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Risk analysis of Waste Collection Workers in COVID-19 Pandemic period - Case Study

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***Abstract*—** *The decomposition processes of organic matter also through pathogenic microorganisms resulting in the generation of toxic and leachate gases that, if not effectively managed, can result in serious environmental impacts, contaminating the air, the soil, as well as human health. Workers connected to the collection of urban waste carry out the handling often improperly due to the absence of Personal Protective Equipment, being exposed to various contaminations. This work aims to analyze, in a succinct way, the possible impacts caused on the health of street sweepers, mainly during the COVID-19 pandemic period. The study took placefrom the on-site observation of the collection workers in the city of Recife, Pernambuco, Brazil. The analysis of conformity and non-conformity in the use of PPE by street sweepers was based on NR-6/2018 during the monitoring of routes performed during the day and night. It was found that most of the garbage collectors who were working on the collection were not in compliance with the use of personal protective equipment (PPE) to prevent exposure to occupational risks in the collection activity.*

I. INTRODUCTION

The unrestrained production of waste is one of the major problems linked to solid waste, as well as its collection and destination. The fast pace of population growth combined with the Pandemic COVID-19 period, which is still out of control, constitutes a worrying factor for the health of the population as well as of workers in solid waste collection services. According to the Brazilian Association of Public Cleaning and Special Waste Companies (ABRELPE, 2020), Brazil generated about 79.09 million tons of waste. Compared with the countries of Latin America, Brazil is the champion of waste generation, representing 40% of the total generated in the region (541 thousand tons / day). According to the same association, in relation to the year 2020, it is estimated that, due to the necessary safety measures in the quarantine, there was an increase of 15 to 25% in the amount of solid household waste and an increase of 10 to 20 times in the generation of hospital waste in health care units.

Many household wastes are contaminated due to the disposal of handkerchiefs, paper towels, diapers, or paper, among others, associated with the lack of orientation of the population regarding the separation of the wastes contaminated by COVID-19, serve as a major exposure focus for the street sweepers.

It should be noted that in addition to the risk caused by COVID-19, collection workers are in direct contact with other types of pathogenic microorganisms, toxic gases and leachate. During the period of decomposition of residues, microbiological processes are predominant in the formation of gases. However, there are other mechanisms involved that act either in isolation, or in association with

microbiology, in the transformation of substances into gases. These mechanisms are those of volatilization and chemical reactions (MACIEL, 2003).

According to Lins & Lins (2020), when workers connected to direct contact with solid waste do not use adequate PPE, they can be directly affected by hydrogen sulfide gas, which is highly toxic and irritating, acting on the nervous system, eyes and eyes. respiratory tract, with acute, subacute, and chronic intoxication, depending on the concentration of the gas, the duration in contact with gas, frequency of exposure and susceptibility. It is a volatile gas, and the main route of penetration is respiratory. The authors still maintain that when reaching the upper respiratory tract, sneezing, dyspnea, and coughing are manifested. These symptoms can evolve towards acute broncho pneumopathies and may even be confused with symptoms of COVID-19. Upon reaching the eyes, conjunctivitis may manifest.

According to Pedrosa (p.12, 2010) "the activity of garbage collection is classified as one of the most risky and unhealthy existing, due to the frequent contact of the worker with agents harmful to health" because in addition to performing their activities on top of the collection trucks, they are exposed to other types of risks such as physical and accidents.

The general objective of this article is to address the possible environmental risks to which workers responsible for the collection of Urban Solid Waste (MSW) are exposed, taking as examples the street sweepers in the city of Recife, capital of the state of Pernambuco (PE), Brazil.

II. METHODOLOGY

To evaluate the work environment of the street sweepers, direct observation and recording techniques were used, that is, it is a descriptive research, as according to Cervo and Berviam (2002, p. 66) “aims to observe, record, analyze and correlate phenomena or facts, without interfering in the analyzed environment. It is the type most used in the social sciences”. It should be noted that the development of observation instruments was based on the work of Antunes (2009) and Germano (2010).

Through Table 1, it became possible to identify, in part, the potential risks of agents in the workplace: physical, chemical, biological, ergonomic and others, as well as the existing preventive / control measures. Lazarri (2009) mentioned that workers involved in the collection of solid waste are exposed, in their work process, to six different types of occupational risks, namely:

- Physical: noise, vibration, heat, cold, humidity.
- Chemicals: gases, fog, fog, dust, toxic chemicals.
- Mechanics: pedestrians, falls, crushing by the compactor, fractures.
- Ergonomic: overload of the musculoskeletal function and the spine, with consequent pathological impairment and adoption of uncomfortable forced postures.
- Biological: contact with pathogenic biological agents (bacteria, fungi, parasites, viruses), mainly through sharps.
- Social: lack of training and adequate working conditions.

Field visits were made, which according to Santos (2002, p. 28), is the natural place where facts, phenomena and processes take place. The research was developed with monitoring, not interacting directly, collecting, and analyzing data through observation over a period of 1 year, in different shifts.

Table 2 was directed at environmental risk and the existing measures for control. It was possible to compile the existing protection measures (means, procedures, practices, infrastructures, etc.) against impacts that could increase environmental risks. It is noteworthy that the individual measures (also admitted as possible), were removed because there is no sense in protecting only one individual against environmental impacts.

The assessment of environmental aspects was based on the product of two factors: severity (s) and frequency (f), with each factor varying from 1 to 5 values. Severity is any actual or potential condition that can result in damage or loss.

The severity and frequency criteria are presented in Table 3. The significance (S) of each aspect is given by the expression:

$$S=2*s+f \quad \text{Eq. (II)}$$

Table 1. Working conditions.

Physical Agents				
Weather	Noise	Vibrations	Moisture	Prevention/control measures
Mechanical Agents				
Hit-and-run	Falls	Crushes	Fractures	Prevention measures
Chemical Agents				
Gases	Fog	Toxic Substances	Dust	Prevention measures
Biological Agents				
Fungi	Bacteria	Protozoa	Pathogen	Prevention measures
Ergonomic Agents				
Postures	Overloads	Extended Journey	Stress	Prevention measures
Social Agents				
Lack of Training	Prejudice	Working Conditions	Prevention measures	

Source: Adapted from Germano (2010).

Table 2.Severity and Frequency criteria of the comparative method for the evaluation of environmental aspects.

	Severity	**Frequency**
1	Too Low	Meaningless – once a year or less
2	Reduced	Reduced – more than once a year up to once a month
3	Medium	Moderate – more than once a month up to once a week
4	High	High – more than once a week up to once a day
5	Very High	Extremely high – continuous or more than once a day

Source: Germano(2010).

Significance is classified into three levels according to Table 3:

Table 3. Significance levels of the comparative method for evaluating environmental aspects

Level A	Significant (significance between 11 and 15)
Level B	Sensitive (significance between 9 and 10)
Level C	Non-Significant (significance between 3 and 8)

Source: Adapted from Germano (2010).

Similarly, risk assessment (R) arises from the product of two factors: gravity (G) and probability (P) resulting from the multiplication of preventive measures (MP) by exposure (E), as can be seen in equations III and IV.

$$R = G * P \quad \text{Eq. (III)}$$

$$P = MP * E \quad \text{Eq. (IV)}$$

All factors, G, MP and E, range from 1 to 4 values according to Chart 4.

Table 4. Severity Criteria, Preventive Measures and Exposure of the comparative method for occupational risk assessment.

	Severity	Preventive measures	Exposure
1	No disability	Organizational measures (e.g., structural measures, signage, health surveillance) or systematically applied procedures	The exposure of people is less than 1 hour per day
2	Partial temporary disability	Training, training, or procedures not systematically applied	Exposure of persons is less than 4 and more than 1 hour per day
3	Permanent disability partial, absolute temporary disability, professional illness (fitness)	Protective equipment (collective and individual) or without procedures adopted	Exposure of persons is less than 6 and more than 4 hours per day
4	Death, professional illness (ineptitude) or permanent total disability	No preventive measures taken	The exposure of people is more than 6 hours a day

Fonte: Germano (2010).

Risk is classified into two levels according to Table 5.

Table 5. Risk Levels of the comparative method for risk assessment.

Acceptable Risk	Acceptable between 1 and12
Risk not acceptable	Not acceptable between 16 and64

Source: Adapted from Germano (2010).

There was no need to use the Declaration of Helsinki because it is an adapted Methodology, besides not containing the use of images or names of people. It's just an observation survey.

III. RESULTS AND DISCUSSION

3.1 The Use of the Direct ObservationTechnique:

During the period of 1 year, it was possible to observe numerous collection trucks and the work carried out by the Collection Workers in the city of Recife in the year 2020. All analyses refer to workers who are linked to the compactor truck.

Waste collection professionals work in two shifts, a group during the day (from 7 am to the end of the route) recording about 8 hours of work. As for the nighttime the professionals are replaced. Every employee of the collection performs a workload of up to 8 hours and can stop if you finish your pre-defined journey.

When performing their activities outdoors, the Collection Workers are exposed to physical risks and accidents. Many of these workers are exposed to the weather without any kind of protection, such as covers, for example. Noise is common when the compactor truck is triggered to compact waste (often) in addition to the noises produced in traffic, and may generate partial or permanent hearing losses, headaches, nervous tension, stress, and hypertension. Velloso et al. (1997) also observed that the collection activities when carried out in the hills and in streets of precarious asphalt, place "the Collection Workers subject to trepidation because they travel in the stirrup of the collecting vehicle and, vibration, can cause low back pain and body pain, in addition to stress". In addition, the authors also state that during the collection of waste, the

Collection Workers "go up and down slopes, traveling miles on foot." According to Neves (2003), this finding comes because complaints of muscle pain are common due to over-running in a script, in addition, it becomes more exhausting to climb and descend the truck several times, and, in scripts with collection points close to each other, the Collection Worker rarely climbs the truck, going through the script next to the truck. It is also note point that the Collection Workers are subjected to situations of trampling.

It was observed that the Collection Workers perform their tasks at a fast pace, carrying several garbage bags simultaneously, holding them by the hands, arms, chest and even in the head, raising the risks of accidents. In addition, the associated biological and chemical risk is also observed. The possibility of biological contamination considering the huge variety of viruses, bacteria and protozoa present in the residues is a reality.

The odor of rotten egg emanating from the residues in the compactor trucks is associated with the sulfide gas. As observed by Lins & Lins (2020) the sulfide gas is highly toxic and irritating, and acts on the nervous system, eyes and airways and can generate acute, subacute, or chronic intoxication, depending on the concentration of gas, duration, frequency of exposure and individual susceptibility.

In turn, ammonia also present in compactor trucks with residues tends to cause an irritation in the mucous membranes and this can be felt right away when we are close, for example, close to the leach treatment system. According to Lins & Lins (2020), ammonia when it reaches the upper airways, sneezing, dyspnea, and cough, where these symptoms can evolve in the sense of acute broncho pneumopathies. When it reaches the eyes, these tears and may manifest conjunctivitis.

Another common agent is dust, which may be responsible for discomfort and momentary loss of vision, as well as respiratory and pulmonary problems as observed by Ferreira & Anjos (2001).

In municipal solid waste can still be found a variety of chemical and biological residues such as batteries and batteries; oils and greases; pesticides/herbicides; solvents; paints; cleaning products; cosmetics; expired remedies; aerosols; diapers; scarves; toilet paper, where they can be classified as dangerous, bringing deleterious effects to human health and the environment. In periods of pandemic, such as covid-19, residues such as diapers, scarves and toilet paper may contaminate the other residues due to its persistence.

Recent studies (VAN DOREMALEN et al., 2020; KAMPF et al., 2020) have suggested that SARS-CoV-2 persists in aerosol for approximately three hours and on surfaces for up to nine days, which underlies the theory that transmission only by droplets or fomites would not justify such potential for rapid dissemination of the virus in populations. Van Doremalen et al. (2020) also verified the stability of SARS-CoV-1 and SARS-CoV-2 (Covid-19) in the environment and evaluated the possible reasons why the new coronavirus presents greater transmissibility between humans directly or indirectly.

Ramos (2012) stated that pathogenic microorganisms appear in municipal solid waste through the presence of paper scarves, dressings, disposable diapers, toilet paper, absorbents, and condoms, where diseases such as Ascaris lumbricoides; Entamoeba coli; Schistosoma Mansoni; the hepatitis B-causing virus caused by a virus belonging to the Family Hepadnaviridae; and the most current Coronavirus COVID 19(SARS-CoV-2).

In addition to these, microorganisms responsible for dermatitis should also be mentioned. Mycoses are common, appearing more often on the hands and feet, where gloves and shoes establish favorable conditions for the development of microorganisms. Relatively high rates of coronary heart disease and hypertension have been detected among urban cleaning workers (especially among household workers). In all operations, exposure to organic dust and microorganisms can cause diseases of the respiratory tract.

In view of the investigation carried out in the analyzed period, it was observed that most of the Collection Workers were equipped with gloves and uniforms. It is emphasized that the uniforms used were not in accordance with what was required by NR-6/2018 where they should have a safety sleeve to protect the arm and forearm against biting and piercing agents.

Throughout the monitoring of various paths of the compactor trucks no Collection Worker was equipped with masks (at least cloth), essential protection against the new coronavirus COVID-19. The biological risk is real considering the frequency and time of exposure of Collection Workers, in addition to the chemical risk due to exposure to sulfide and ammonia gases. NR-6/2018 indicates the use of the facial respirator against organic vapors (gifts of organic matter decomposition) and specific gloves made of lightweight synthetic fiber. The gloves used by the Collection Workers have been synthetic rubber.

3.2 Useof the Evaluation Instrument:

y completing Table 6 of the working conditions according to the methodology adopted and based on Tables 1 to 5, it was observed that the average significance related to physical agents reached an average of 13 to 14 points, being classified as significant.

Performing the physical risk analysis, based on equations III and IV, as well as tables 2 to 5, it was observed that the total value was 36, which according to the methodology adopted is considered an unacceptable risk. The risk study is associated with severity (G) and probability (P) resulting in the multiplication of preventive measures (MP) by exposure (E).

As for mechanical agents, following the same methodological criterion adopted for physical risk, it was observed that the mean significance was 10 points, being classified as sensitive. However, considering that Collection Workers do not use EPIs related to mechanical risks, it reaches the maximum level of 64 points, being considered an unacceptable risk.

Table 6. Working Conditions.

Weather	Noise	Vibrations	Moisture	Prevention/control
Physical Agents				measures
15	15	15	9	36

Mechanical Agents				
Hit-and-run	Falls	Crushes	Fractures	Prevention/control measures
10	10	10	10	64

Chemical Agents				
Gases	Fog	Toxic Substances	Dust	Prevention/control measures
15	5	10	10	48

Biological Agents				
Fungi	Bacteria	Protozoa	Pathogen	Prevention/control measures
15	15	15	10	64

Ergonomic Agents				
Postures	Overloads	Extended Journey	Stress	Prevention/control measures
15	10	10	8	48

Social Agents			
Lack of Training	Prejudice	Working Conditions	Prevention/control measures
10	10	15	16

Source: The authors (2021).

Analyzing the chemical agents, following the methodological criterion adopted for the other analyses, it was observed that the mean significance reached 10 points, being classified as sensitive. However, considering that Collection Workers do not use EPIs as the facial respirator against organic vapors, according to NR-6/2018, chemical risks reach the level of 48 points, being considered an unacceptable risk.

The biological agents obtained an average significance of 11 points, being classified as significant. During the follow-ups, it was observed that the Collection Workers were not using the appropriate EPIs according to NR-6/2018. Biological agents also reached a maximum level of 64 points, being considered an unacceptable risk.

For ergonomic agents, an average significance of 10 points was obtained and classified as sensitive. During direct observation, there was a total unconcern about the aspects related to posture by the Collection Workers. In addition, to carry out the services more quickly, it was common to observe the Collection Workers with overload of waste

bags. Ergonomic agents also reached a maximum level of 48 points, being considered an unacceptable risk.

Social agents were also analyzed, obtaining an average significance of 10points, being framed as sensitive. When performing the risk analysis, a score of 16 points was found, being at the limit between acceptable and unacceptable risk.

IV. FINAL CONSIDERATIONS

Using the technique of direct observation, when performing their activities outdoors, the Collection Workers are exposed to physical risks and accidents. Many of these workers are exposed to the weather, noise generated by compactor trucks and can cause a lot of damage to health.

In municipal solid waste, a variety of chemical and biological residues such as batteries are still found; oils and greases; pesticides/herbicides; solvents; paints; cleaning products; cosmetics; expired remedies; aerosols; diapers; scarves; toilet paper. In periods of pandemic, such as covid-19, residues such as diapers, scarves and toilet paper may contaminate the other residues due to its persistence.

In view of the investigation carried out in the analyzed period, it was observed that most of the Collection Workers were equipped only with gloves and uniforms. It is emphasized that the uniforms used were not in accordance with what was required by NR-6/2018 where they should have a safety sleeve to protect the arm and forearm against biting and piercing agents.

Throughout the monitoring of various paths of the compactor trucks no Collection Worker was equipped with masks (at least cloth), essential protection against the new coronavirus COVID-19. The biological risk is real considering the frequency and exposure time of the Collection Workers, in addition to the chemical risk related to exposure to sulfide and ammonia gases.

Analyzing all agents, following the methodological criterion adopted, it was observed that the mean significance reached 10 points, being framed as a sensitive significance. Analyzing the risks, it was observed that they are generally unacceptable.

The lack of training and uses of epis suitable for Collection Workers (during waste collection) demonstrates the omission on the part of contracting companies regarding the purchase and collection of the use of equipment by their employees, thus raising the level of environmental risks.

The lack of more robust information may cause distortions in the studies conducted, suggesting that it can be applied in small cities to better characterize the variables inserted.

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