Original article

Prevalence and factors associated with respiratory diseases and diarrhea in recyclable material cooperative workers in the city of São Paulo, Brazil: a cross-sectional study, 2013*

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Abstract

Objective: to analyze the prevalence of respiratory diseases and diarrhea among recyclable material cooperative workers in São Paulo City, Brazil, and associated factors. Methods: this was a cross-sectional study conducted in three cooperatives, with data collected through structured interviews and measurement of environmental fungal concentration; Poisson regression was used to estimate prevalence ratios (PR). **Results:** 156 individuals were interviewed; the highest asthma, chronic obstructive pulmonary disease (COPD), and diarrhea prevalence rates occurred in cooperatives with higher total fungal concentration; highest adjusted prevalence of asthma was found in Cooperative A (PR=8.44 – 95%CI 1.09;65.37), and highest adjusted prevalence of diarrhea was found in Cooperative C (PR=2.09 – 95%CI 1.11;3.94), compared to Cooperative B; the highest COPD prevalence was found in smokers and former smokers (PR=8.66 – 95% CI 2.84;26.35). **Conclusion:** fungal control measures must be adopted for disease prevention in recyclable material cooperatives.

Keywords: Solid Waste Segregators; Occupational Health; Fungi; Respiratory Tract Diseases; Diarrhea; Cross-Sectional Studies.

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Introduction

In Brazil, 395,000 individuals are estimated to be working as solid waste sorters, garbage and recyclable material collectors, or street sweepers and related activities.[1] Their daily activities include collecting, separating and compacting waste aluminum, plastic, glass, paper and cardboard which is then sold to the productive sector. This activity can result from individual initiatives or be organized in the form of recyclable material worker cooperatives. There are also people who collect recyclable materials in the street and sell it through cooperatives.[2]

Despite the importance of this work and the large number of people working as recyclable material operators, few studies in Brazil are dedicated to systematically identifying and quantifying the different types of agents implying health risks for those involved in this occupation. The process of collecting and separating solid waste is an occupational activity that results in risk to health, given the nature of the material and the precarious work environment and work process conditions.[3,4]

Brazilian recyclable material cooperatives have different levels of organization, availability of space, infrastructure and equipment, as well as a varied number of workers. In some places, electrical installations, lighting and ventilation are not adequate, with excessive humidity and presence of mice and cockroaches.[3]

> *The process of collecting and separating solid waste is an occupational activity that results in risk to health, given the nature of the material and the precarious work environment and work process conditions.*

Recyclable materials handled by workers are frequently contaminated with the remains of waste food, and this is propitious to the development of fungi and vectors. Under these conditions, certain symptoms and diseases are more likely to occur, as well as the possibility of worsening respiratory and dermatological problems. These workers are more prone to common illnesses such as influenza, bronchitis and ulcers.[5] As such, as a result of daily handling of solid waste, exposure of these workers to bioaerosols – particles of microbial, vegetable or animal origin, also known as 'organic dust' – is considered to be an occupational health problem.[6]

In view of the growth in the number of people working with recyclable material and considering the social vulnerability and occupational risks to which they are subject, the objective of this study was to analyze prevalence of asthma, chronic obstructive pulmonary disease (COPD) and diarrhea among recyclable material cooperative workers in São Paulo City, and factors associated with the occurrence of these health conditions in their work environment and work processes.

Methods

This was a cross-sectional study conducted in three recyclable material sorting cooperatives in Greater São Paulo between August and December 2013.

Initially we visited 12 cooperatives indicated by the National Recyclable Material Workers' Movement, in order to identify the work environment and work processes characteristics of this type of activity. The criteria used to select the cooperatives were: at least 30 employees; use of similar work processes and similar characteristics to the other cooperatives (collecting, sorting, compacting and baling); and closeness to the University of São Paulo Faculty of Medicine in order to make the field work feasible.

All the workers (adult men and women) at the three cooperatives selected took part voluntarily in the study.

The dependent variables were prevalence of asthma, COPD and diarrhea. The questionnaire included questions intended to screen for COPD and asthma. In the case of COPD, we adapted the Global Initiative for Chronic Obstructive Lung Disease questionnaire.[7] In order to screen for asthma, we used the International Study of Asthma and Allergies in Childhood questionnaire, as validated by Maçãira et al.[8] Occurrence of cases of diarrhea in the last six months was self-reported.

The independent variables were comprised of sociodemographic, behavioral and workplace information:

a) age (categorized in years: 20-34; 35-50; 51-71);
b) sex (male; female);
c) race/skin color (white, black, brown, yellow or indigenous; the latter four categories were grouped together and described as 'non-white');
d) schooling (in complete years of study: 0-8; 9 or more);
e) tobacco smoking (non-smoker; smoker or former smoker);
f) use of breathing protection mask (always; occasionally or never);

g) use of gloves (always; occasionally or never);
h) use of boots (always; occasionally or never);
i) cooperatives (identified as A, B and C);
j) fungus concentration (mean, expressed as colony-forming units per m^3 [CFU/m^3] of each cooperative).

The data were collected using a structured questionnaire. Assessment of fungal microbiota present inside the cooperatives was performed in six different work environments: office, kitchen, conveyor belt, compactor, weighing scales and waste electrical and electronic equipment room. Double samples were planned for these places. The samples were collected in August, October and December 2013, at Cooperatives A, B and C, respectively.

Fungus sampling was performed using an air monitoring device (T-air Millipore), using the method based on quantifying sedimentation (per m^3), using an air filter, of anemophilous fungus spores on Petri dishes containing Sabouraud dextrose agar, positioned at a height of 1.5 meters above floor level (approximate region of human breathing). When preparing the culture medium, the Sabouraud dextrose agar was dissolved in boiling water, to which chloramphenicol was added (100µg/mL); following this the mixture was placed in an autoclave at 121°C for 15 minutes. The potential for hydrogen (pH) was corrected to 5.6 and the mixture was distributed in Petri dishes, inside the device. Following exposure for 10 minutes at each of the established places, the culture dishes, fastened to the device, were closed with their own lids and sealed with Parafilm® to prevent any possible contamination. The dishes were later incubated at 25ºC for up to five days.

Analysis of the dishes was performed at the University of São Paulo Institute of Biomedical Sciences Microbiology Department. The isolated colonies were submitted to the microculture technique,[9] using Sabouraud dextrose agar medium and potato dextrose agar medium. Identification of fungi[10] and quantification of CFU/m^3 were performed by analyzing slides of the microbiological material stained with lactophenol blue solution, using an optical microscope.

We obtained mean total fungi concentration (in CFU/m^3) per collection place at each cooperative and also for the samples grouped together. Comparison of the composition of fungi genera between the cooperatives was done by grouping together the collection areas.

The data were organized on an Excel® spreadsheet. The categorical variables were compared using Pearson's chi-square test with a 0.05 significance level. Poisson logistic regression with robust variance was used in order to identify possible factors associated with COPD, asthma and diarrhea prevalence ratios among the workers. Prevalence ratio (PR) and respective 95% confidence interval (95%CI) were calculated for each variable in univariate models. Following this, all the variables were included in a multivariate model and adjustment was analyzed as each variable was excluded, one by one, by means of the maximum likelihood ratio test. Considering that tobacco smoking is a confounding factor for respiratory diseases, this variable was included in the questionnaire and used in the analyses. All statistical analyses were performed using Stata 13.0®.

The study project was approved by the University of São Paulo Faculty of Medicine Research Project Ethics Analysis Committee: Process No. 169/13, dated May 8th 2013. All individuals who agreed to take part in the study were informed of its objectives before signing a Free and Informed Consent form.

Results

Of the 12 cooperatives visited, 9 had fewer than 30 cooperative members and a further 2 were very far from the researchers' workplace. Three cooperatives were therefore selected, identified as A, B and C, which had 35, 58 and 63 workers, respectively, totaling 156 individuals. There were no refusals or losses.

Mean age of the workers was 44 ± 12.1 years, 28% of them were in the 20-34 age range, 35% in the 35-50 age range and 37% in the 51-71 age range. Women accounted for 60% of the interviewees, while smokers and former smokers accounted for 61% (Table 1).

Mean time spent working as a garbage collector in the street and/or as a cooperative member was 4.4 ± 3.4 years, with no statistical difference between the cooperatives ($p>0.05$). Mean cigarette consumption per day was 16 ± 9 and the mean length of time that former smokers had stopped smoking was 110 months (data not shown). Out of the total number of individuals, 77% stated that they were of a race/color that was not white, and the majority had low schooling levels (79%) (Table 1).

Almost all the workers (97%) occasionally or never used breathing protection masks, 69% reported frequent use of gloves and 88% reported frequent use of boots. When screening for asthma and COPD, 11% and 32% of the individuals were identified as being positive,

Table 1 – Prevalence of asthma, chronic obstructive pulmonary disease (COPD) and diarrhea according to sociodemographic, behavioral and cooperative variables, São Paulo city, 2013

Variable	Total		Asthma		COPD		Diarrhea	
	n	%	n	%	n	%	n	%
Total	**156**	**100**	**17**	**11**	**50**	**32**	**53**	**34**
Age (years) (N=156)								
20-34	44	28	5	11	10	23	14	32
35-50	54	35	6	11	24	44	20	37
51-71	58	37	6	10	16	28	19	11
Sex (N=156)								
Male	62	40	4	6	17	27	18	29
Female	94	60	13	14	33	35	27	29
Race/skin color (N=154)								
White	35	23	2	6	9	26	9	26
Non-white	119	77	15	13	40	33	36	30
Schooling (complete years) (N=155)								
≤8	124	79	13	11	44	36	36	29
≥9	31	21	4	13	5	16	9	29
Tobacco smoking (N=156)								
Non-smoker	61	39	4	7	3	5	19	31
Smoker or former smoker	95	61	13	14	47	50	26	28
Use of mask (N=153)								
Always	4	3	1	25	1	25	2	50
Occasionally or never	149	97	15	10	48	32	41	28
Use of gloves (N=153)								
Always	105	69	15	14	39	37	34	32
Occasionally or never	48	31	2	4	11	23	10	21
Use of boots (N=154)								
Always	136	88	15	11	44	33	38	28
Occasionally or never	18	12	2	11	6	33	6	33
Cooperatives (N=156)								
A	35	22	4	12	12	35	9	26
B	58	37	2	3	15	26	11	19
C	63	41	11	18	23	36	25	40

respectively; diarrhea prevalence was 34% (Table 1).

The greater part of the interviewees (41%) worked at Cooperative C, where prevalence of asthma (18%), COPD (36%) and diarrhea (40%) was also higher. COPD prevalence in the smoker and former smoker group was 50%, while in the 35-50 age group it was 44%. Prevalence of diarrhea among workers who always used a mask was also high (50%) (Table 1).

Mean fungi concentration per collection site varied between 116 CFU/m³ (office) to 751 CFU/m³ (conveyor belt), these two rates being found in Cooperative C (Table 2), with no significant difference between sample sites when the cooperatives were grouped together (p=0.506). When the sites were grouped together, Cooperative B (315 CFU/m³) was found to have a lower concentration than Cooperative A (531 CFU/m³) and Cooperative C (503 CFU/m³) (p=0.045).

The fungi genera identified were: Aspergillus spp., Cladosporium spp., Fusarium spp., Nigrospora spp., Rhizopus spp., Mucor spp. and Penicillium spp., as well as non-sporogenous fungi (Table 2). The genera with the highest mean concentrations in Cooperative A were Cladosporium spp. (237 CFU/m³) and Aspergillus spp. (137 CFU/m³). In Cooperative B, the highest concentrations corresponded to Penicillium spp. (95 CFU/m³) and Fusarium spp. (70 CFU/m³). In Cooperative C, mean concentrations between genera were similar, varying between 120 and 130 CFU/m³ for Aspergillus spp. and Rhizopus spp., respectively (Table 2).

The Aspergillus spp., Fusarium spp. and Penicillium spp. genera were identified in the three cooperatives analyzed. Among these genera, Aspergillus spp. had a higher concentration in Cooperative A, in comparison

Table 2 – Mean concentration, standard deviation (SD) and number of samples (n) of total fungi in colony-forming units (CFU/m³), in the different collection areas and different fungi genera, by cooperative (A, B, C), São Paulo city, 2013

Variables	A			B			C				Total[a]		
	Mean	SD	n	Mean	SD	n	Mean	SD	n	p-value	Mean	SD	n
Place													
Weighing scales				280	35	2				–	280	35	2
Kitchen	363		1	356	11	2	288		1	–	341	36	4
Office	615	3	2				116		1	–	449	288	3
Conveyor belt	598		1	334	20	2	751	99	2	–	554	216	5
Compactor	457		1	289	135	2	680	158	2	–	479	222	5
Waste electrical and electronic equipment	540		1				378	98	2	–	432	116	3
Total	**531**	**102**	**6**	**315**	**63**	**8**	**503**	**256**	**8**	**0.506**	**442**	**188**	**22**
Fungi genera													
Aspergillus spp.	137	24	6	63	30	8	120	60	8	0.009	104	51	22
Cladosporium spp.	237	80	6	51	18	8				<0.001	83	107	14
Fusarium spp.	76	43	6	70	23	8	124	103	8	0.247	91	69	22
Nigrospora spp.				30	16	8				–	11	17	8
Rhizopus spp.							130	95	8	–	47	85	8
Mucor spp.				2	2	6				–	1	1	6
Penicillium spp.	81	60	6	95	52	8	128	113	8	0.539	104	80	22
Non-sporogenous fungi				3	1	8				–	1	2	8

a) Total sample: comparison between places (p=0045).

to the other cooperatives (p=0.009). The Fusarium spp. and Penicillium spp. genera showed no significant difference in the distribution of concentrations between the cooperatives (p=0.247 and p=0.539, respectively). Cladosporium spp. was only found in Cooperatives A and B, with higher concentrations in Cooperative A (p<0.001). Nigrospora spp., Mucor spp. and non-sporogenous fungi were only found in Cooperative B, with the latter two types having very low concentrations (≤3 CFU/m³).

In the univariate analysis, the 'cooperative' variable had statistically significant association with asthma and diarrhea prevalence ratios, and Cooperative C had higher prevalence ratios for both outcomes: asthma, PR=5.06 – 95%CI 1.17;22.0 (Table 3); and diarrhea, PR=2.09 – 95%CI 1.13;3.87 (Table 4). Smokers and former smokers had association with COPD (PR=10.17 – 95%CI 3.30;31.33) (Table 5). Age also had statistically significant association with COPD, although only in the intermediate age range of 35-50 years (PR=1.96 – 95%CI 1.05;3.65) (Table 5).

The multivariate models had a better fit when all the variables studied were kept in them. In these models, higher adjusted prevalence of asthma was found in Cooperative A (PR=8.44 – 95%CI 1.09;65.37) (Table 3) and higher adjusted prevalence of diarrhea was found in Cooperative C (PR=2.09 – 95%CI 1.11;3.94) (Table 4), in relation to Cooperative B, which had lower fungi concentration. Use of gloves 'occasionally or never' was also found to be associated with lower prevalence of asthma (PR=0.18 – 95%CI 0.04;0.86) (Table 3). Finally, adjusted COPD prevalence was higher among smokers and former smokers (PR=8.66 – 95%CI 2.84;26.35), when compared to its prevalence among non-smokers (Table 5).

Discussion

Among recyclable material workers, this study identified a predominance of individuals aged 35 or over, females, people with low schooling levels and low use of masks as personal protective equipment (PPE), although reported frequent use of gloves and boots was high. Fungi concentration in the cooperatives varied according to workplace. Among the fungi genera identified, Aspergillus spp., Fusarium spp. and Penicillium spp. were found in all the cooperatives analyzed. Following multivariate analysis, the asthma and diarrhea prevalence ratios were higher in cooperatives that also had higher total fungi concentrations. The COPD prevalence ratio was higher among smokers and former smokers.

With regard to limitations in the development of the study, it is possible that there may have been

Table 3 – Crude and adjusted asthma prevalence ratio (PR) according to sociodemographic, behavioral and cooperative variables (n=156), São Paulo city, 2013

Variables	$_{crude}$PR	95%CI[a]	p-value[b]	$_{adjusted}$PR	95%CI[a]	p-value[b]
Age (years)			**0.990**			**0.706**
20-34	1.00			1.00		0.706
35-50	0.98	0.32;3.02		0.77	0.21;2.91	
51-71	0.93	0.30;2.85		0.82	0.23;2.88	
Sex			**0.159**			**0.104**
Male	1.00			1.00		
Female	2.17	0.74;6.36		2.58	0.82;8.07	
Race/skin color			**0.296**			**0.510**
White	1.00			1.00		
Non-white	2.14	0.51;8.95		1.59	0.40;6.35	
Schooling (complete years)			**0.710**			**0.515**
≤8	1.00			1.00		
≥9	1.22	0.43;3.50		1.37	0.54;3.50	
Tobacco smoking			**0.170**			**0.280**
Non-smoker	1.00			1.00		
Smoker or former smoker	2.11	0.72;6.20		1.68	0.66;4.28	
Use of mask			**0.317**			**0.857**
Always	1.00			1.00		
Occasionally or never	0.41	0.07;2.38		0.83	0.10;6.65	
Use of gloves			**0.099**			**0.032**
Always	1.00			1.00		
Occasionally or never	0.3	0.71;1.26		0.18	0.04;0.86	
Use of boots			**0.396**			**0.564**
Always	1.00			1.00		
Occasionally or never	0.71	0.25;4.04		0.58	0.09;3.73	
Cooperatives			**0.061**			**0.041**
A	3.41	0.66;17.75		8.44	1.09;65.37	
B	1.00			1.00		
C	5.06	1.17;22.00		3.94	0.88;17.54	

a) 95%CI: 95% confidence interval.

b) Wald test.

difficulty in understanding the questions contained in the questionnaire, given the respondents' low level of schooling. Other points worthy of note are (i) the small number of fungi samples collected in the ambient air in the cooperatives and (ii) absence of external reference groups for making comparisons. A further limitation to be considered was non-standardized diagnosis of diarrhea, which may have affected self-reported prevalence of this symptom, above all in a socially vulnerable population like this one. It was also not possible to add more precise data about tobacco smoking to the analyses, capable of providing greater robustness to the findings in relation to COPD and tobacco smoking. Finally, the small sample size (156 workers) led to estimates being imprecise, given the amplitude of the confidence intervals.

Currently no occupational exposure limits have been established for fungi and bacteria in this type of work environment, probably because the effects of microorganisms on health differ greatly between species.[11] Some studies, conducted in similar environments, report relationship between exposure and development of adverse effects on health in concentrations ranging between 10^3 and 10^9 UFC/m^3 for total fungi,[12,13] although the concentrations found in our study were below these levels.

Some studies conducted in waste sorting centers point to high amplitude of fungi concentration in the air (between 650 UFC/m^3 and 9x10^5 UFC/m^3), varying according to the sample site, the method used and the way in which the samples were processed.[14-16] These values are above the mean values found in the cooperatives we studied, and the low values we found could be related to the small number of samples collected, the method used or the smaller quantity of waste handled. Values slightly above 650 UFC/m^3 were only found in the conveyor belt and compactor areas of Cooperative C, where handling of waste is greater.

Table 4 – Crude and adjusted diarrhea prevalence ratio (PR) according to sociodemographic, behavioral and cooperative variables (n=156), São Paulo city, 2013

Variables	crude[PR]	$_{95\%}$CI[a]	p-value[b]	adjusted[PR]	$_{95\%}$CI[a]	p-value[b]
Age (years)			**0.132**			**0.378**
20-34	1.00			1.00		
35-50	1.16	0.67;2.03		1.35	0.69;2.62	
51-71	0.61	0.30;1.20		0.63	0.31;1.30	
Sex			**0.112**			**0.988**
Male	1.00			1.00		
Female	0.26	0.60;1.65		1.00	0.59;1.68	
Race/skin color			**0.675**			**0.801**
White	1.00			1.00		
Non-white	1.14	0.61;2.13		1.08	0.59;2.00	
Schooling (complete years)			**0.979**			**0.859**
≤8	1.00			1.00		
≥9	0.99	0.53;1.84		0.94	0.48;1.83	
Tobacco smoking			**0.640**			**0.269**
Non-smoker	1.00			1.00		
Smoker or former smoker	0.89	0.54;1.46		0.73	0.42;1.28	
Use of mask			**0.255**			**0.229**
Always	1.00			1.00		
Occasionally or never	0.55	0.20;1.53		0.58	0.23;1.42	
Use of gloves			**0.182**			**0.306**
Always	1.00			1.00		
Occasionally or never	0.66	0.35;1.22		0.69	0.34;1.41	
Use of boots			**0.640**			**0.918**
Always	1.00			1.00		
Occasionally or never	1.18	0.58;2.41		1.04	0.50;2.15	
Cooperatives			**0.064**			**0.043**
A	1.4	0.64;3.03		1.83	0.74;4.53	
B	1.00			1.00		
C	2.09	1.13;3.87		2.09	1.11;3.94	

a) 95%CI: 95% confidence interval.

b) Wald test.

The wide variety of fungi identified in the cooperatives has also been detected in other studies of waste sorting environments.[14-17] The results found by our study are in keeping with the studies cited, when they report dominance of the Penicillium spp. and Aspergillus spp. genera, described as producers of mycotoxins that are a potential risk to health.[18] Exposure to the most prevalent fungi genera in this study can increase predisposition to allergic reactions and respiratory diseases such as asthma, for instance.[19,20] However, no information exists as to the minimum concentration of these fungi capable of causing health problems.

A study conducted with garbage collectors demonstrated an exposure-response relation between high fungi concentration and a higher number of reports of diarrhea, with prevalence of 5.60 (95%CI 2,39;13,08).[21] That data corroborates the results of this study with regard to high prevalence of diarrhea cases in cooperatives with higher fungi concentrations (Cooperative C). The hygiene conditions found in these environments – high levels of mould, heat and excess humidity – are conducive to proliferation of fungi.

Asthma is considered to be the most prevalent occupational lung disease in industrialized countries, accounting for between 26% and 52% of occupational respiratory diseases, whereby this variation is associated with type of occupation and the country studied.[22] In a study conducted in Brazil in 2013, prevalence of medical diagnosis of asthma in individuals aged over 18 was 5% in the state of São Paulo, this being higher than the national average (4.4%), as well as being higher among women.[23] In Latin American countries, there is evidence of a greater number of asthma cases among poor populations living in urban areas.[24] These characteristics are in line with those of the group we investigated and reinforce the findings of our study. It is

Table 5 – Crude and adjusted chronic obstructive pulmonary disease (COPD) prevalence ratio (PR) according to sociodemographic, behavioral and cooperative variables (n=156), São Paulo city, 2013

Variables	$_{crude}$PR	95%CI[a]	p-value[b]	$_{adjusted}$PR	95%CI[a]	p-value[b]
Age (years)			**0.052**			**0.455**
20-34	1.00			1.00		
35-50	1.96	1.05;3.65		1.36	0.77;2.40	
51-71	1.23	0.62;2.46		1.04	0.57;1.90	
Sex			**0.303**			**0.092**
Male	1.00			1.00		
Female	1.29	0.79;2.11		1.47	0.94;2.30	
Race/skin color			**0.448**			**0.941**
White	1.00			1.00		
Non-white	1.27	0.68;2.35		1.02	0.62;1.66	
Schooling (complete years)			**0.063**			**0.248**
≤8	1.00			1.00		
≥9	0.45	0.19;1.04		0.63	0.29;1.38	
Tobacco smoking			**<0.001**			**<0.001**
Non-smoker	1.00			1.00		
Smoker or former smoker	10.17	3.30;31.33		8.66	2.84;26.35	
Use of mask			**0.767**			**0.561**
Always	1.00			1.00		
Occasionally or never	1.3	0.23;7.24		1.62	0.32;8.33	
Use of gloves			**0.116**			**0.229**
Always	1.00			1.00		
Occasionally or never	0.63	0.35;1.12		0.65	0.32;1.32	
Use of boots			**0.950**			**0.795**
Always	1.00			1.00		
Occasionally or never	1.02	0.51;2.06		0.91	0.46;1.80	
Cooperatives			**0.439**			**0.516**
A	1.36	0.72;2.57		1.36	0.65;2.85	
B	1.00			1.00		
C	1.41	0.82;2.44		1.12	0.71;1.78	

a) 95%CI: 95% confidence interval.

b) Wald test.

also important to note that diverse variables are involved in the etiology of this disease, such as environmental issues (e.g. pollution) and lifestyle (e.g. tobacco smoking).[24,25]

Prevalence of respiratory symptoms compatible with those of asthma and COPD is higher among garbage collectors when compared to office workers in garbage recycling facilities.[26] Furthermore, greater asthma prevalence was found in the cooperative that had higher fungi concentration; however, we had no samples of reference groups outside the cooperatives that could have enabled comparisons. It is possible that individual exposure to fungi may have been based on fungi concentrations in the places where each individual worked. However, this approach may be subject to exposure classification bias, depending on the job activity performed, given that garbage collectors circulate in the cooperative environment and some workers carry out their duties in more than one workplace.

Tobacco smoking is the main COPD risk factor. However, even among smokers, around 15% to 20% of cases have been attributed to occupational exposure, including exposure to bioaerosols.[27] In São Paulo City, COPD case prevalence varies between 6% and 16% of the population aged 40 or over, whereby cigarette use is the most commonly associated risk factor.[28] In addition, risk of developing this disease has been related, above all, to individuals from lower socio-economic classes.[29] Indeed, COPD prevalence among the cooperative workers was higher among smokers and former smokers, and was much higher than the rate found in the general population. No direct relationship was found between COPD and concentration of fungi in the environment, and this high prevalence may be related to the conditions of vulnerability in which these workers live, and which is reflected in their health in general.[3]

Frequency of PPE use (masks, gloves and boots) did not affect the prevalence of the diseases we screened for. Notwithstanding, use of breathing protection masks was found to be low;[30] furthermore, the breathing protection masks available in the cooperatives we assessed are not specific for biological agents and the periodicity with which this equipment is changed may not be sufficient to protect workers, making them susceptible to exposure to bioaerosols, increased respiratory symptoms similar to those of influenza and greater risk of COPD.[27] Although the results of this study showed that occasional use or non-use of gloves by workers may be related to lower prevalence of asthma, this fact may be due to chance, since there are no biological mechanisms to justify the occurrence of this. Moreover, if their hands were not sanitized correctly when putting on or taking off gloves, or if contaminated gloves were not sanitized, their use may not be an efficient protection factor.

Notwithstanding the limitations of this study, the results presented suggest that the work environment can expose these workers to fungi concentrations that are potentially harmful to their health. Such exposure, associated with low use of personal protective equipment and/or incorrect use and care thereof, precarious working conditions and high vulnerability of this population, can potentialize adverse effects on their health. Considering the growth of this occupational category, we recommend that initiatives be implemented to reduce exposure to agents having the potential to cause risk to the health of recyclable material workers.

Authors' contributions

Souza GF and Gouveia N designed the study and coordinated data collection and processing. Souza GF assisted with processing air samples and analyzing the material collected. Souza GF, Muto EY, Nascimento FP and Gouveia N contributed to analysis, interpretation and discussion of the results, as well as contributing to drafting the manuscript. All the authors have approved the final version and are responsible for all aspects thereof, including the guarantee of its accuracy and integrity.

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