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Risks inherent to work environment of formal and informal recyclable material collectors

This work aimed at analyzing comparatively the occupational risks to which, the recyclable material collectors are submitted while working cooperatively or informally, in Campina Grande, Paraíba, Brazil. The participant survey was conducted from March 2012 to December 2013 with 11 recyclable material collectors, seven of them organized in an Association, ARENSA (Association of Collectors of Recyclable Materials of Nossa Senhora Aparecida Community) and four of them working informally. The chosen groups reside in the same neighborhood, Tambor. The investigated occupational risks were chemical, physical, biological and ergonomic. It was found that garbage collectors are submitted daily, in their work routines, to different occupational risks. Among them are exposure to noise, vibration, solar radiation, temperature change, direct and indirect contact with chemical materials such as solvents and liquids that leak from batteries, exposure to pathogenic organisms contained in organic, sanitary and health service waste. They perform heavy physical exertion during collection and transport of recyclable materials in a work day that exceeds eight hours. However, the risks are intensified among informal recyclable material collectors. Among other factors, lack of training, not receiving selected and sanitized waste from its source, maintaining direct contact with other types of waste (organic, sanitary and health services waste), worsened by the absence of Personal Protection Equipment (PPE) during work activities. It follows that there is a relation between the organization of associated recyclable material collectors and the reduction of risks inherent to the profession when compared to informal workers. However, associated recyclable material collectors are not exempt from these risks, which require more effective public policies, especially relating to Integrated Solid Waste Management.

Keywords: Recyclable Material Collectors; Solid Waste; Occupational Risks.

Riscos inerentes ao ambiente laboral de catadores de materiais recicláveis formais e informais

Neste trabalho objetivou-se analisar comparativamente os riscos ocupacionais, nos quais estão submetidos os catadores de materiais recicláveis que atuam em associação e na informalidade, em Campina Grande, Paraíba, Brasil. A pesquisa participante foi realizada de março de 2012 a dezembro de 2013, com 11 catadores de materiais recicláveis, sendo sete profissionais organizados em Associação, a ARENSA (Associação de Catadores de Materiais Recicláveis da Comunidade Nossa Senhora Aparecida) e quatro que trabalham na informalidade. Os grupos escolhidos residem no mesmo bairro, Tambor. Os riscos ocupacionais averiguados foram os químicos, físicos, biológicos e ergonômicos. Verificou-se que os catadores de materiais recicláveis estão submetidos diariamente, em suas rotinas de trabalho, a diferentes riscos ocupacionais, dentre eles, exposição a ruídos, vibração, radiação solar, alteração da temperatura, contato direto e indireto com materiais químicos, como solventes e líquidos que vazam de pilhas e baterias, exposição a organismos patogênicos contidos em resíduos orgânicos, sanitários e de serviço de saúde. Realizam esforço físico intenso durante a coleta e transporte de materiais recicláveis, numa jornada de trabalho que ultrapassa a oito horas diárias. No entanto, os riscos são intensificados entre os catadores de materiais recicláveis informais. Dentre outros fatores, falta de formação, por não receberem os resíduos selecionados e higienizados na fonte geradora, mantendo contato direto com os demais tipos de resíduos (orgânicos, sanitários e de serviço de saúde), agravando-se pela ausência de Equipamentos de Proteção Individual (EPI) durante atividades laborais. Conclui-se que existe relação entre a organização de catadores de materiais recicláveis em associação e a diminuição dos riscos inerentes ao exercício da profissão, quando comparado aos informais. No entanto, os catadores de materiais recicláveis associados não se encontram isentos destes riscos, requerendo políticas públicas mais efetivas, especialmente relacionadas à Gestão Integrada de Resíduos Sólidos.

Palavras-chave: Catadores de Materiais Recicláveis; Resíduos Sólidos; Riscos Ocupacionais.

Topic: **Engenharia Sanitária**

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INTRODUÇÃO

The problem of solid waste in contemporary society has been aggravated by the acceleration of the industrial process, which adds to raw materials taken from nature properties that make them a foreign element to the natural system (FILARDI *et al.*, 2011).

This problem is accentuated with the expansion and densification of urban areas, given that the sanitary health infrastructure in most Brazilian cities does not meet the fast pace of this growth (POLAZ; TEIXEIRA, 2009).

Data from the Brazilian Association of Public Cleaning Companies and Special Waste's Research (ABRELPE, 2013) show that, each year, in Brazil, 76,387,200 tons of solid waste are produced, 58.26%are properly disposed and 41.74% do not have a proper disposal, not meeting the criteria of the National Solid Waste Policy, Law no. 12305/2010, which establishes an environmentally suited final destination for waste (BRAZIL, 2010). In this process, re-using, recycling, composting, recovery and energy use are also included. It also covers final disposal in compliance with specific operational standards in order to avoid damage or risks to public health and safety and to minimize adverse environmental impacts.

In the city of Campina Grande, Paraíba, Brazil, the scenario is no different from the rest of the country in relation to the issue of solid waste. The municipality, since January 5, 2012, have its waste disposed in a landfill located in the municipality of Puxinanã, 15 km away, which does not meet the standards and norms of Brazilian Association of Technical Standards (ABNT), standard no. 8419 (BRAZIL, 1992), and is operating under the influence of an court injunction.

According to the Municipal Department of Urban Services and Environment (SESUMA), in Campina Grande a monthly average of 17,650.42 tonnes of waste are collected, corresponding to a daily average of 580.29 tons of solid waste. In 2013, a total of 211,805.09 tonnes of waste was sent to the city's landfill (CAMPINA GRANDE, 2013).

The average *per capita* of municipal solid waste generationin the country is around 1.041 kg/inhab.day. In larger cities such as Rio de Janeiro-RJ, São Paulo-SP and Curitiba-PR, this number exceeds 1.5 kg/inhab.day (ABRELPE, 2013). In Campina Grande, the generation per capita is 1.45 kg/inhab.day and it is considered an elevated amount because it corresponds to a medium-sized municipality when compared to major urban centers (CAMPINA GRANDE, 2013).

Most solid waste produced in Brazil and in other countries has the potential for reuse or recycling. However, it is not an effective procedure, having consequences due to improper disposal and consequential negative social and environmental impacts (SILVA *et al.*, 2010).

In 2012, the Ciclosoft survey indicated that 14% of Brazilian municipalities have municipal programs of selective collection that operate regularly. 86% of these initiatives are concentrated in the South and Southeast regions of the country (CEMPRE, 2014).

According to Ribeiro and Besen (2007), the separation of recyclable materials plays a strategic role in the integrated management of solid waste, considering several aspects: it stimulates the habit of

separating solid waste at the generating source for its use; it promotes Environmental Education aimed at reducing consumption and loss and, therefore, stimulates conscious consumption, generating jobs and income, improving the quality of organic material for composting.

The lack of a solid waste management and selection at the source contributes to increase negative health impacts on recyclable material collectors, since this type of activity is considered risky, in that the waste is not correctly packed (RIBEIRO *et al*., 2011).

Recycled garbage collectors work in precarious conditions related to occupational safety and health, including the precariousness of his own feeding, which is commonly taken from the garbage (LOPES *et al*., 2011). The occupational form is particularized by the contamination of recyclable material collectors, who handle hazardous substances considered dangerous when handled without any protection (CAVALCANTE; FRANCO, 2007).

The risks come in many facets, from the most visible, such as unsanitary workspaces, to the most ignored, such as the prejudice suffered in society and the lack of preparation of those involved (ZACHARIAS; BAVARESCO, 2009).

A study by Batista, Lima and Silva (2013) identified that the techniques employed by recyclable material collectors in their work routine indicate situations of continuous accident risks, especially due to the non-use of Personal Protective Equipment (PPE), specific to each operation, and the use of inadequate tools, especially with regard to physical and chemical risks that can lead to risky situations and accidents, especially puncture cutting accidents.

Recyclable material collectors are devoid of labor guarantees that supports them, especially in relation to occupational accidents and diseases. They also have no access to retirement, to thirteenth salary and unemployment insurance; they are underpaid, victims of prejudice and not recognized for their work. Furthermore, there are many risks to health in the collection activity of solid waste (MEDEIROS; MACÊDO, 2007).

Considering the scenario presented, it was questioned: What are the risks in which associated and informal recyclable material collectors are submitted to in Campina Grande, PB, Brazil? Is there a relation between the organization of associated recyclable material collectors and the reduction of risks inherent to the profession? These questions drove the conduction of this research, whose main objective is to analyze comparatively the risks in which recycled material collectors are submitted to when working in association or informally in Campina Grande, PB, Brazil.

METHODOLOGY

Characterization of the research and of the study area

The participant survey was conducted from March 2012 to December 2013 with 11 recyclable material collectors who work and reside in the Nossa Senhora Aparecida Community, district of Tambor, Campina Grande, Paraíba, Brazil. Seven of them are organized into an Association (ARENSA, Association of Recyclable Material Collectors of Nossa Senhora Aparecida Community) (87.0%) and four of them work

informally (22.0%).

The sample difference occurred because the majority of informal recyclable material collectors who resides in Tambor district did not accept to participate in the study, because, among other things, they feel ashamed of their profession.This work was developed in Nossa Senhora Aparecida Community, located in Tambor district, in Campina Grande, PB, Brazil, which originated from a land invasion.

The city of Campina Grande is situated 120 km from the capital of the State of Paraíba, João Pessoa (7° 13' 11" S, 35° 52' 31" W, 550 m above sea level), in Serra da Borborema, which gives it a pleasant climate throughout the year (semi-arid tropical climate). According to a research conducted by the Brazilian Institute of Geography and Statistics in 2013, the city of Campina Grande has a population of 400,002inhabitants (BRAZIL, 2014).

Data collection instruments

For the analysis of occupational risks, the classification of risk factors proposed by the Pan-American Health Organization in Brazil was adopted. They were organized into four groups: chemical, physical, biological, ergonomic risks (BRAZIL, 2001).

To identify chemical risks a direct observation was made through weekly visits and the monitoring of individual activities of associated and informal recyclable material collectors. Direct and indirect contact with potentially dangerous chemicals such as batteries, oils, greases and solvents were analyzed.

In relation to physical risks, during the monitoring of work activities of recyclable material collectors, factors such as whether the work was difficult or not, noise changes, vibration, solar radiation, temperature (hot/cold) and moisture were analyzed, observing the NR-9 regulation (BRAZIL, 1978). The observation was made through weekly meetings and the monitoring of individual activities of associated and informal recyclable material collectors.

Biological risks were identified through microbiological cultures, for which four individual samples of fingers[1] from associated workers and four individual samples of fingers from informal workers were collected through scraping with sterile scalpel (Figure 1) and referred to a private laboratory of the city, in a sterile container at room temperature for analysis in selective media, for biochemical identification and for sowing in Agar Sabouraud for bacteria and fungi, respectively.

In the analysis of ergonomic risks, through direct observation, weekly evaluations were made during individual work routine of recyclable material collectors associated with ARENSA to verify proper positioning in lifting and manual handling of loads, taking into account the parameters established in NR - 11 and NR-17 regulations (BRAZIL, 1978).

To assess occupational risks that recyclable material collectors are exposed to, a matrix of interaction was built observing the colors established in the NR-5 regulation (BRAZIL, 1978). According to this regulation, red color identifies chemical risks; green, physical risks; brown, biological risks; and yellow, ergonomic risks.

[1]Finger samples: samples taken in the digital extremities, fingers and hands.

Figure 1: Collection of samples from fingers of associated and informal recyclable material collectors. Campina Grande, Paraíba, Brazil, 2013.

Data analysis

Data were analyzed quantitatively and qualitatively using triangulation, which, according to Thiollent (2008), consists in quantifying, qualifying and describing obtained data. Qualitative data relating to occupational risks were distributed in a matrix of interaction that related data between occupational risks, activities and aspects with the work steps of recyclable materials collectors investigated.

Ethical aspects

In order to meet ethical aspects, an Informed Consent was written in a language accessible to recyclable material collectors. It was approved by the Ethics Committee on Research Involving Human Subjects (CEP) of the State University of Paraíba - UEPB, on March 16, 2011, with Opinion No. 0034.0.133.000-11, according to the Resolution No. 466/2012, regulated by the National Health Council (BRAZIL, 2012).

RESULTS AND DISCUSSION

A matrix of interaction was made. It crossed data among occupational hazards, activities and aspects with work steps of associated and informal recyclable material collectors: collection, transportation, receipt, sorting and packaging of solid waste, evaluating Risk Presence (RP) and Risk Absence (RA); Severe (Se) Serious (Se), Medium (M). (Chart 1).

Physical Risks

The physical risks identified were exposure to noise, vibration, solar radiation, temperature change and moisture. It was observed that there is great divergence between the data from associated and informal recyclable materials collectors with respect to the identified physical risks. This discrepancy stems from different factors, including work routine, time and materials used for sampling.

Vibrations are quite common during the collections by informal recyclable material collectors due to the type of cart used for this procedure. It is inappropriate to professional practice, which, throughout its daily use, may cause back pain, body aches and stress (Figure 2A).

Chart 1: Matrix of Interaction of occupational risks to which recyclable material collectors associated with ARENSA and informal are subjected. Campina Grande, Paraíba, Brazil, 2013.

Occupational Risks / Activities/ Aspects		Recyclable material collectors																			
		Collection				Transportation				Receipt				Sorting				Packaging			
		CA		CI		CA		CI		CA		CI		CA		CI		CA		CI	
		R	I	R	I	R	I	R	I	R	I	R	I	R	I	R	I	R	I	R	I
Physical	Noise	RP	M	RP	Se	RP	Se	RP	Se	RP	Se	RP	Se	RP	Se	RP	S	RP	Se	RP	S
	Vibration	RA		RP	Se	RA		RP	Se	RA		RP	M	RA		RP	M	RA		RP	M
	Exposure to solar radiation	RP	S	RP	S	RP	S	RP	S	RP	Se	RP	S	RP	Se	RP	S	RA		RP	S
	Temperature change	RP	Se	RP	Se	RP	Se	RP	Se	RP	Se	RP	Se	RP	M	RP	Se	RP	M	RP	Se
Chemical	Smoke	RP	Se	RA		RP	Se	RA		RP	Se	RA		RP	S	RA		RP	S	RA	
	Gas and dust	RP	M	RP	M	RP	M	RP	M	RP	M	RP	M	RP	M	RP	M	RP	M	RP	M
	Heavy metals and other chemical substances	RA		RP	Se	RA		RP	M	RA		RP	M	RP	M	RP	Se	RA		RP	M
Biological	Exhibition/Contact with Organic Waste	RA		RP	S	RA		RP	S	RA		RP	S	RA		RP	S	RA		RP	S
	Exposure/Contact with Sanitary Waste	RA		RP	S	RA		RP	S	RA		RP	S	RA		RA		RA		RA	
	Exposure/Contact with Health Services Waste	RA		RP	M	RA		RP	M	RA		RP	M	RP	M	RA		RA		RA	
	Contact with pathogenic microorganisms	RP	S	RP	S	RP	S	RP	S	RP	S	RP	S	RP	S	RP	S	RP	S	RP	S
	Exposure to macrovectors	RP	Se	RP	Se	RP	Se	RP	Se	RP	Se	RP	Se	RP	Se	RP	Se	RP	Se	RP	S
Ergonomic	Exertion	RP	M	RP	Se	RP	M	RP	Se	RP	M	RP	Se	RP	M	RP	Se	RP	Se	RP	Se
	Lifting and weight transport	RP	M	RP	Se	RP	Se	RP	Se	RP	M	RP	Se	RP	M	RP	Se	RP	Se	RP	Se
	Requirement of inadequate posture	RP	M	RP	Se	RP	M	RP	Se	RP	M	RP	Se	RP	M	RP	Se	RP	Se	RP	Se
	Extended working hours	RA		RP	M	RA		RP	Se	RA		RP	Se	RA		RP	Se	RA		RP	M
	Stress situations	RP	M	RP	Se	RP	M	RP	M	RP	M	RP	M	RP	M	RP	M	RP	M	RP	Se

Caption: CA - Recyclable material collectors associated with ARENSA; CI - Informal recyclable material collectors. R - Risk; I- Intensity. Risk Presence (RP) and Risk Absence (RA). Severe (S), Serious (Se) and Medium (M).

Among other aspects, this type of transport does not support a significant amount of recyclable materials, with an average of 45 kg (SILVA, 2013), forcing the collector of recyclable material to return home several times to pack the collected material and then return to performing the collection in the streets, competing with other informal recyclable material collectors and the municipal waste collector car.

The speech of one informal recyclable material collector expresses this feeling of competition: "*The garbage car devastates everything, then I get nothing… I have to run in front of it*".Another physical risk that associated and informal recyclable material collectors are exposed to daily is the excess of noise from waste collection up to its packaging. The noise is generated by the type of transport used by recyclable material collectors, by noise coming from the traffic, by advertisements sound carts and by the selling of CD and DVD.

According to Ferreira and Anjos (2001) and Velloso (2005), vibration and noise during the work routine of associated and informal recyclable material collectors may have many consequences, among them partial or permanent loss of hearing, headache, discomfort, nervous tension, stress, body aches and

back pain.

These risks may be mitigated by the use of appropriate equipment for collection, such as the cart used by associates, and the use of PPE such as hearing protection (Figures 2B, 2C).Among present physical risks (RP) with greatest importance and severity (Chart 1), sun exposure and change of temperature and humidity during work activities stood out.

Considering the workday as having determined hours by the members of ARENSA (from 8 to 17 hours), and after consulting the website of AESA (Executive Agency for Water Management of the State of Paraíba)(2013), it was observed that the minimum temperature, during this research, ranged from 19.6°C to 20.6°C, and the maximum 28.2°C to 30.2°C. Informal collectors did not have determined hours. They commonly exceed eight hours a day, and work during times with a lower solar incidence, from 5 to 10 am and from 4 pm onwards. However, these work hours are modified according to daily needs of the informal professional, because the products necessary for their livelihood are acquired under their convenience. Thus, they usually do not store food.

The lack of an established workload by informal collectors, and, in some cases, also organized collectors, may exceed the eight hours laid down in Article 7 of the Federal Constitution (BRAZIL, 1988) and by Article 58 of the Consolidated Laws of Labor (CLT) (BRAZIL, 1943), overloading them.

According to Medeiros and Macedo (2007), stress is the result of the tensions to which the recyclable material collectors are subjected to, and it can be the invisible cause of the many accidents at work and occupational diseases by reducing the capacity of self-control of these professionals, body's natural defenses and stress of organisms.

Temperature changes also carry risks to associated and informal recyclable material collectors. The heat caused by high temperatures, according to Moura (2010), results in dehydration, rash, cramps, physical fatigue, psychoneurotic disorders, cardiovascular problems and heat stroke.

Importantly, exposure to ultraviolet radiation (UV) is considered by the National Cancer Institute José Alencar Gomes da Silva (INCA) (2013) as the main cause of skin cancer, type melanoma and non-melanoma. According to Ferreira and Nascimento (2008), as an immediate effect burns and late changes occur, such as wrinkles, freckles, white spots, rough skin texture, dilated capillaries, squamous masses and tumors. The high incidence of skin cancer (about 25% of all malignant tumors registered in the country) is mainly related to workers who are exposed to solar radiation (INCA, 2013).

The chemical photo protection method, with the use of sunscreen, is recommended as an effective strategy to reduce health problems caused by ultraviolet radiation to which these workers are exposed. It is also important to link chemical protection with physical barrier, such as the use of long-sleeved sweaters, caps and sunglasses. Care with respect to the exposure time in the sun has to be addressed. In addition to this, the association with physical barrier methods is more effective in reducing the occurrence of skin aggravations (VITOR *et al.*, 2008).

Regarding sun exposure, it was proposed to associates the use of protective clothing such as hats, as they have no financial condition at the moment to acquire solar filters and especially be careful about

exposure time in the sun. Thus, the morning period was recommended for sampling and the afternoon for the sorting and packaging of the waste collected. It was found, during work activities, that members effectively use hats as protection against sun exposure. On the other hand, informal workers did not use any PPE.

Chemical Risks

Among chemical risks, it was noted the habit of smoking among 42.8% of the members. This habit was not identified during the follow-ups among the informal recyclable material collectors investigated. In addition to damage to the health of associated smoking and non-smoking collectors (passive smoking), the risk of fire is high since recyclable materials, such as paper and plastic, are highly flammable. Besides these materials, there are containers that contain alcohol, acetone and perfume leftovers. It was also observed that at the time of the sorting of flammable waste the collectors smoke, which enhances the risk of fire in and out of the ARENSA shed.

Smoking is a serious public health problem and it remains the leading preventable cause of death worldwide, accounting for nearly six million deaths a year (WHO, 2011), half of them of individuals in a productive age (WHO, 2010). The consequences of smoking in the short-term include respiratory effects (reduced lung function and lung growth, shortness of breath, more frequent expectoration and increased risk of lung cancer), and not respiratory effects (increased heart rate, decreased physical capacity, more frequent visits to health professionals for psychological and emotional complaints), nicotine addiction and the risk associated with the use of other drugs (alcohol, marijuana, cocaine) (WHO, 2011; WHO, 1999).

Also regarding chemical risks, it was verified a direct and indirect contact with liquids that leak from batteries, oil, greases, pesticides, herbicides, solvents, paints, cleaning products, cosmetics, medicines, aerosols and heavy metals such as lead, cadmium and mercury, expressing a high intensity risk for the professionals studied.

According to a research conducted in ARENSA by Batista, Lima e Silva (2013), containers with acrylic paints, removers and chemical solvents are materials that cause, according to reports by ARENSA's own recyclable material collectors, irritation of the hands and arms and, due to exposure time, dizziness and vertigo, with consequent headaches.

Contact with this type of chemical material occurs in virtually all stagesof work activities of these professionals. In the case of informal workers, risks are heightened, with a greater potential for contamination during collection, since these professionals do not receive separate and sanitized solid waste, requiring the removal of these materials mixed to the sanitary and organic waste that is contained in disposed bags that are placed in front of homes.

Heavy metals such as lead, cadmium and mercury, when absorbed and incorporated into the biological chain, have a cumulative effect, and therefore may cause diseases such as lead poisoning and nervous system disorders (MOURA, 2010).

According to Kemerich*et al.* (2013), with the improper disposal of batteries heavy metals such as

lead, nickel, cadmium, mercury, zinc, copper, manganese, silver, among others, may lixiviate, infiltrating and contaminating the soil, ground water and also the fauna and flora of the nearby regions. In addition, these metals are bioaccumulative. When absorbed by humans through the food chain, they are deposited in bones and fat tissues, which may cause diseases ranging from brain damage to kidney and lung disorders (GOMES; MELO, 2006).

The use of PPE favors risk prevention, but, without separation and cleaning of waste at its source, this procedure is only palliative. It is noteworthy that among associated recyclable material collectors it was noted the use of gloves, boots, pants and care while performing work activities, unlike what happens with informal collectors.

Biological Risks

The biological risks found were more severe among informal recyclable material collectors, mainly due to exposure and direct and/or indirect contact with organic waste, sanitary waste and health services waste; among associated collectors, they were observed to a lesser intensity.

During all work steps of the two groups of recyclable material collectors, the following was observed: the exposure and/or contact with organic waste/leachate, exposure and/or contact with sanitary waste and disposable diapers, exposure and/or contact with health service waste, contact with pathogens microorganisms and exposure to macrovectors. During the monitoring of informal recyclable material collectors' work, the exposure to all biological risks indicated in the matrix of interaction (Chart 1) could be identified.

The severity occurs because the population does not recognize recyclable material collectors as professionals and it is not sensitized to separate dry recyclable waste and wet recyclable from non-recyclable waste (common trash). This forces them to open trash bags to look for recyclable materials in organic and sanitary waste and often in health service waste (syringes used by patients with *Diabetes mellitus*), as mentioned by informal recyclable material collectors themselves, which is aggravated by the lack of use of PPE in this group.

Studies conducted by Silva *et al.* (2012) in a neighborhood of Campina Grande revealed that 100% of studied patients pack and destine incorrectly health service waste generated in households, packing it into plastic bags mixed with solid waste without any care.

Associated workers, however, despite the best conditions they had, are not free of biological risks, mainly because recyclable materials disposed by households are not 100% sanitized. According to a research by Silva (2013) in the district of Santa Rosa, 5% of households produce recyclable solid waste mixed with organic, and even with insulin syringes.

Another fact to be noted is that 75.0% of studied informal recyclable material collectors select organic waste found during the collection of recyclable materials and take them to their homes to feed the animals they have (dogs, cats, horses, birds, among others). They also often sell this waste each month to other informal recyclable material collectors.

The home organic solid waste, regardless of its origin, has a high number of organisms that indicate fecal contamination with an interest to clinical medicine in the sum of 10^2 to 10^7 MPN/g of waste (LANGE; CUSSIOL, 2006). The authors studied *Clostridium perfringens*, *Enterococcus* sp., thermotolerant coliforms, *Pseudomonas aeruginosa* and *Staphylococcus*, noting that household organic waste has poor sanitary quality and confirmed microbial contamination of this type of waste.

In a study conducted in the urban area of municipalities in the semi-arid of Paraíba (Cabaceiras, Caraúbas and Queimadas) by Silva *et al.* (2010), it was identified the prevalence of helminthes' eggs in household organic waste. Helminthes' eggs ranged from 12.82 to 14.39 eggs/gST, with a viability of 95.42%. In order of prevalence, *Ancylostoma* sp., *Enterobius vermicularis*, *Fasciola hepatica and Ascaris lumbricoides* were recorded.

In Campina Grande, Santa Rosa district, a considerable diversity of helminthes' eggs was found in household organic waste. In order of prevalence, *Ascaris lumbricoides* (46.0%), *Enterobius vermicularis* (37.0%), *Ancylostoma* sp. (15.0%), *Hymenolepis nana*(2.0%) (SILVA *et al.,* 2012; SILVA *et al.,* 2011).

These data show that the organic solid waste is an important source of contamination and it endangers the environment and human health (SILVA *et al.*, 2010).The Regulatory Standard no. 15 of the Ministry of Labor and Employment (MLE) considers this activity as unhealthy in a maximum degree due to the contact of workers with biological agents present in solid waste.

In the samples resulting from bacterial cultures, among associated and informal recyclable material collectors, the contamination by two *Enterobacteriaceae* genera was examined: *Enterobacter spp*. (50.0%) and *Citrobacter spp*. (25,0%). These results challenge the initial hypothesis that among associated recyclable material collectors there would be a lower risk of biological contamination due to the use of PPE and the receipt of selected recyclable solid waste at the source. Therefore, it was found that the use of personal protective equipment without its due hygiene, as well as body hygiene, is not enough to prevent this type of risk. We noted that the destination of recyclable solid waste mixed with wet recyclable waste (organic) and non-recyclable, especially sanitary and/or health service waste generated in households (syringes used for insulin self-administration, for example), enhances biological risks.

Enterobacteria can be isolated from various infectious sites and they are responsible for abscesses, pneumonia, meningitis, septicemia, wound infections, urinary tract infections and gastrointestinal tract infections (BRAZIL, 2004).

The genus *Enterobacter spp.* comprises gram-negative and facultative anaerobic bacteria; the genus *Citrobacter spp*. is also gram-negative. These genera of bacteria occur in almost all nature, fresh water, soil, sewage, plants, animals and human feces. Some are opportunistic pathogens, causing burns, wounds and urinary infections. Occasionally, they can also cause sepsis and meningitis (BRAZIL, 2004).

Cussiol *et al*. (2006, p. 1190) state that:

> The risk of disease transmission resulting from environmental contamination is a very remote possibility in most cases. Obviously, this risk potential increases when the waste is handled improperly, or is not properly packed and disposed.

Some fungi are constantly present in the body, including on the skin. The existence of the resident

bacterial microbiota and the body's immune defenses prevent spreading (VIRGEM, 2010). The conditions that favor the onset of mycoses are heat and moisture, and, because they are opportunistic microorganisms, they can cause diseases in elderly and immunocompromised individuals.

In the samples resulting from fungal cultures, we found only a single genus of the family *Cryptococcaceae*, *Candida spp.* (75.0%), in both samples taken from associated and informal collectors. The situation studied, together with bacteriological cultures, is also applied to fungal cultures, in which we realize that the use of PPE in non-hygienic conditions contributes to the contamination of those associated to ARENSA.

The *Candida spp.* causes ringworms that affect skin surfaces or mucous membranes, resulting in oral candidiasis, vaginal candidiasis, intertrigo, paronychia and onychomycosis. One of the ways of transmission of such mycosis occurs by friction, heat and humidity, facilitating the development of the fungus already existing in the skin or in mucous membranes (BRAZIL, 2002).

These results are consistent with the symptomatology presented by associated and informal recyclable material collectors, since during monitoring they complained of failure to treat "nail diseases", "fluffy nails", diseases caused by fungi. They report also to believe that mycoses happen due to the daily contact with the conditions of the collected solid waste.

Oliveira (2009) believes that the collection can be considered as one of the activities that favors the emergence of biological risks such as viruses, bacteria, parasites, protozoa, fungi and bacilli that come in contact with the human skin through the digestive and respiratory tracts. Such situations expose recyclable material collectors to diseases such as tetanus, flu, diarrhea, skin diseases, worms, meningitis, and pneumonia, among others.

It was also observed, during the monitoring of work activities of associated and informal recyclable material collectors, the contact with vectors such as rats, flies and cockroaches. These vectors are drawn mainly by looking for food from leftovers that are within the recyclable materials and shelter in the cracks among these residues. The associated collectors themselves said they commonly find rats in the Shed of ARENSA: *"We find rats here all the time, and in the other day I picked up a plastic bottle with three rats in it"* (testimony of an ARENSA associated).

Rats are responsible for transmitting many diseases, among them leptospirosis, plague, murine typhus, trichinosis, rabies, salmonellosis and scabies. The main diseases caused and transmitted by flies are conjunctivitis, typhoid fever, diarrhea, tuberculosis and erysipelas. Cockroaches can cause serious problems to human health and can transmit pathogens such as typhoid fever, hepatitis A, intestinal worms, amebiasis, giardiasis, helminthiasis and salmonellosis (BRAZIL, 2013).

Bites by animals (dogs, rats) and ant bites can also cause infectious, parasitic or allergic diseases to these professionals (FERREIRA, 1997).As preventive measures for hygiene and safety, Oliveira (2009) mentions sanitation, use of PPE, personal hygiene, vaccination and moments of awareness in order to mitigate and/or prevent occupational risks. According to Brazil (2007), the transient microbiota colonizes the most superficial layer of the skin, allowing its mechanical removal by washing the hands with soap and

water.

Hand hygiene is considered the single most important action in infection control. The simple use of soap and water reduces the microbial population present on the hands and, in most cases, interrupts the disease transmission chain (BRAZIL, 2007).

Hernandes (2004), in a study on the effectiveness of soaps and antiseptics for hand hygiene against clinically important pathogens in hospitals, found that the simple liquid soap caused a decline of 93.83% of the microbial population of artificially contaminated hands, with clinic samples with *Acinetobacter baumannii*, methicillin-resistant, *Staphylococcus aureus*, *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa* and *Candida albicans* yeast.

A research conducted by Virgem (2010) in Aracaju with cooperative recyclable material collectors after hand washing with soap and water and then with the use of alcohol gel showed an 88% reduction in bacterial contamination and 37.5% of yeasts and molds contamination.

The population with care must be oriented on how to store and forward their solid waste properly, in order to preserve the environment, their own health and that of recyclable material collectors (LAZARRI, 2008).

Ergonomic Risks

Ergonomic risks identified in this work among associated and informal recyclable material collectors were intense physical effort, lifting and manual transport of weight, poor posture, prolonged working hours and stress.

It was found that all recyclable material collectors are exposed to ergonomic risks. However, at some times during work activities, such risks are intensified, especially in the case of informal collectors, who use refrigerator box carts, wood and bicycle tires, completely inadequate for the development of the collection activity. In contrast, associated collectors use carts designed for professional use, which are the result of the perception of these professionals' needs.

Another issue to be addressed is the typical position observed among informal collectors, at the time of collecting recyclable materials, who bend themselves (lower) to open the bags disposed in front of residences. Another moment of intense physical effort and position that directly affects the spine, and therefore the posture, was observed during the arrival of the samples (receipt). The informal recyclable material collectors remove recyclable materials from the cart, arranging them on the ground to sort and prepare for packaging, and later for selling (monthly).

Among ARENSA associates, the intensity and the frequency of physical efforts are considerably lower when compared to informal collectors. This is due mainly to the type of equipment used, for example, designed carts and sorting tables that they have available, and the formation applied to the group and the people that participate in selective collection and have selected and sanitized solid waste separated at the source.

It was found that the activity that requires more physical effort and affects the most the body

posture among those associated with ARENSA comprises the placing of Bags on sorting tables as well as during packaging, which takes place inside the shed, and also the closing of the Bags, for it requires the use of polyethylene tapes to tie the bales made of recyclable material.

Compaction of recyclable materials also requires intense physical effort because associated and informal collectors do not have a press or other tool that performs this type of work.These repetitive movements, in addition to the daily workload superior to eight hours in the case of informal recyclable material collectors, culminate in stress, body aches, back pain, headaches, mood swings, physical fatigue, among other symptoms reported by several authors (MARRAS, 2000; FERREIRA; ANJOS, 2001; LIPP, 2007; ALENCAR; CARDOSO; ANTUNES, 2009; BATISTA; LIMA and SILVA, 2013) and by recyclable material collectors themselves during the monitoring of work activities.

Adding to the risks presented in this work, daily physical workload, unsanitary conditions and work routine result in loss of health by these professionals, causing a decrease of their work capacity, and consequently the decrease in family income, which causes the worsening of food, housing, education and psychological-behavioral conditions.

CONCLUSIONS

According to the data surveyed in this study, it was found that associated and informal recyclable material collectors are daily subjected to different occupational risks in their work routines, given the precarious and unhealthy conditions to which they are exposed. However, the risks are intensified among informal recyclable material collectors, among other factors, by not receiving selected and sanitized waste from its source, maintaining direct contact with other types of waste (organic, sanitary and health services waste), worsened by the absence of Personal Protection Equipment (PPE) during work activities.

It was found that temperature changes and exposure to solar radiation are seen as physical risks of greater significance, occurring especially when these professionals are in activities outside the shed in the case of associated collectors, and in residences in the case of informal collectors. However, this exposure also happens in other stages such as receipt, sorting and packaging of solid waste. As mitigating measures, also resulting from the sensitization process, it was found that associated collectors use personal protection, such as hats, and perform the collection in homes in the morning, because, at this time, the solar radiation is less intense. It was found that the lack of separation of waste at the source causes social and environmental impacts and occupational risks to recyclable material collectors.

The presence of bacteria of the family Enterobacteriaceae was identified in bacteriological cultures from associated and informal collectors, among whom we found two *Enterobacter* spp. genera (50.0%), and *Citrobacter* spp. (25.0%). In the samples resulting from fungal cultures, we found only a single genus of the family Cryptococcaceae, *Candida* spp. (75.0%). This result reflects, in addition to biological risks, the exacerbation of social and environmental problems represented mainly by unhealthy conditions to which these professionals are exposed, worsening on those who work informally. This also reveals the incipience in the selective collection, considering the presence of organic, sanitary and health service waste.

Among ergonomic risks, the cart used by informal collectors is designated as the "villain" due to the effort that they make during the collection of recyclable materials in having to return several times to their homes to accommodate the waste, since this cart does not support a significant amount of recyclable materials.

It was found that, in addition to the use of personal protective equipment, efficient technologies that can meet the needs of the recyclable material collectors are needed in order to avoid work accidents, making them aware in order not to use inappropriate tools during the performance of their work activities.

It follows that there is a relation between the organization of associated recyclable material collectors and the reduction of risks inherent to the profession when compared to informal workers. However, associated recyclable material collectors are not exempt from these risks, which require more effective public policies, especially relating to Integrated Solid Waste Management.

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