities, the cooperative helps to alleviate the causes, hence creating an environment more conducive to better wellbeing. It is necessary to strengthen these cooperatives and group networks, allowing knowledge to transfer while expanding on health education, proper waste handling, and hygiene. Furthermore, by registering and working alongside government, injuries and illnesses that require medical care can now be compiled and noted, thus allowing policy makers, if they so wish, a greater opportunity to see the outcomes of injuries and, thus, look toward preventions.

Additionally, it is necessary that tacit and experiential knowledge be shared by recyclers with industry, consumers, and policy makers. This knowledge mobilization would optimistically demonstrate experiential wisdom, working to raise awareness in proper waste separation. By notifying consumers of the proper way to dispose of materials, particularly those that are prone to lead to injuries, such as broken glass, syringes, chemicals, or infectious materials, recyclers can further legitimize their employment as a necessary public service while working toward creating a safer work environment. However, Furedy[59] discovered that most recyclers were unaware of some of the infectious hazards associated with waste collection. When asked, recyclers defined health simply as their ability to work.[32] Hence, it is necessary, through associations and cooperatives, to facilitate discussion surrounding the merits of wellbeing and occupational health. The recycler must be as equally informed about the future consequences of long-term exposure to waste collection and their health.[44,62,63]

The nature of chemical and biological injures are preventable and happen because of a failure in policy enforcement regarding commercial and industrial regulation and residential knowledge awareness. To enhance safety measures during collection and separation, states and organizations should monitor both the public and private sectors, ensuring they adhere to sustainable solid waste management practices and policies. In fact, health promoting policy must be addressed and enforced at all government levels.[64] As exemplified governments, such as in Buenos Aires, have already moved forward to creating branches that work with recyclers. Furthermore, education of both the public and informal recyclers and appropriate signage, with regard to chemicals, could certainly cut down on injuries associated with chemicals and contaminants.[44,60]

Informal recyclers are an unpaid public service necessary for our current state of mass consumption. They are typically pushed into this livelihood and most see it as a temporary means of employment. The importance of their work is typically unacknowledged, when in fact, they are assisting in reducing solid waste and working toward a more recyclable and reusable society. Assisting and legitimizing their employment is crucial for economies struggling to cover the costs of formal waste management. In

summary, further effective preventative measures include: knowledge mobilization between recyclers, the community, and policy makers; adherence to household source separation of solid waste; support from both the public and private sector toward the proper disposal of solid waste; and continued financial assistance to burgeoning cooperatives and worker-run collectives for personal protective equipment and workplace health promotion.

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