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Review

Covid-19 effects on municipal solid waste management: What can effectively be done in the Brazilian scenario?

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ABSTRACT

The Covid-19 pandemic will leave a lasting impact on nearly every aspect of life in society and has also raised concerns on the contamination risks associated with waste management. This study presents a review on the main recommendations related to the management of municipal solid wastes during the pandemic. The recommendations were classified according to the target audience, and their applicability to the Brazilian reality is discussed. Results show that most analyzed recommendations are related to hygiene routines, use of personal protective equipment, and proper segregation, packing and final destination of potentially contaminated wastes. Brazilian organizations show a special concern about the exposure risks of waste pickers, advising for the temporary suspension of manual waste collection and sorting, hygiene protocols, social distancing and quarantine of recyclable materials. Overall, the recommendations are highly dependent on awareness and engagement of citizens and on planning and support of municipalities, which must invest in information campaigns and provide alternatives for the infectious waste produced in households. Furthermore, this study points out that the recommendations were issued in an emergency scenario, but as the pandemic is expected to last for an extended period of time, they must be revised as local contexts change, seeking to maintain and extend citizens engagement in selective collection and even in actions towards waste reduction.

1. Introduction

The SARS-Cov2 virus has spread at a considerable rate all over the world since the first cases of Covid-19 were reported. On June 5, 2020 the world had 6,694,512 confirmed cases and 392,940 deaths by the disease, with Brazil ranking second in number of confirmed cases (614,941) behind the United States (1,880,703), and ranking third position in number of deaths (34,021), behind the United States (108,496) and the United Kingdom (40,344) (John Hopkins University - JHU, 2020).

As the pandemic was declared, the countries with identified Covid-19 cases have adopted actions recommended by the World Health Organization (WHO) to slow down person-to-person transmission, such as closing schools and universities, stopping non-essential activities, restricting circulation of people, and in more extreme cases, the total isolation of people in their homes. These actions helped saving lives and providing the rest of the world with expertise and time to prepare emergency response systems, to increase capacity to detect and care for patients, and to ensure enough space, supplies, and personnel in hospitals (WHO, 2020a). The main recommended preventive approaches involved hand hygiene, respiratory etiquette, physical distancing,

reducing work travels whenever possible, regularly cleaning indoor and outdoor workplaces (including objects and surfaces), promoting risk communication, training and education, and managing people suspected or proven to be infected (WHO, 2020b).

The increase in Covid-19 cases has also raised concerns worldwide about the contamination risks associated with solid waste management, mainly focused on medical and household waste, since many diagnosed patients do not need hospitalization, and remain in home isolation. In this last scenario, the risk of increasing the spread of the virus through household waste from contaminated individuals cannot be disregarded, since the municipal waste collection systems may not be able to handle a sudden increase in infectious waste.

A review carried out by Kampf et al. (2020) has analyzed 22 studies related to the coronaviruses persistence (both human and veterinary) on inanimate surfaces (metals, plastics, paper, ceramics, glass and others) and found that human coronaviruses can remain infectious on these surfaces for up to 9 days, depending on the material type. The authors emphasize that the coronaviruses may be inactivated by disinfecting the potentially contaminated surfaces with 0.1% sodium hypochlorite or 62-71% ethanol within 1-minute exposure time. Data about the lifespan of SARS-CoV-2 in different media and surfaces have

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been summarized by Nghiem et al. (2020), and show that the virus can remain viable for 3 hours in aerosols, 4 hours in copper, 24 hours in cardboard, 2-3 days in stainless steel, 3 days in plastics and sewage, and 3-4 days in solid feces.

Nzediegwu and Chang (2020) reported the increased use of face masks as personal protective equipment (PPE), which at the beginning of the pandemic was used mainly by healthcare professionals, but with the growing spread of the virus has become mandatory for the entire population in many countries. Thus, the authors pointed out that millions of potentially contaminated masks have been discarded every day around the world, increasing the risk of coronavirus dissemination, and the environmental contamination by the materials itself, especially in those countries in which good solid waste management practices are scarce.

The World Health Organization (WHO) have provided guidance on how to safely manage fecal waste and wastewater, to keep the quality of water supplies, to provide information on hygiene and sanitation practices, and to manage both healthcare and household waste generated by people in quarantine (WHO, 2020c). Likewise, other organizations have conducted debates on virtual platforms (ISWA, 2020a; ISWA, 2020b), and developed guidelines aiming at raising the awareness and encouraging local actions related to the safe solid waste management (SWM) to protect the environment and the public health, including the solid waste workers (CDC, 2020; European Commission, 2020; SWANA, 2020; WIEGO, 2020a).

In Brazil, despite internal disagreements within the federal government, which is reluctant to accept the WHO recommendations regarding social distancing and other preventive measures, universities and research institutes have been making significant efforts on several scientific fields. The quick response of such institutions has resulted in the production of personal protective equipment, respirators and testing kits (The Lancet, 2020). Similarly, Brazilian organizations involved in environmental and waste management have issued technical reports and recommendations for safer waste handling, although sometimes with conflicting approaches. Such initiatives are of utmost importance, since waste management, along with water and sewage treatment, are still unsolved issues in the country.

Within the context of a pandemic, it is important to highlight that both formal and informal waste workers have historically been exposed to several occupational health risks, especially in developing countries, where these professionals work outdoors and in direct contact with improperly conditioned waste (Gutberlet and Baeder, 2008; Mol et al., 2017). The potential occupational risks are divided in: *mechanical* - cuts, traumas, fractures, lacerations, traffic accidents; *ergonomic* - musculoskeletal illness from moving heavy weights; *chemical* - dermatitis and respiratory diseases due to chemical substances exposure; *biological* - infections from contact with pathogens; and *social* - malnourishment or under-nourishment, and lack of training (Gutberlet and Baeder, 2008). Regarding biological risks, these workers are typically exposed to waterborne diseases such as diarrhea, intestinal worms, hepatitis A, and leptospirosis (Cruvinel et al., 2019), and vector-borne diseases such as dengue, Zika or chikungunya fevers (Cruvinel et al., 2020). Improper workers training, negligence during work routine, informality of this profession, lack of infrastructure, and inadequate working conditions figure among the factors influencing the rates of accidents involving waste workers (Mol et al., 2017).

In a study of the working conditions of waste pickers in Brazil, Fidelis et al. (2020) pointed out the lack of studies and information related to health, quality and safety at their working activities. As stated by Gutberlet and Baeder (2008), these workers face a lot of risks and pressures in their daily working routine, which involve collecting as much material as possible in order to guarantee their livelihood, and their health hardly receive media or public attention.

Considering the current low recycling rates, most of Brazilian municipalities have been looking for opportunities to improve their recycling systems. Nevertheless, during this Covid-19 pandemic, the local

governments and organizations involved in solid waste management are facing a huge challenge: deciding whether to temporarily suspend the selective collection services (ABLP, 2020).

Since solid waste management is an essential service that cannot be disregarded during a pandemic situation, this paper aims at presenting the main approaches that have been recommended by several national and international organizations to prevent risks associated with Covid-19 for waste workers, and analyze their applicability to the Brazilian context.

The rationale for this study comes from the need to discuss key recommendations associated with the management of wastes generated in households during the pandemic, which so far has not been done by any other published study, and to point out the limitations that Brazilian municipalities may face.

The study was based on an integrative literature review, aiming to identify the approaches and recommendations regarding to waste management and risk prevention to waste workers, with focus on municipal solid waste. The recommendations provided by Brazilian and international organizations were analyzed, summarized and classified according to the target audience. The main actors identified are waste workers in general, waste pickers, recycling cooperatives and associations, employers (companies providing WM services to the municipalities), local government and waste generators (citizens). The information exclusively related to waste generated in healthcare institutions was not included.

The remainder of this paper is organized as follows. Section 2 describes the panorama of MSWM in Brazil. Section 3 presents and discusses the main approaches and recommendations adopted by national and international organizations. Finally, Section 4 offers considerations on the applicability of the recommendations of Section 3 to the Brazilian context of solid waste management.

2. Overview of municipal solid waste management in Brazil

The Brazilian population surpassed 211 million inhabitants in 2020 (IBGE, 2020). MSW generation reached 68.2 million tons in 2018, of which 62.79 million tons were collected by the door to door collection system (Brazil, 2019).

Solid waste management (SWM) is regulated by the National Solid Waste Policy (NSWP), which came in force in 2010. This policy establishes a mandatory hierarchy for waste management, consisting of non-generation, reduction, reuse, recycling and treatment of waste, and whereby landfilling is considered as the least favorable option. In addition, the policy has adopted several instruments, taking into account the principles of extended producer responsibility and the life cycle of products, among which stand out: implementation of MSWM plans, which is a condition for the municipalities to receive federal funds for financing waste management projects, social inclusion and economic emancipation of waste pickers, selective collection of recyclable wastes, implementation of reverse logistics systems, and closure of existing dumps (Brazil, 2010).

Regarding waste materials valorization, a small fraction from the total MSW produced is diverted from landfills through selective collection and recycling. Despite the improvements in selective collection in the last couple of years, currently only 17% of the population is served by this type of collection (CEMPRE, 2019). About 90% of the MSW recycled are collected by 800,000 waste pickers, who work individually or as members of formalized associations or cooperatives (MNCR, 2019).

The per capita collection of recyclable materials within the country is 14.4 kg/inhab/year, which is equivalent to 1.7 million tons/year. However, these quantities comprise a significant fraction of refuses, and the materials effectively recovered account to approximately 1.05 million tons/year (Brazil, 2019).

Reverse logistics is an instrument covered by the NSWP with great potential of increasing the materials recovery rates while supporting the

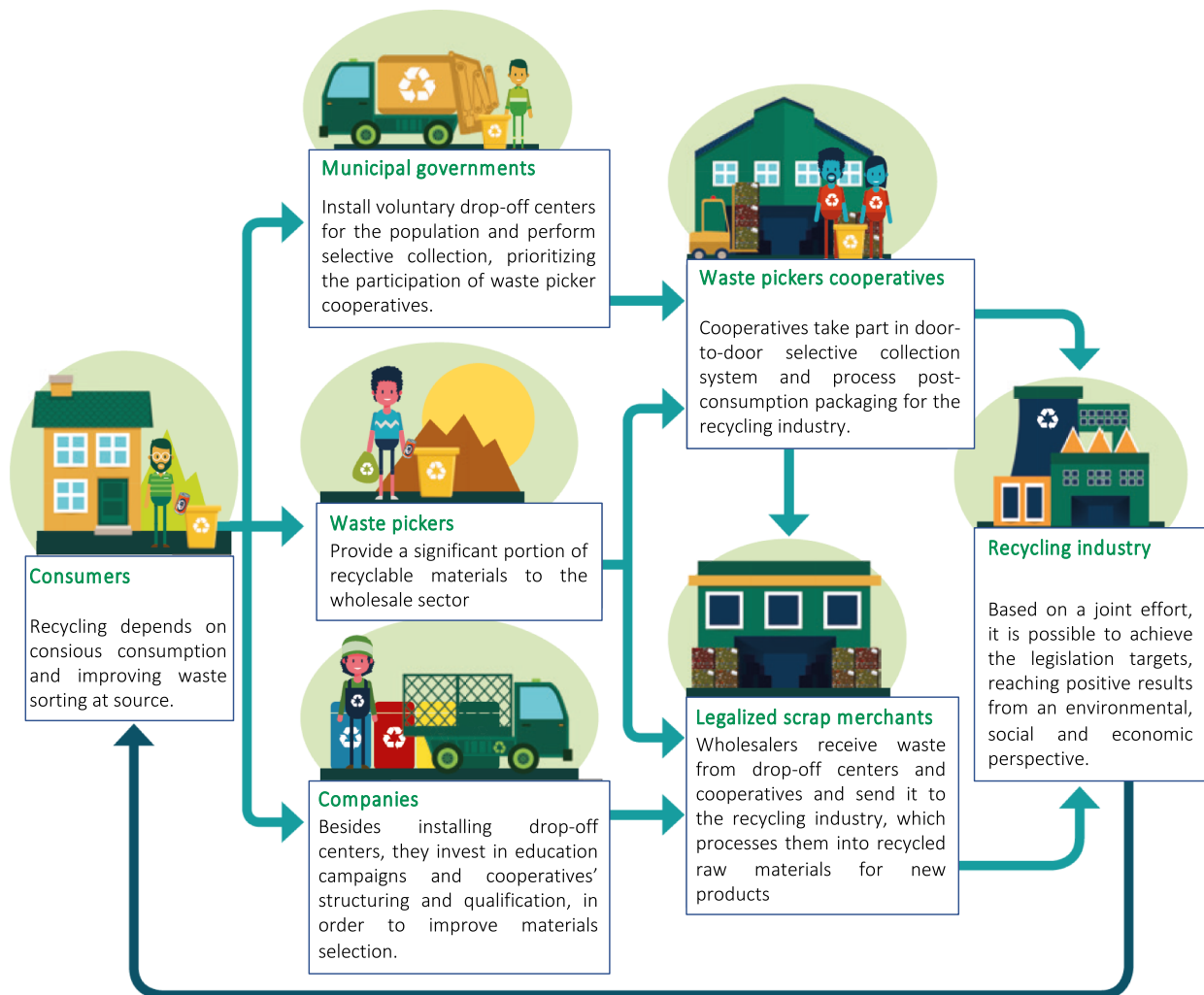


Fig. 1. Logistics flow of packaging recycling currently adopted in Brazil (Modified by authors from CEMPRE, 2019).

recycling cooperatives and waste pickers (Brazil, 2010), whereby manufacturers, importers, traders and distributors of packaging and packaged products are committed to ensure the final destination of post-consumption products. In this regard, a Sectorial Agreement was signed on November 25, 2015, comprising packaging composed of paper and cardboard, plastic, aluminum, steel, glass or by the combination of these materials (Brazil, 2018). Figure 1 shows a schematic flow of the packaging reverse logistics system that has been implemented to comply with the sectoral agreement.

The first stage of the agreement (from November 2015 to November 2017) resulted in investments of R\$ 2.8 billion that benefited 802 recycling cooperatives and 858 recycling industries, and in the installation of 2,802 drop-off centers leading to an increase in packaging recycling rates by 26.8% (CEMPRE, 2019).

Regarding the organic wastes, although the biodegradable fraction represents about 50% of MSW (Massukado, 2016), from the 62.78 million tons collected in 2018, only an insignificant amount of 124,000 tons has been composted in 70 facilities throughout the country (Brazil, 2019). Despite the lack of specific data on food waste, it is estimated that 41,000 tons of food are thrown away every day in the country (SNA, 2016). Currently there are only limited initiatives focused on the donation of food surpluses, which have low adherence, due to the fear of donors to participate in these programs, since the Brazilian Civil and Penal Codes hold the donor responsible for diseases caused by consumption of the food (Zago and Barros, 2019). However,

on May 19, 2020, due to the economic crisis caused by the Covid-19 outbreak, the House of Representatives approved the Law 1194/20 regulating the donation of surplus food from supermarkets, restaurants and other establishments (House of Representatives, 2020).

Considering the low rates of recycling and organic matter valorization, landfilling remains the main alternative (Brazil, 2019) and 95% of MSW ends up in landfills (World Bank, 2018). Moreover, despite the NSWP target of closing all dumps by 2014, 40% of the MSW is still improperly disposed of in the open dumps existing in about 3,000 municipalities (ABRELPE, 2019).

The summary of the current status of MSWM in Brazil reveals the weak internalization of NSWP requirements, which is consistent with the study of Iyamu et al. (2020), that reports the main limiting aspects of MSWM in Brazil: (i) improper waste disposal, (ii) lack of effective education campaigns on waste prevention¹, reduction, reuse and recycling, including composting, (iii) weak commitment in implementing MSWM that greatly varies among cities due to different local conditions, (iv) inconsistency in statistical data related to MSWM, and (v) lack of practical viability of long term strategies related to consumers liabilities and support to waste pickers.

¹ It is worth mentioning the absence of a clear definition of "non-generation" of waste in the National Solid Waste Policy, which may be one of the reasons why municipalities rarely include prevention actions in their management plans.

Such limitations may be related to the absence or inefficiency of management plans, as reported in a study of [World Bank \(2018\)](#), which concludes that several Brazilian municipalities have turned to private consultants to prepare SWM plans and some of them were elaborated by copying and pasting from documents previously issued by other cities, without sufficient customizing. Within this perspective, [Pereira and Ferdinando \(2019\)](#) highlight the absence of management plans, among other aspects, as an important barrier that jeopardizes the efficiency of SWM in small-sized cities.

Waste management plans are an important instrument to ensure compliance with the hierarchy proposed in the NSWP. Therefore, they must be prepared by using participatory methodologies, and based on local waste characterization data. Thus, the plans can consistently support the decision making on the best available alternatives and technologies, which must encompass environmental, social, legal, technological and economic aspects, which in turn vary among different municipalities.

Considering the continental dimensions of Brazil, its social and economic inequality, and the MSWM practices, which vary among different regions, and even within the same city, the adoption of special measures and approaches for waste management in a critical pandemic situation, is a great challenge. There is no single solution that can be adopted across the country, but a set of preventive measures that should be evaluated on a case-by-case basis. The risks associated to the various actors involved must be considered, especially those related to the most vulnerable individuals, such as workers and waste pickers.

3. Recommendations on MSWM during the COVID-19 Pandemic

3.1. International scenario

Recommendations presented by eight organizations with different scopes (worldwide, regional or national) were analyzed according to the different actors addressed: waste generators (citizens), waste collectors, employers (service providers) and local governments ([Table 1](#)).

Waste workers are mentioned by six organizations and generators are addressed by five organizations. The prevalence of recommendations addressed to these actors probably is because they are directly involved in the first steps of waste management, performing activities such as waste generation and segregation at the source, collection and, in the case of recyclable wastes, sorting and processing.

ISWA's recommendations stand out as the most detailed. However, there are some contradictions regarding recyclable waste: on one hand, they encourage maintaining waste segregation at source and longer-term storage of recyclables ("waste quarantine") to reduce risks of viable viruses in the materials; on the other, they recommend discontinuation of all manual sorting. This ambiguity might create a deadlock for waste pickers associations in countries like Brazil, on which recyclables sorting is often manual. In such cases, the waste service providers and local authorities must choose the best approach according to the local reality, in order to provide assertive orientation to both citizens and waste workers.

OSHA recommends avoiding processes such as shredding waste, which might re-aerosolize viruses from surfaces ([OSHA, 2020b](#)). However, shredding is not only performed on material recovery facilities, as compactor trucks also end up shredding waste bags and other containers. When assessing the respiratory health risk exposure of waste collectors [Vimercati et al \(2016\)](#) reminded that the physical effort and muscle work required for lifting and manhandling containers increase flow volume and respiratory frequency that in turn will increase the amount of bioaerosol inhaled, including airborne organic compounds, vehicle exhaust fumes, gases and dust particles; the authors suggested preventive measures, such as using adequate PPE. In this regard, [Moi et al. \(2017\)](#) evaluated the use of PPE (glove, boot, uniform, mask, apron, glasses, sunblock and ear protectors) by workers exposed to household and healthcare waste in the city of Belo Horizonte, Brazil,

and found that the use of masks and aprons was more common for workers handling healthcare waste than among municipal waste collection workers.

[WIEGO \(2020b\)](#) has prepared a series of informative materials in 16 different languages aimed directly toward waste pickers associations. WIEGO's *Cuidar Project* in Brazil issued informative materials based on orientations of WHO, SWANA and MNCR, and on data from [Kampf et al \(2020\)](#) ([WIEGO, 2020c](#)). It has also compiled and disseminated several statements issued by informal workers' organizations and international networks directed to policymakers ([WIEGO, 2020d](#)).

WHO's recommendations are detailed for handling of healthcare waste generated in institutions, MSW collection workers and waste pickers are not explicitly addressed.

3.2. Brazilian scenario

The Brazilian Ministry of Health established that the waste generated from care with people suspected or confirmed of Covid-19 contamination (both at hospitals or home isolation), should be considered as infectious waste category A1 ([ANVISA, 2018](#)), since this pathogen fits as a Class 3 biological agent – high individual transmission risk and moderate transmission risk to the community ([ABES, 2020](#)). Based on this classification and considering the precautionary principle, the management of Covid-19 wastes in Brazil include recommendations focused on different actors, similarly to those adopted by international organizations, with different degrees of specificity ([Table 2](#)).

The Brazilian Association of Environmental Engineering and Sanitation (ABES) guidelines follow most of the recommendations already adopted for healthcare waste management, and consider the high transmissibility of the disease, the precautionary principle and risk management measures. Besides the recommendation shown in [Table 2](#), [ABES \(2020\)](#) suggests four possibilities to the final stages of waste handling:

Establishment of an agreement between the patient and his family with the health service where the patient in isolation is being supervised, in which the health service assumes responsibility for collection, transportation, treatment and final disposal of the waste produced at home.

The municipal public cleaning service carries out a special collection for Covid-19 wastes and temporarily include the households as special collection points of small generators of infectious waste.

The condominium or the patient himself can make a private contract with a special licensed waste collection service so that the Covid-19 waste is collected and transported for treatment.

Someone from the family or person responsible for the patient can take the waste to the closest health unit, which will be responsible for waste treatment.

The Brazilian Association of Public Cleaning and Waste Companies (ABRELPE) is the national member of ISWA (International Solid Waste Association) and represents the companies that provide solid waste management services. Thus, most recommendations are addressed to employers and companies involved in collection, treatment and disposal of solid waste ([ABRELPE, 2020a; 2020b](#)). The association emphasizes the importance of maintaining the solid waste management systems during this period, as a measure to prevent the contamination of Covid-19, and other diseases related to solid wastes, and stresses the potential increase in generation rates of household waste (15-25%) during the pandemic period ([ABRELPE, 2020a](#)).

The Corporate Commitment to Recycling (CEMPRE) is an organization that promotes the 3R concept (reduce, reuse and recycling) throughout the country, by means of partnerships with manufacturers, and supporting recycling associations and cooperatives. Hence, its recommendations are focused on recyclable materials and mainly addressed to the citizens, recycling cooperatives and waste pickers.

The Environmental Company of the State of São Paulo (the largest and most industrialized and economically important state in Brazil, and

Table 1
Measures and recommendation for solid waste handling and management by international organizations.

Reference	Scope	Measures / recommendations	Actors
Basel Convention (2020) CDC (2020)	Worldwide	Separate collection and disposal of household waste generated by Covid-19 patients	Citizens
	National (USA)	Observe social distancing and use of adequate PPE	Waste Workers
		Enhance personal hygiene standards and sanitize objects and surfaces regularly	
		Provide adequate information on Covid-19 risks	Employers
		Ensure social distancing and provide adequate PPE	
European Commission (2020)	Regional (EU)	Ensure adequate use and change frequency of PPE	
		Provide sanitizing and hygiene material and supplies	
		Sanitize and clean objects and surfaces regularly	
ISWA (2020c)	Worldwide	Separate collection and disposal of household waste generated by Covid-19 patients	Citizens
		Ensure social distancing	Employers
		Provide sanitizing and hygiene material and supplies	
		Ensure enhanced personal hygiene standards and use and change frequency of PPE	
		Observe social distancing and use of adequate PPE	Waste workers
ISWA (2020c)	Worldwide	Sanitize and clean objects and surfaces regularly	
		Provide adequate PPE and ensure enhanced personal hygiene standards	
		Discontinue immediately manual sorting of mixed waste or commingled recyclables, including disabling and substituting the manual stages in mechanical-manual systems.	Local authorities, Employers
		Provide adequate information on Covid-19	
		Maintain adequate segregation of recyclable waste	Citizens
OSHA (2020a) OSHA (2020b)	National (USA)	Consider longer-term storage of recyclables	
		Separate collection and disposal of household waste generated by Covid-19 patients	
		Enhanced personal hygiene standards	Waste workers
USEPA (2020)	National (USA)	Observe social distancing	Waste workers
		Avoid processes such as shredding waste	Waste workers
		Focus on waste prevention whenever it is possible	
WHO (2020c)	Worldwide	Separate collection and disposal of household waste generated by Covid-19 patients	Citizens
		Maintain adequate segregation of recyclable waste	
		Consider longer-term storage of recyclables	
WHO (2020d) WIEGO (2020d)	Worldwide	Enhanced personal hygiene standards	Waste workers
	Worldwide	Separate and properly pack household waste generated by Covid-19 patients	Citizens
	Worldwide	Enhanced personal hygiene standards	
WIEGO (2020d)	Worldwide	Ensure household waste generated by Covid-19 patients is destined to sanitary landfills	Local authorities
		Observe social distancing	Waste workers
		Use of adequate PPE	
		Sanitizing objects and surfaces regularly	
		Enhanced personal hygiene standards	
		Provide adequate information on Covid-19 risks	

also the most affected by Covid-19) has recommended the interruption of manual collection and sorting of recyclable materials in all municipalities within the state, and established that the manufacturers involved in reverse logistics systems are not required to meet the quantitative targets during the period of the pandemic, provided that the systems continue to invest in the recycling cooperatives (CETESB 2020).

3.3. Discussion

The reported organizations have issued recommendations aimed at the target audiences of their activities. Considering the precautionary principle, the urgency in protecting the waste workers health in different levels, and preventing the virus spread, most of recommendations are related to hygiene routines, use of PPE and proper segregation and packing of potentially contaminated wastes. However, these measures alone are a major challenge to the municipalities and companies involved in SWM.

By analyzing the different sets of recommendations, and contrasting them with the current waste management scenario in Brazil, while witnessing the daily increase on the number of deaths and confirmed cases of Covid-19, two questions arise:

“How to ensure, in a large and diverse country such as Brazil, that most decision makers are aware and capable of elaborating efficient education campaigns and raise citizens’ awareness about the risks related to the transmission of Covid-19 by improper solid waste management?”

“How to ensure that all employers provide proper PPE and guarantee its correct use by the waste workers?”

Awareness and knowledge on the importance of SWM are

foundations that are built over time. One cannot expect that, in the face of a critical pandemic situation, those municipalities that usually dump their wastes without any concern on public health and environmental impacts, will change suddenly and improve solid waste management conditions. The recommendations presented in this study are therefore appropriate for the municipalities that have relatively well-structured solid waste management systems.

Brazilian organizations show a special concern about the exposure risks of waste pickers, and in this sense, recommendations such as temporary suspension of manual waste collection and sorting, hygiene protocols for individuals, surfaces, and materials, social distancing during the operation of recycling cooperatives, and quarantine of recyclable materials prevail.

A survey on the situation of selective collection gathered information between March 23rd and April 24th, 2020, found that 35.5% of the 504 municipalities contacted did not change the selective collection schedule, 26.3% reduced the truck fleet and the frequency of waste delivery to cooperatives, 24.9% temporarily suspended selective collection, and 12.7% do not have selective collection implemented (CEMPRE, 2020b).

In the city of São Paulo, the selective collection was interrupted in all cooperatives associated with municipal government. Despite the interruption, the municipality has been financially supporting the workers, and the two mechanized sorting centers continue operating with reduced staff (CEMPRE, 2020b). Deciding on the interruption or continuation of selective collection and sorting activities is not an easy task, especially because in Brazil each states’ capital and their metropolitan regions, which are the largest waste generators, have their own selective collection model, making the adoption of a generalized

Table 2
Measures and recommendation for solid waste handling and management by Brazilian organizations.

Organization	Scope	Measures / recommendations	Actors
ABES (2020)	National (Brazil)	<p>All waste produced by contaminated individuals at home isolation (recyclables, food leftovers, infectious wastes, liquids and sharp materials) must be segregated from wastes produced by other family members.</p> <p>Waste should be double bagged preferably by using white plastic bags, or in the absence of this type, resistant plastic bags, identified with a label indicating the presence of hazardous waste ("Covid-19 Waste").</p> <p>Segregate and pack properly sharp wastes in order to avoid accidents during collecting and transporting.</p> <p>Recyclable materials from contaminated individuals cannot be sent for selective collection or recycling.</p> <p>Before collection, store the bagged waste inside the property itself, in a reserved place, away from children, people and animals, or even in a bathroom for the exclusive use of the patient, if possible. If it is temporarily stored in the condominium, it is recommended to reserve an exclusive space, identifying it as an area for waste storage until the external collection.</p> <p>The municipal public cleaning service must determine the procedures for collection and destination COVID-19 wastes produced at homes.</p> <p>Infectious wastes should not be disposed of in landfills without previous treatment.</p> <p>Remove employees of risk groups from activities, by granting or anticipating vacations, teleworking, paid leave or any other measure agreed between employer and employee.</p> <p>Develop recruitment and training plans to meet the temporary absences and possible increase in absenteeism rates.</p> <p>Ensure the correct use of PPE already determined for the routine operation and adoption of basic hygiene standards for its activities, in addition to avoid touching the eyes, nose and mouth.</p> <p>Ensure constant verification of PPE, especially gloves, and replace immediately those that show any damage.</p> <p>Reschedule the collection teams' shifts and days to avoid agglomerations in garages and other places.</p> <p>Suspend activities that may cause waste bags to open or break, with direct handling by workers.</p> <p>Suspend bulky waste collection services, since such activities demand social proximity.</p> <p>Intensify the cleaning of PPE, changing rooms, cafeterias, bathrooms, vehicles and containers, whenever possible with the use of disinfectants.</p> <p>Increase the frequency of covering the waste in landfills.</p> <p>Develop a contingency plan to meet any increase in the generation of MSW and especially healthcare waste.</p> <p>Increase the number of teams for cleaning and removing discarded waste in inappropriate places.</p> <p>Establish protocols or review existing ones for protecting workers health in case of direct exposure to the waste.</p> <p>All waste produced at homes by individuals with confirmation or suspicion of contamination should be double plastic bagged, placing them for regular collection of MSW at days and hours scheduled by the collection system.</p> <p>Prevent the contact of pets with the potentially contaminated waste.</p> <p>Handkerchiefs, paper towels, masks, gloves or any other material for protection or prevention of Covid-19 are not recyclable and should not be disposed of with regular waste.</p> <p>Reduce the amount of wastes produced and reduce the volume of recyclables by compacting when possible.</p> <p>Handkerchiefs, paper towels, masks, gloves or any other material for protection or prevention of Covid-19 are not recyclable and should not be disposed of with regular waste.</p> <p>Reduce the amount of wastes produced and reduce the volume of recyclables by compacting when possible.</p> <p>Bins containing waste must be emptied and cleaned regularly.</p> <p>Waste must be placed in quarantine before handling by the collectors.</p> <p>Adopt good practices of personal hygiene, such as washing hands with soap and water or using alcohol gel.</p> <p>Provide soap, alcohol gel, gloves and appropriate PPE to the workers.</p> <p>Cleaning floors by using wet sweeping techniques along with the use of disinfectants such as those based on chlorine, alcohols, some phenols and iodophors and the quaternary ammonium.</p> <p>Avoid the circulation of the elderly, children and other family members of the collectors in cooperatives and locations for waste management, aiming at reducing possible contagion.</p> <p>Scavengers with symptoms of COVID-19, as well as those who are at risk, should be removed from their work activities for the period necessary to contain the disease.</p> <p>Waste from assistance to suspects or those confirmed to be infected by COVID-19 must be classified in category A1 (infectious medical waste), according to Resolution RDC/ANVISA n° 222, of 03/28/2018.</p> <p>The payment to scavengers must be maintained, even if there is a temporary reduction or interruption in the selective collection service, in order to guarantee a minimum income for them.</p> <p>Temporary interruption of the collection and manual sorting of recyclable materials in all municipalities in the State.</p> <p>The reverse logistics system must continue to invest in the cooperatives at least the same values that had been invested in the previous 6 months, in the form of direct remuneration to the cooperative members, or other form of assistance that is complementary to the assistance adopted by the municipal, state or federal governments.</p>	<p>Citizens</p> <p>Local authorities</p> <p>Employers</p> <p>Employers</p> <p>Citizens</p> <p>Citizens, waste workers</p> <p>Recycling cooperatives</p> <p>Local authorities, employers</p> <p>Local authorities, employers</p> <p>Manufacturers</p>
ABRELPE (2020a; 2020b)	National (Brazil)		
ABRELPE (2020a, 2020b)	National (Brazil)		
CEMPRE (2020a)	National (Brazil)		
CETESB 2020	Regional (São Paulo State)		

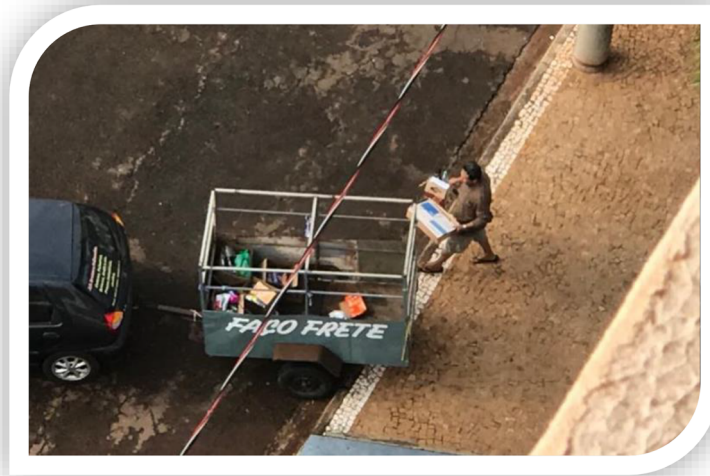


Fig. 2. Informal waste picker stoking recyclable materials from waste bins in the street with no gloves nor mask.

approach very difficult (ABLP, 2020).

The social distancing and other preventive measures adopted during the pandemic may potentially increase generation of waste comprised of single-use plastics, PPE (e.g. masks), food delivery packaging and others (Klemes et al, 2020). Therefore, the interruption of selective collection without proper planning may create a future barrier in returning this activity, since the population will have discontinued the habit of segregating recyclable wastes. In addition, special measures must be taken by the local governments in order to provide income source to waste pickers.

It is also worth mentioning that the informal waste pickers working individually or in cooperatives not associated to the municipalities, are excluded from the emergency financial support programs. Only in the city of São Paulo there are about 20,000 waste pickers and 30 recycling cooperatives in this condition (MNCR, 2020).

Informal waste pickers are a reality throughout the country, and the suspension of selective collection partially prevents the contamination risk, since the individuals excluded from government supporting aid will continue to pick up materials on the streets. Fig. 2 depicts this situation; the photo was taken on June 4th, 2020, in a medium-sized city in São Paulo State, and shows a man handling recyclable materials from condominium bins. He is not wearing mask nor gloves, and is subject to the risk of infection, in case of exposure to any contaminated material among the recyclables.

This reality, added to the trend of increasing generation rates of ordinary and infectious wastes produced during home isolation, bring to light the importance of population awareness on their responsibilities, as generators, in properly segregating potentially contaminated wastes, such as masks, in order to avoid the mixture with un-contaminated wastes (Klemes et al, 2020).

Regarding the recommendations presented in the previous section, waste prevention is seldom mentioned as a management strategy, except by ABRELPE (2020b) and USEPA (2020). However, the main goal of prevention in these cases is to reduce the amount of waste, and to avoid the overload of the MSWM systems, especially regarding the collection, workforce and landfill disposal.

In fact, the analyzed documents were issued in order to deal with an emergency situation, when the generation of waste comprised of packages and disposable items seems to be increasing, but now that the pandemic is expected to last for an extended period of time, additional care should be taken in order to not step back on the reduction, reuse and recycling initiatives already established.

It is worth noting that the recommendations and guidelines reported in this paper are not seen as ‘static’ documents, but information that will be revised as local contexts change, especially to maintain and extend citizens engagement with selective collection and even in actions towards waste reduction, when circumstances once again allow it.

The sustainable use of material and energetic resources – and waste management is directly related to that approach – is of paramount importance to the recovering and reshaping of economies; this so-called ‘reboot’ (Kemper, 2020) will be a near future necessity, especially in developing countries.

4. Conclusions

This study summarizes recommendations related to municipal solid waste management during the Covid-19 pandemic, analyzes and classifies them according to the intended audience, and discusses their applicability and feasibility to the Brazilian reality.

The recommendations provided by both national and international organizations are based on precautionary principle and involve measures to prevent the risk of infection of waste workers by the possible presence of virus on the materials surface and due to the individual's proximity during the operation of waste sorting facilities. These measures include distancing of waste workers during their activities, providing information on proper waste handling, requiring the employers and local authorities to provide PPE and cleaning suppliers to workers, and requiring the local authorities to provide special collection of household infectious wastes, among others, are recommended.

Most recommendations, however, are highly dependent on the citizen's awareness and engagement, and on the planning and support of municipalities, which should invest in information campaigns and provide alternatives for collecting the infectious waste produced in households.

Municipal solid waste management in Brazil is still an unsolved issue, consequently, during this pandemic, the municipalities with weaker management systems face new challenges, as they need to handle a sudden increase in household waste generation.

Ultimately, it was observed that waste prevention and reduction are not emphasized by the recommendations analyzed. Although such recommendations have been issued in an emergency context, current circumstances can and should stimulate a reassessment of habits and approaches, in a movement that has been called ‘reboot’.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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