

Association of waste-collection employment
with the prevalence of respiratory and irritation
symptoms among waste-collection workers

Kyeongmin Lee

The Graduate School of Public Health

Yonsei University

Department of Occupational Health

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A Master's Thesis

Submitted to the Department of Occupational Health
and the Graduate School of Public Health of Yonsei University

in partial fulfillment of the
requirements for the degree of
Master of Public Health

Kyeongmin Lee

December 2013

This certifies that the masters thesis
of Kyeongmin Lee is approved.



----- Thesis Supervisor: Jaehoon Roh



----- Chinyon Kim: Thesis Committee Member #1



----- Donguk Park: Thesis Committee Member #2

The Graduate School of Public Health

Yonsei University

December 2013

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ABSTRACT

Association of waste-collection employment with the prevalence of respiratory and irritation symptoms among waste-collection workers

Kyeongmin Lee

Department of Occupational Health

The Graduate School of Public Health

Yonsei University

Directed by Professor Jaehoon Roh, M.D., Ph.D.

Objective: Waste-collection workers perform a variety of jobs, such as collecting, sweeping, and sorting. They are exposed to harmful substances, depending on job type, which can cause severe respiratory and irritation symptoms. The objective of this study is to investigate the prevalence rate of respiratory and irritation symptoms among waste-collection workers and examine if type of waste-collection work influences the development of respiratory and irritation symptoms.

Methods: We randomly interviewed 1,055 waste-collection workers from 30 private companies and 16 municipal administrative offices. Waste-collection workers who collect and handle street and household wastes agreed to participate in the study. Workers who

sort collected municipal and street wastes at a plant were also included. The questionnaire first distributed to the 1,055 workers was completed by trained interviewers. Our study subjects were involved in the sweeping streets, collecting municipal household waste, and sorting the collected waste for recycling. They were asked to report individual characteristics such as age, gender, duration of employment, monthly wage, average hours of work per day, shift of work, average days of work per week, type of company, and type of waste-collection work. The questionnaire was primarily designed to investigate symptoms pertaining to respiratory symptoms (cough, dyspnea, wheeze) and irritation (eye, skin, nose) that they may have suffered. We selected several demographic and work environment characteristics as independent variables that could be associated with the development of those health symptoms. They were characterized in such a way that the number of categories could be appropriately divided for further analysis. Chi-square (χ^2) test was used to examine the differences in demographic and work environment characteristics and respiratory and irritation symptoms. Only variables with *p*-values <0.25 were eventually introduced to our multiple logistic regression analysis. Finally, odds ratios (OR) with 95% confidence intervals (95% CI) for respiratory and irritation symptoms were calculated.

Results: The distribution of the study participants (n=1055) was evaluated according to demographic and work environment characteristics. Age (n=993) averaged 48.7 years old (SD: 7.5) with a range of 26-68 years old. The average of employment duration (n=1033) was 9.2 years (SD: 6.0) with a range of 0.1-28 years. The average monthly wage (n=966) was ~~W~~2,190,800 (SD: ~~W~~456,000) with a range of ~~W~~800,000-~~W~~3,300,000. The number of males and females was 986 (93.4%) and 46 (4.3%), respectively. The number of subjects working less than and more than eight hours per day were 153 (14.5%) and 696 (66.0%),

respectively. 33.4% (352) of the workers studied were found to work a night shift, while the number of day-shift workers was 703 (66.6%). The numbers of subjects working five days per week and the number of those working more were 435 (41.2%) and 574 (54.4%), respectively. The number of subjects employed at non-sub-contracting companies was 647 (61.3%), and the number of subjects employed at sub-contracting companies was 403 (38.2%). The number of subjects employed in sweeping was 400 (37.9%), the number of subjects in collection was 565 (53.6%), and the number of subjects in sorting was 71 (6.7%).

The prevalence rates of cough, dyspnea, and wheeze were respectively 42.2% (n=445), 19.2% (n=203), and 13.0% (n=137). The prevalence rates of eye, skin, and nose irritation were 49.1% (n=518), 14.3% (n=151), and 28.6% (n=302), respectively.

The difference in symptoms among categorical variables was examined by chi-square (χ^2) test. Monthly wage, type of company, average hours of work per day, type of waste-collection work, and average days of work per week were found to be significant factors associated with cough ($p<0.05$). Duration of employment, monthly wage, type of company, average hours of work per day, and shift of work were significantly associated with dyspnea symptom ($p<0.05$). No environmental or occupational factors were found to be significantly associated with wheeze at $p<0.05$. Gender and type of waste-collection work were significantly associated with eye irritation ($p<0.05$). Duration of employment, wage, type of company, average hours of work per day, type of waste-collection work, and shift of work were significantly associated with skin irritation ($p<0.05$). Age, duration of employment, shift of work, and average days of work per week were significantly associated with nose irritation ($p<0.05$).

We also examined the effect of waste-collection work on the prevalence of respiratory and irritation symptoms among waste-collection workers using logistic regression analysis. For the symptom cough, sweeping (reference) waste-collection work showed a significantly lower risk than that of waste collection work (OR: 0.53, 95% CI: 0.36-0.77). Waste-collection night-shift work (reference) showed a lower risk than did daytime waste-collection work (OR: 0.57, 95% CI: 0.37-0.89). The risk of cough for waste-collection workers working over five days per week (OR: 1.62, 95% CI: 1.18-2.23) was found to be significantly higher than that of those working five or fewer days per week (reference). For the symptom of dyspnea, work environment and occupational factors were not associated with any characteristics. For the symptom wheeze, waste-collection occupational factors were not associated with the development of wheeze. For eye irritation, the risk for this symptom in sorting work was 2.18 times (OR: 2.18, 95% CI: 1.16-4.09) higher than that in sweeping (reference). For skin irritation, no waste-collection occupational factors were associated with the development of skin irritation. For nose irritation, the development of nose irritation among daytime workers (OR: 0.44, 95% CI: 0.27-0.72) was found to be significantly lower than among night-shift workers (reference). Waste-collection workers working over five days per week showed almost two times higher nose irritation symptoms (OR: 1.90, 95% CI: 1.32-2.72) than did those working five days or less (reference).

Conclusion: Prevalence rates of respiratory and irritation symptoms were found to be significantly associated with waste-collection work and work environment factors. Given that waste-collection workers differ in their exposure to harmful substances related to respiratory and irritation symptoms depending on occupational environment factors, these

factors should be considered to reduce prevalence rates of respiratory and irritation symptoms.

Keywords: Waste collection workers, respiratory symptom, irritation symptoms, household waste, job, work environment characteristic

I. Introduction

Waste collection is practiced all around the world. Overall, the job of a municipal waste-collection worker can be characterized by frequent lifting, carrying, pushing, and/or pulling of heavy items, such as the various types of wastes generated by a household. In general, most systems for the collection of domestic waste make use of a closed waste truck featuring an automatic lifting device to empty two- or four-wheeled containers (Fuijjer et al. 2004) holding several types of wastes.

It has been widely known that waste-collection workers can be exposed to a variety of chemical and biological materials that might be related to several types of widely known health problems (Poulsen et al. 1995). Waste-collection workers are exposed to organic dust containing microorganisms, diesel exhaust particles from vehicles that they use or that pass on the street, which have been identified as a human carcinogen, and inclement weather conditions. All of these may contribute to respiratory problems such as cough, itching nose, wheeze, chronic bronchitis, phlegm, chest tightness and asthma (Poulsen et al. 1995; Hansen et al. 1997; Yang et al. 2001; Ono-Ogasawara et al. 2004; Sabde et al. 2008). In addition, a number of studies have reported that waste-collection workers suffer from airway inflammation, nausea, diarrhea, and irritations (Ivens et al. 1997; Ivens et al. 1999; Heldal et al. 2003; Wouters et al. 2013). It has been frequently reported that waste-collection workers show an increased risk of a respiratory and influenza-like symptoms (Sigsgaard et al. 1994; Poulsen et al. 1995; Thorn et al. 1998). The implications of chronic inflammation in the nose and subsequent nasal symptoms are not yet known, but need to be established (Wouters et al. 2002; Heldal et al. 2003).

A high frequency of gastrointestinal problems has been also reported for waste-collection workers, especially in the summer months (Poulsen et al. 1995; Ivens et al. 1997; Thorn et al. 1998; Ivens et al. 1999; Yang et al. 2001). An exposure-response relation was found among waste-collection workers between nausea and endotoxin exposure, and between diarrhea and exposure to both endotoxin and viable fungi (Ivens et al. 1999).

These studies focused on the prevalence rate of symptoms of which waste-collection workers complained. To the best of our knowledge, few studies have examined the association between respiratory health problems and occupational environmental characteristics. Occupational exposure characteristics including job title and work conditions could be closely related to the development of health problems.

The ultimate goal of this study was to investigate the prevalence rate of respiratory and irritation symptoms suffered by waste-collection workers and to examine if particular types of waste-collection work influence the development of respiratory and irritation symptoms.

II. Methods

1. Brief description of waste-handling activities

Over the entire process of waste collection and disposal, waste handlers may participate in a variety of activities that could differentially influence exposure to hazardous agents. Accordingly, we defined four activity groups based on the routing of wastes, different types of wastes, working conditions, and common practices in such a way that potential differences in bioaerosol exposure within a single activity group were minimized and the contrast among groups was maximized. Waste handling involves a number of different wastes, including source-separated biodegradable waste (*i.e.*, food waste from homes and restaurants), source-separated non-biodegradable waste (recyclable and reusable materials), and non-separated wastes. First, all wastes are collected from fixed sites and loaded into small vehicles or motorcycles equipped with small containers. Waste from multiple districts is then transferred from the smaller collection vehicles to larger transport equipment. During this activity, the agitation of large amounts of waste may facilitate exposure among loaders working at the back end of the truck. The waste is then transported, usually over long distances, to a material processing plant. During this stage, workers riding within the cab of the truck may be exposed to bioaerosols and vehicle exhaust materials generated during loading. Having reached the material processing plant, wastes are sorted in order to remove valuable recyclable or reusable materials. Biodegradable or food waste is sent for further processing into organic fertilizer or animal food, whereas non-separated waste (*e.g.*, leaves, vegetables, dead animals, feces, and other non-usable waste) is transported directly to a landfill or incinerator. This study focused on occupational health symptoms by occupational environment within the

residential area or material processing plant. We excluded potential exposure at disposal sites.

2. Study population

We randomly interviewed 1,055 waste-collection workers from 30 private companies and 16 municipal administrative offices. Waste-collection workers collecting and handling street and household wastes agreed to participate in the study. Workers who sort municipal and street wastes collected at the plant were also included. Waste-collection workers handling special forms of waste such as hospital, industrial, and construction wastes were excluded from the study.

Our study subjects were distributed across the entire country. The number of subjects by region was 158 (15.0%) in Seoul, followed by 109 (10.3%) in Busan, 7 (0.7%) in Gwangju, 446 (42.3%) in Gangwon-do, 181 (17.2%) in Gyeonggi-do, 10 (0.9%) in Gyeongsangbuk-do, 14 (1.3%) in Jeollanam-do, 22 (2.1%) in Jeollabuk-do, and 108 (10.2%) in Chungcheongbuk-do (Figure 1).

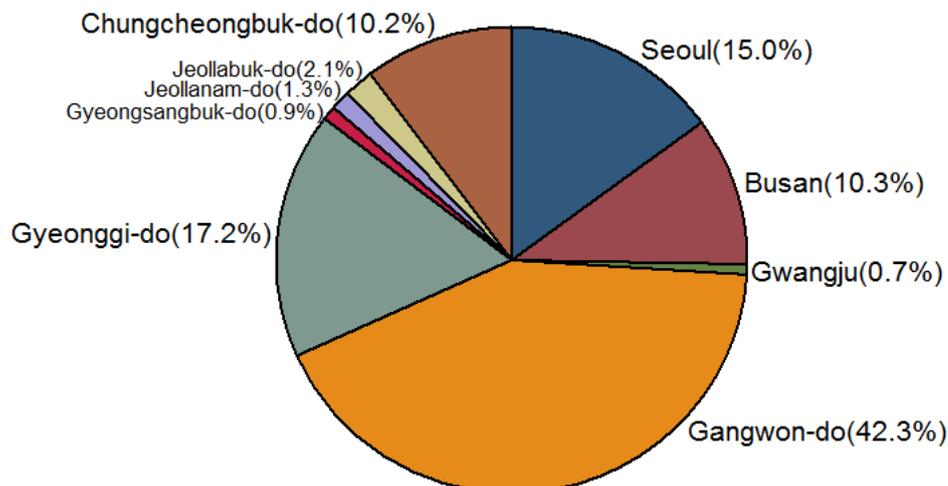


Figure 1. The distribution of waste-collection workers of study subjects by region in Korea.

3. Questionnaire

The questionnaire distributed to the 1,055 workers was completed by trained interviewers. Our study subjects were involved in street sweeping, collecting municipal household waste, and sorting waste collected for recycling. They were asked to report individual characteristics such as age, gender, and duration of employment, as well as their work and any respiratory and/or irritation symptoms. Demographic information, including age, gender, monthly wage and duration of employment were asked. The questionnaire was primarily designed to investigate respiratory symptoms (cough, dyspnea, wheeze) and irritation (eye, skin, nose) that they suffered. Subjects were asked to report if they had any persistent experience of these symptoms. The following questions were those substantially used to assess the prevalence rate of respiratory and irritation symptoms:

- Q1. How many times have you persistently had the following symptoms over the last one year?
 - cough, dyspnea, wheeze
 - eye, skin, nose irritation
- Q2. How many years have you worked in waste-collection?
- Q3. What kind of waste-collection job do you have?

We interviewed work environment characteristics such as average hours of work per day, shift of work, average days of work per week, type of company and work activity. All responses to questionnaires were collected through one of two means. We collected questionnaires completed by the study subjects themselves by directly visiting their

offices or via mail. Subjects completed the questionnaire with the consent of union officials. All questions subjects did not complete were treated as missing values

4. Statistical analysis

Descriptive statistics, and univariate and multiple logistic regression analyses were conducted using Stata Version 11.1 software (Stata Corp, LP, College Station, Texas, USA). The respiratory and irritation symptoms were classified into binary (existence or nonexistence). If the subjects answered 'more than three times' to the above question (How many times have you persistently had the following symptoms over the last one year?), we assessed that they have those symptoms. The prevalence of respiratory and irritation symptoms was dichotomized into YES and NO for each subject.

We selected several demographic and work environmental characteristics as independent variables that may be associated with the development of those health symptoms. They were gender, age, duration of employment, monthly wage, type of waste-collection work, type of company, average hours of work per day, shift of work, and average days of work per week. Age, duration of employment, and monthly wage among the independent variables were continuous variables. The others were characterized so that the number of categories was appropriately divided for further analysis. Type of waste-collection work was divided into three categories: 1=sweeping work (reference), 2=collection work, and 3=sorting work. Type of the company was divided between two categories: 1=non-sub-contracting company (reference), and 2=sub-contracting company. Average hours of work per day were divided on the basis of eight hours into two categories: 1=eight hours or under (reference), and 2=over eight hours. Shift was divided between two categories: 1=night (reference), and 2=day. Average days of work per week were divided on the basis of five days in two categories: 1= five or fewer working days (reference), and 2=over five working days. Gender was divided into two categories: 1=Male (reference), and 2=Female. Chi-square (χ^2) test was used to

examine the difference of categorical variables for demographic and work environmental characteristics, as well as respiratory and irritation symptoms. Only variables with p -values <0.25 were finally introduced into our multiple logistic regression analysis. Finally, logistic regression analysis was used to identify factors significantly associated with the respiratory and/or irritation symptoms, respectively. Logistic regression models were used to assess the association of waste-collection work types to the development of respiratory and irritation symptoms. Odd ratios (OR) with 95% confidence intervals (95% CI) were calculated.

III. Results

1. General characteristics of waste-collection workers

The distribution of study participants (n=1055) was evaluated by demographic and work environment characteristics (Table 1). Age (n=993) averaged 48.7 years old (SD: 7.5) with range of 26-68 years old. The average employment duration (n=1033) was 9.2 years (SD: 6.0, range: 0.1-28). The average monthly wage (n=966) was ₦2,190,800 (SD: ₦456,000, range: ₦800,000-₦3,300,000). The number of males and females was 986 (93.4%) and 46 (4.3%), respectively. The number of subjects working eight or under and over eight hours during a day were 153 (14.5%) and 696 (66.0%), respectively. This result indicated that the number of subjects working over eight hours a day was much higher than those working a regular eight hours or less. 33.4% (352) of study workers were found to be employed on a night shift, while the number of daytime shift workers was 703 (66.6%). The numbers of subjects working five days or less and over five days per week were 435 (41.2%) and 574 (54.4%), respectively. The number of subjects employed at non-sub-contracting companies was 647 (61.3%), and the number of subjects employed at sub-contracting companies was 403 (38.2%). The number of subjects sweeping was 400 (37.9%), the number of subjects collecting was 565 (53.6%), and the number of subjects sorting was 71 (6.7%), respectively.

Table 1. Categorical variables of study subjects

Variable	N (Total=1055)	%
Gender		
Male	986	93.4
Female	46	4.3
No response	28	2.3
Average hours of work per day		
≤ 8 hours	153	14.5
> 8 hours	696	66.0
No response	206	19.5
Shift of work		
Night	352	33.4
Day	703	66.6
No response	0	0
Average days of work per week		
≤ 5 days	435	41.2
> 5 days	574	54.4
No response	46	4.3
Types of company		
Non-sub-contracting	647	61.3
Sub-contracting	403	38.2
No response	5	0.5
Types of waste-collection work		
Sweeping	400	37.9
Collecting	565	53.6
Sorting	71	6.7
No response	14	1.3

2. Prevalence rates estimated by health symptoms

Table 2 indicates the prevalence rate of symptoms our subjects reported. The prevalence rates of cough, dyspnea, and wheeze were respectively 42.2% (n=445), 19.2% (n=203), and 13.0% (n=137). The prevalence rates of eye, skin, and nose irritation were 49.1% (n=518), 14.3% (n=151), and 28.6% (n=302), respectively. The prevalence rates of cough and eye irritation were found to be higher than the others.

Table 2. Prevalence rates of respective symptoms

	N, (Total n=1055)	Prevalence rate, (%)
Respiratory symptoms		
Cough	445	42.2
Dyspnea	203	19.2
Wheeze	137	13.0
Irritation symptoms		
Eye irritation	518	49.1
Skin irritation	151	14.3
Nose irritation	302	28.6

3. Prevalence rate of respiratory symptoms

The prevalence rate (PR) of respiratory symptoms was shown according to several demographic and occupational characteristics. The difference in symptoms among categorical variables was examined by chi-square (χ^2) test (Table 3). The association between the symptoms and age and work duration was also examined by t-test analysis (Table 5).

3.1. Cough

Monthly wage, type of company, average hours of work per day, type of waste-collection work, and average days of work per a week were found to be significant factors associated with cough ($p < 0.05$). Employment duration and shift of work were significant at $p < 0.25$. Non-sub-contracting company showed a significantly higher prevalence rate (PR: 46.8%) of cough than that (PR: 34.5%) of sub-contracting company. The prevalence rate (PR: 34.6%) of waste-collection workers working over eight hours per day was found to be significantly higher than that (PR: 45.8%) of workers working eight hours or less per day. The prevalence rate of sorting workers (PR: 50.7%) was significantly higher than that of others (collection PR: 36.3%, sweeping PR: 48.5%). Workers working over five days per a week showed a significantly higher prevalence rate (PR: 46.3%) than that (PR: 38.6%) of workers working five days or less.

3.2. Dyspnea

Duration of employment, monthly wage, type of company, average hours of work per day, and shift of work were significantly associated with dyspnea ($p < 0.05$). The prevalence rate (PR: 23.7%) of non-sub-contracting workers was significantly higher than

that of sub-contracting workers (PR: 12.4%). The prevalence rate of workers working over eight hours (PR: 21.8%) was found to be higher than that of workers working eight or fewer hours (PR: 10.5%). Day shift workers also showed a higher prevalence rate (PR: 21.6%) than that of night shift workers (PR: 14.5%).

3.3. Wheeze

No environmental or occupational factors were found to be significantly associated with wheeze at $p < 0.05$. Duration of employment, monthly wage, and type of company were significant at $p < 0.25$.

Table 3. Prevalence rate of respiratory symptoms by categorical variable

Variables	N	Cough		Dyspnea		Wheeze	
		Yes	No	Yes	No	Yes	No
Gender, n (%)							
Male	986	421 (42.7)	565 (57.3)	191 (19.4)	795 (80.6)	130 (13.2)	856 (86.8)
Female	46	17 (37.0)	29 (63.0)	8 (17.4)	38 (82.6)	6 (13.0)	40 (87.0)
Total	1032	438 (42.4)	594 (57.6)	199 (19.3)	833 (80.7)	136 (13.2)	896 (86.8)
p value		NS		NS		NS	
Type of company, n (%)							
Non-sub-contracting	647	303 (46.8)	344 (53.2)	153 (23.7)	494 (76.4)	94 (14.5)	553 (85.5)
Sub-contracting	403	139 (34.5)	264 (65.5)	50 (12.4)	353 (87.6)	43 (10.7)	360 (89.3)
Total	1050	442 (42.1)	608 (57.9)	203 (19.3)	847 (80.7)	137 (13.1)	913 (86.9)
p value		<0.0001*		p<0.0001*		0.071 [†]	
Average hours of work per day, n (%)							
≤ 8 hours	153	53 (34.6)	100 (65.4)	16 (10.5)	137 (89.5)	20 (13.1)	133 (86.9)
> 8 hours	696	319 (45.8)	377 (54.2)	152 (21.8)	544 (78.2)	95 (13.6)	601 (86.4)
Total	849	372 (43.8)	477 (56.2)	168 (19.8)	681 (80.2)	115 (13.5)	734 (86.5)
p value		0.012*		<0.0001*		NS	
Type of waste-collection work, n (%)							
Sweeping	400	194 (48.5)	206 (51.5)	85 (21.2)	315 (78.8)	57 (14.3)	343 (85.6)
Collection	565	205 (36.3)	360 (63.7)	101 (17.9)	464 (82.2)	67 (11.9)	498 (88.1)
Sorting	71	36 (50.7)	35 (49.3)	16 (22.5)	55 (77.5)	10 (14.1)	61 (85.9)
Total	1036	435 (42.0)	601 (58.0)	202 (19.5)	834 (80.5)	134 (12.9)	902 (87.1)
p value		<0.0001*		NS		NS	

Shift of work, n (%)							
Night	352	135 (38.4)	217 (61.7)	51 (14.5)	301 (85.5)	48(13.6)	304 (86.4)
Day	703	310 (44.1)	393 (55.9)	152 (21.6)	551 (78.4)	89 (12.7)	614 (87.3)
Total	1055	445 (42.2)	610 (57.8)	203 (19.2)	852 (80.8)	137 (13.0)	918 (87.0)
p value		0.075 [†]		0.006 [*]		NS	
Average days of work per week, n (%)							
≤ 5 days	435	168 (38.6)	267 (61.4)	87 (20.0)	348 (80.0)	57 (13.1)	378 (86.9)
> 5 days	574	266 (46.3)	308 (53.7)	114 (19.9)	460 (80.1)	77 (13.4)	497 (86.6)
Total	1009	434 (43.0)	575 (57.0)	201 (19.9)	808 (80.1)	134 (13.3)	875 (86.7)
p value		0.014 [*]		NS		NS	

P value: Chi-square test

NS=no significance over p=0.25

**: p<0.05*

†: p values between 0.05 and 0.25

4. Prevalence rate of irritation symptoms

The prevalence rate (PR) of irritation symptoms was shown for several demographic and occupational characteristics. The difference in symptoms was examined by Chi-square (χ^2) test (Table 4). The association between the symptoms and age and duration of employment was also examined by t-test analysis (Table 5).

4.1. Eye irritation

Gender and type of waste-collection work were significantly associated with eye irritation ($p < 0.05$). Monthly wage, type of company, and average hours of work per day were weakly significant at $p < 0.25$. Female workers showed a significantly higher prevalence rate (PR: 73.9%) than did male workers (PR: 48.1%). Sorting workers also showed a higher prevalence rate (PR: 66.2%) than that of others (collection PR: 47.3%, sweeping PR: 49.5%).

4.2. Skin irritation

Duration of employment, monthly wage, type of company, average hours of work per day, type of waste-collection work, and shift of work were significantly associated with skin irritation ($p < 0.05$). Age and gender were weakly significant at $p < 0.25$. The prevalence rate of sub-contracting workers (PR: 18.4%) was found to be higher than that of non-sub-contracting workers (PR: 11.9%). The prevalence rate of workers working eight or fewer hours (PR: 20.9%) was also found to be higher than that of workers working over eight hours (PR: 12.8%). Sorting workers showed a higher prevalence rate (PR: 22.5%) than that of others (collection workers PR: 15.9%, sweeping workers PR:

10.8%). Night shift workers showed a higher prevalence rate (PR: 17.9%) than that of day shift workers (PR: 12.5%).

4.3. Nose irritation

Age, duration of employment, shift of work, and average days of work per week were significantly associated with nose irritation. Monthly wage, gender, type of company, and average hours of work per day were significant at $p < 0.25$. Night shift workers showed a higher prevalence rate (PR: 33.8%) than that of day shift workers (PR: 26.0%). The prevalence rate of workers working over five days per week (PR: 32.1%) was found to be higher than that of workers working five days or less (PR: 25.5%).

Table 4. Prevalence rate of irritation symptoms by categorical variable

Variables	N	Eye irritation		Skin irritation		Nose irritation	
		Yes	No	Yes	No	Yes	No
Gender, n (%)							
Male	986	474 (48.1)	512 (51.9)	139 (14.1)	847 (85.9)	280 (28.4)	706 (71.6)
Female	46	34 (73.9)	12 (26.1)	11 (23.9)	35 (23.9)	17 (37.0)	29 (63.0)
Total	1032	508 (49.2)	524 (50.8)	150 (14.5)	882 (85.5)	297 (28.8)	735 (71.2)
p value		0.001*		0.065 [†]		0.210 [†]	
Type of company, n (%)							
Non-sub-contracting	647	334 (51.6)	313 (48.4)	77 (11.9)	570 (88.1)	175 (27.1)	472 (72.9)
Sub-contracting	403	184 (45.7)	219 (54.3)	74 (18.4)	329 (81.6)	127 (31.5)	276 (68.5)
Total	1050	518 (49.3)	532 (50.7)	151 (14.4)	899 (85.6)	302 (28.8)	748 (71.2)
p value		0.060 [†]		0.004*		0.120 [†]	
Average hours of work day, n (%)							
≤ 8 hours	153	70 (45.8)	83 (54.3)	32 (20.9)	121 (79.1)	53 (34.6)	100 (65.4)
> 8 hours	696	371 (53.3)	325 (46.7)	89 (12.8)	607 (87.2)	205 (29.5)	491 (70.5)
Total	849	441 (51.9)	408 (48.1)	121 (14.3)	728 (85.7)	258 (30.4)	591 (69.6)
p value		0.090 [†]		0.009*		0.207 [†]	
Type of waste-collection work, n (%)							
Sweeping	400	198 (49.5)	202 (50.5)	43 (10.8)	357 (89.2)	116 (29.0)	284 (71.0)
Collection	565	267 (47.3)	298 (52.7)	90 (15.9)	475 (84.1)	160 (28.3)	405 (71.7)
Sorting	71	47 (66.2)	24 (33.8)	16 (22.5)	55 (77.5)	23 (32.4)	48 (67.6)
Total	1036	465 (44.9)	524 (55.1)	149 (14.4)	887 (85.6)	299 (28.9)	737 (71.1)
p value		0.011*		0.010*		NS	

Shift of work, n (%)							
Night	352	166 (47.2)	186 (52.8)	63 (17.9)	289 (82.1)	119 (33.8)	233 (66.2)
Day	703	352 (50.1)	351 (49.9)	88 (12.5)	615 (87.5)	183 (26.0)	520 (74.0)
Total	1055	518 (49.1)	537 (50.9)	151 (14.3)	904 (85.7)	302 (28.6)	753 (71.4)
p value		NS		0.019*		0.008*	
Average days of work per week, n (%)							
≤ 5 days	435	220 (50.6)	215 (49.4)	65 (14.9)	370 (85.1)	111 (25.5)	324 (74.5)
> 5 days	574	285 (49.7)	289 (50.4)	80 (13.9)	494 (86.1)	184 (32.1)	390 (67.9)
Total	1009	505 (50.1)	504 (49.9)	145 (14.4)	864 (85.6)	295 (29.2)	714 (70.8)
p value		NS		NS		0.024*	

P value: Chi-square test

NS: no significance over $p=0.25$

**: $p < 0.05$*

†: p values between 0.05 and 0.25

Table 5. Average levels of continuous variables by respiratory and irritation symptom

Symptoms	Age (n=993)	Duration of employment (n=1033)	Wage (n=966)
	Mean±SD	Mean±SD	Mean±SD
Respiratory			
Cough	48.5±7.6	9.6±6.1	2,250,000±450,000
<i>p-value</i>	NS	0.075 [†]	0.001
Dyspnea	48.9±7.9	10.2±6.1	2,340,000±460,000
<i>p-value</i>	NS	0.013	<0.0001
Wheeze	48.7±7.7	9.8±6.1	2,250,000±440,000
<i>p-value</i>	NS	0.203 [†]	0.156 [†]
Irritation			
Eye irritation	48.5±7.5	9.3±6.0	2,220,000±470,000
<i>p-value</i>	NS	NS	0.071 [†]
Skin irritation	47.5±8.2	8.3±5.3	2,060,000±499,000
<i>p-value</i>	0.058 [†]	0.032	0.001
Nose irritation	47.5±7.6	8.3±6.0	2,160,000±478,000
<i>p-value</i>	0.001	0.002	0.098 [†]

Age unit : years, Duration of employment unit : years, Wage unit : won

p-value : *t-test*

NS: No significance over $p=0.25$

[†]: *p value* between 0.05 and 0.25

Table 6. Summary of the effect of demographic and occupational factors on the respiratory and irritation symptoms of waste collectors

Variables	Respiratory symptoms			Irritation symptoms		
	Cough	Dyspnea	Wheeze	Eye	Skin	Nose
Age	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	**	****
Duration of employment	**	***	*	<i>NS</i>	***	****
Monthly wage	****	****	*	**	****	**
Gender	<i>NS</i>	<i>NS</i>	<i>NS</i>	****	**	*
Type of company	****	****	**	**	***	*
Average hours of work per day	***	****	<i>NS</i>	**	***	*
Type of waste-collection work	****	<i>NS</i>	<i>NS</i>	***	***	<i>NS</i>
Shift of work	**	***	<i>NS</i>	<i>NS</i>	***	****
Average days of work per week	***	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	***

*: $p < 0.25$, **: $p < 0.1$, ***: $p < 0.05$, ****: $p < 0.01$
NS: No significance

5. Effect of waste-collection work on respiratory and irritation symptoms

We examined the effect of waste-collection work on the prevalence of respiratory and irritation symptoms among waste-collection workers using logistic regression analysis. Results of the logistic regression analysis to predict factors causing each respiratory and irritation symptom are shown in Table 7 and Table 8, respectively. Age and gender were adjusted for this model.

5.1. Cough

We summarized waste-collection work environmental factors affecting the development of the symptom of cough among waste-collection workers (Table 5). The logistic regression model found type of employment, average hours of work per day, type of waste-collection work, shift of work, and average days of work per week were significantly associated with cough. Sweeping (reference) waste-collection work showed significantly lower risk than that of other waste collection workers (OR: 0.53, 95% CI: 0.36-0.77). Waste-collection night-shift work (reference) demonstrated lower risk than did day-shift waste-collection work (OR: 0.57, 95% CI: 0.37-0.89). The risk of cough for waste-collection workers working over five days per week (OR: 1.62, 95% CI: 1.18-2.23) was found to be significantly higher than that of workers working five days or less (reference).

5.2. Dyspnea

Work environment and occupational factors were not associated with any characteristics. However average hours of work per day (OR: 0.98, 95% CI: 3.67) was found to be significant at $p < 0.10$

5.3. Wheeze

Waste-collection occupational factors were not associated with the development of wheeze.

5.4. Eye irritation

The type of waste-collection work was found to be significant for the development of eye irritation. The risk for this symptom among those engaging in sorting work was 2.18 times (OR: 2.18, 95% CI: 1.16-4.09) higher than that of those occupied in sweeping (reference). A difference in eye irritation between types of company (OR: 0.69, 95% CI: 0.47-1.01) was found at the $p < 0.10$ significant level.

5.5. Skin irritation

No waste-collection occupational factors were associated with the development of wheeze.

5.6. Nose irritation

The development of nose irritation by day shift workers (OR: 0.44, 95% CI: 0.27-0.72) was found to be significantly lower than that of night workers (reference). Waste-collection workers showed almost two times higher nose irritation symptoms (OR: 1.90, 95% CI: 1.32-2.72) than did workers at five days or less (reference).

Table 7. Associations between work environment characteristics and respiratory symptoms

Characteristics	Cough		Dyspnea		Wheeze	
	OR	95% CI	OR	95% CI	OR	95% CI
Type of waste-collection work						
Sweeping (reference)						
Collection	0.53*	0.36-0.77		NS		NS
Sorting		NS		NS		NS
Average hours of work per day						
< 8 hours (reference)						
≥ 8 hours		NS	1.90	0.98-3.67		NS
Shift of work						
Night (reference)						
Day	0.57*	0.37-0.89		NS		NS
Average days of work per week						
≤ 5 days (reference)						
> 5 days	1.62*	1.18-2.23		NS		NS
Type of company						
Non-sub-contracting (reference)						
Sub-contracting		NS		NS		NS
Adjusted R²(p)	0.03 (<0.0001)		0.03 (0.004)		<0.01 (0.542)	

OR and 95% Confidence interval (CI) were adjusted for age, gender, wage, and duration of employment

NS=no significance over p=0.1

*: p<0.05

Table 8. Associations between work environment characteristics and irritation symptoms

Characteristics	Eye irritation		Skin irritation		Nose irritation	
	OR	95% CI	OR	95% CI	OR	95% CI
Type of waste-collecting work						
Sweeping (reference)						
Collection	1.37	0.95-1.97	NS		0.66	0.41-1.05
Sorting	2.18*	1.16-4.09	NS			NS
Average hours of work per day						
< 8 hours (reference)						
≥ 8 hours		NS	NS			NS
Shift of work						
Night (reference)						
Day		NS	NS		0.44*	0.27-0.72
Average days of work per week						
≤ 5 days (reference)						
> 5 days		NS	NS		1.90*	1.32-2.72
Type of company						
Non-sub-contracting (reference)						
Sub-contracting	0.69	0.47-1.01	NS			NS
Adjusted-R² (p)	0.02 (0.002)		0.04 (0.001)		0.04 (<0.001)	

OR and 95% Confidence interval (CI) were adjusted for age, gender, wage, and duration of employment

NS=no significance over $p=0.1$

*: $p<0.05$

IV. Discussion

The major purposes of this study were to investigate the prevalence rates of respiratory and irritation symptoms reported by waste-collection workers and to examine whether these symptoms were influenced by a range of occupational waste-collection work characteristics, such as type of waste-collection work, type of company, duration of employment, monthly wage, average days of work per week and shift of work. To date, there have been studies reporting the prevalence of respiratory and irritation symptoms of waste-collection workers in several countries (Sigsgaard et al. 1994; Poulsen et al. 1995; Thorn et al. 1998). In two relatively small epidemiologic studies from Switzerland and Croatia, certain acute pulmonary disorders and chronic bronchitis were found in excess among waste collectors compared to other workers (Rufener et al. 1976; Mustajbegovic et al. 1994). Mustajbegovic (1994) performed an assessment of pulmonary function using FVC and FEV1. The pulmonary function of sanitation workers (n=81) exposed for more than ten years was reduced significantly compared to non-exposed sanitation workers (n=65). In general, most waste-collection workers handle different types of waste, use different collection units, and change job function during the workday. These unique work characteristics of waste-collection workers make it difficult to identify occupational factors causing occupational diseases and symptoms, including respiratory and irritation health problems.

To the best of our knowledge, this is the first study to associate several of the characteristics of waste-collection work and the development of respiratory and irritation symptoms. In South Korea, no study has reported the prevalence rate of health problems reported by waste-collection workers, although Park et al. did study airborne

microorganisms and endotoxins (Park et al. 2011; Park et al. 2013a) and particulate matter generated during municipal waste-collection work (Park et al. 2013b)

In other countries, the prevalence rate of cough was reported to be 27.8% for Danish waste collectors (n=1,515) (Hansen et al. 1997), and 17.3% for household waste collectors (n=533) in Taiwan (Yang et al. 2001). Hansen and Yang reported that cough symptoms showed a high prevalence rate compared to the other symptoms mentioned. This result was far lower than the prevalence rate of cough symptoms in our study (PR: 42.2%). This comparison indicates that cough is the most common health problem waste-collection workers suffer frequently. The prevalence rate of wheeze was reported to be 23.2% for Danish waste collectors and 15.4% for Taiwanese waste collectors. These prevalence rates were slightly higher than the prevalence rate of wheeze (PR: 13.0%) as evaluated in this study. The prevalence rate of eye, skin, and nose irritation symptoms reported among Taiwanese waste-collection workers was 5.8%, 16.1%, and 32.3%, respectively. Those results for skin and nose irritation symptoms were similar to our study result (Table 2), but the eye irritation prevalence rate in those results was remarkably lower than ours. This comparison indicates that the prevalence rates of irritation symptoms generally tend to be similar, with the exception of eye irritation. Hansen and Yang concluded that major causes of respiratory and irritation symptoms among waste-collection workers are the vehicle exhaust, aerosols containing microorganisms, and air pollutants to which waste-collection workers can be exposed.

This study found occupational factors affecting the development of respiratory and irritation symptoms. The logistic regression model found that work environmental characteristics of the type of waste-collection work, shift work, and average working days were significantly associated with cough (Table 7).

Sweeping waste-collection activity or work was found to show significantly higher cough symptoms (Table 7). Sweeping workers are generally performing tasks on the streets during the bulk of their work time. They can be exposed to significant levels of traffic-related air pollutants related to respiratory symptoms, including elemental carbon (EC), organic carbon (OC), fine or coarse particulate matter (PM), poly aromatic hydrocarbons (PAHs), carbon dioxide (CO₂), carbon monoxide (CO), nitrogen oxide (NO_x), and sulfur oxide (SO_x) (Ono-Ogasawara et al. 2004; Lee et al. 2007). In the urban atmosphere, the level of air pollutants occurring during the day may gradually increase until midnight. Therefore, waste-collection workers working longer than the five weekdays could be consistently exposed to air pollutants during the weekend as well as the weekdays, which may pose a higher health risk than that experienced by workers working from Monday through Friday.

We also found that the sorting work type of waste-collection work (OR: 2.18, 95% CI: 1.16-4.09) shows a significantly higher risk of symptoms of eye irritation than that of sweeping work. The risk of eye irritation for sorting workers was found to be two times higher than that of sweeping workers. Park (2013) reported that waste-collection workers who sort waste to remove valuable recyclable or reusable materials were exposed to a high level of inhalable PM. The high level of coarse PMs such as inhalable PM, respirable particulate matter (RPM), and PM₁₀ (particle size < 10um) levels were recorded during the sorting of municipal and household wastes. This characteristic may contribute to increased exposure to coarse particulate matter. Park's study also showed that coarse particles monitored during waste sorting activities were significantly higher than those found during other activities (Park et al. 2013). This result indicates that the high level of coarse PM exposure may sufficiently affect the symptom of eye irritation.

Consequently, the high prevalence rate of eye irritation among workers sorting household wastes may be associated with high levels of IPM, RPM and PM₁₀

We also found that shift of work and average work days per week were significantly associated with nose irritation. Park (2012) concluded that airborne levels of RPM, PM₁₀, IPM, and bioaerosol monitored during the night (20:00-04:00) were higher than those recorded during the day (04:00-14:00) (Park et al. 2013a; Park et al. 2013b). This result indicates that workers working during the night may be exposed to high levels of coarse PM and bioaerosol, which may result in a risk of the development of nose irritation.

Studies conducted in Japan and the Netherlands concluded that irritation symptoms among waste-collection workers may also be associated with automobile exhaust, including diesel exhaust particles (Ishizaki et al. 1987; Scheepers et al. 1992a; Scheepers et al. 1992b). Irritation symptom can be developed by means of irritation of the mucous membranes of the nose.

Hansen (1997) conducted a cross-sectional study to assess the prevalence proportion rate (PPR) of 1,515 (76%) male Danish waste collectors using a questionnaire on work conditions and health problems. They found significantly increased PPRs for cough (PPR=1.3), itching nose (PPR=1.9), wheeze (PPR=1.4), and chronic bronchitis (PPR=2.3). No significant differences in prevalence rate were observed between different working conditions among the waste collectors. The increased PPR of bronchitis was found to be significantly associated with increasing estimated concentrations of all selected microbial parameters. They concluded that waste-collection workers have a moderate increase in several respiratory problems, believing that the occupational exposure of waste collectors to vehicle exhaust, and particularly inhalation of high concentrations of bioaerosol, play an important role in the development of respiratory

problems. Therefore, the causes of the development of respiratory health problems are likely to be exposure to vehicle exhaust and aerosols containing microorganisms (Hansen et al. 1997). As mentioned above, our study results indicate that sweeping workers might be assumed to be exposed to higher microorganism or vehicle exhaust levels than are collection workers. On the other hand, we could confirm that the microorganism exposure levels of worker handling street wastes are much less than those of workers handling household wastes according another study (Park et al, 2013). Therefore, we can estimate that ambient harmful substances like diesel exhaust particles (DEP) in the atmosphere have more influence over our results than do microorganisms.

Nielsen (1995) compared health effects between street cleaners (n=116) and cemetery workers (n=115) exposed to air pollution in Copenhagen. This questionnaire-based study found that street cleaners had a significantly higher prevalence rate of respiratory symptoms than did cemetery workers. The prevalence rate of respiratory symptoms showed chronic bronchitis (OR: 2.5, 95% CI: 1.2-5.1), asthma (OR: 2.3, 95% CI: 1.0-5.1), cough (OR: 1.9, 95% CI: 0.97-3.7), and others (OR: 1.8-7.9, 95% CI: 1.0-28.2). They concluded that traffic-related air pollution is an occupational health hazard for workers who perform physical labor in proximity to traffic (Nielsen et al. 1995). Given that the previous study results were comprehensively reviewed, occupational exposure of sweeping workers to air pollution can be estimated to have much greater influence than that of microorganism exposure.

The level of exposure to organic dust among waste-collection workers is normally lower than that of workers engaged in occupations such as agriculture, textile mills, or sewage treatment plants, who are among the occupational groups most frequently reported to experience respiratory problems (Rylander R. 1985; Sigsgaard T. 1992; Poulsen et al.

1995). We only assessed respiratory and irritation symptoms from three work types including sweeping, collection, and sorting. Workers engaged in agriculture, textile mills, or sewage treatment plants might be likely to be exposed to higher risks than are our subjects and also might complain of the severity of symptoms such as respiratory symptoms and irritation.

V. Conclusions

We interviewed 1,055 waste-collection workers employed in municipal administrative offices or private agencies using questionnaire. Our study subjects were involved in street sweeping, collecting municipal household waste, and sorting waste collected for recycling. They were asked to report individual characteristics such as age, gender, duration of employment, monthly wage, average hours of work per day, shift of work, average days of work per week, type of company, and type of waste-collection work, which may be associated with the development of respiratory and irritation symptoms.

The major goals of this study are to examine the association between respiratory or irritation symptoms and jobs or work environment and to identify significant occupational factors related to health symptoms of waste-collection workers. Key findings obtained from this investigation are as follows.

1. The distribution of the study participants was evaluated according to demographic and work environment characteristics. Age (n=993) averaged 48.7 years old (SD: 7.5) with a range of 26-68 years old. The average of employment duration (n=1033) was 9.2 years (SD: 6.0) with a range of 0.1-28 years. The average monthly wage (n=966) was ₩2,190,800 (SD: ₩456,000) with a range of ₩800,000-₩3,300,000. The number of males and females was 986 (93.4%) and 46 (4.3%), respectively. The number of subjects working less than and more than eight hours per day were 153 (14.5%) and 696 (66.0%), respectively. 33.4% (352) of the workers studied were found to work a night shift, while the number of day-shift workers was 703 (66.6%). The numbers of subjects working five days per week and the number of those working more were 435 (41.2%) and 574 (54.4%), respectively. The number of

subjects employed at non-sub-contracting companies was 647 (61.3%), and the number of subjects employed at sub-contracting companies was 403 (38.2%). The number of subjects employed in sweeping was 400 (37.9%), the number of subjects in collection was 565 (53.6%), and the number of subjects in sorting was 71 (6.7%)

2. The prevalence rates of cough, dyspnea, and wheeze were respectively 42.2% (n=445), 19.2% (n=203), and 13.0% (n=137). The prevalence rates of eye, skin, and nose irritation were 49.1% (n=518), 14.3% (n=151), and 28.6% (n=302), respectively.
3. Chi-square (χ^2) test found that monthly wage, type of company, average hours of work per day, type of waste-collection work, and average days of work per week were significant factors associated with cough. Duration of employment, monthly wage, type of company, average hours of work per day, and shift of work were significantly associated with dyspnea symptom. No environmental or occupational factors were found to be significantly associated with wheeze. Gender and type of waste-collection work were significantly associated with eye irritation. Duration of employment, wage, type of company, average hours of work per day, type of waste-collection work, and shift of work were significantly associated with skin irritation. Age, duration of employment, shift of work, and average days of work per week were significantly associated with nose irritation.
4. Logistic regression analysis found that sweeping (reference) waste-collection work showed a significantly lower cough symptom risk than that of waste collection work (OR: 0.53, 95% CI: 0.36-0.77). Waste-collection night-shift work (reference) showed a lower cough symptom risk than did daytime waste-collection work (OR: 0.57, 95% CI: 0.37-0.89). The risk of cough for waste-collection workers working

over five days per week (OR: 1.62, 95% CI: 1.18-2.23) was found to be significantly higher than that of those working five or fewer days per week (reference). For eye irritation, the risk for this symptom in sorting work was 2.18 times (OR: 2.18, 95% CI: 1.16-4.09) higher than that in sweeping (reference). For nose irritation, the development of nose irritation among daytime workers (OR: 0.44, 95% CI: 0.27-0.72) was found to be significantly lower than among night-shift workers (reference). Waste-collection workers working over five days per week showed almost two times higher nose irritation symptoms (OR: 1.90, 95% CI: 1.32-2.72) than did those working five days or less (reference). For the symptom dyspnea, wheeze and skin irritation, work environment and occupational factors were not associated with any characteristics.

5. The logistic regression model found that work environmental characteristics of the type of waste-collection work, shift work, and average working days were significantly associated with cough. Sweeping waste-collection activity or work was found to show significantly higher cough symptoms. Sweeping workers are generally performing tasks on the streets during the bulk of their work time. They can be exposed to significant levels of traffic-related air pollutants related to respiratory symptoms. Occupational exposure of sweeping workers to air pollution can be estimated to have much greater influence than that of microorganism exposure.
6. The risk of eye irritation for sorting workers was found to be two times higher than that of sweeping workers. The high prevalence rate of eye irritation among workers sorting household wastes may be associated with high levels of IPM, RPM and PM₁₀.

We also found that shift of work and average work days per week were significantly associated with nose irritation.

Most waste-collection workers handle different types of waste, use different collection units, and change job function during the workday. These unique work characteristics of waste-collection workers make it difficult to identify occupational factors causing occupational diseases and symptoms, including respiratory and irritation health problems. This study results will be used to identify occupational and environmental factors influencing the development of respiratory and irritation symptoms.

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ABSTRACT (IN KOREAN)

환경미화원의 호흡기 및 자극 증상에 영향을 미치는

직무 요인 조사 연구

<지도교수 노재훈>

연세대학교 보건대학원 산업보건전공

이경민

서론: 환경미화원들은 쓰레기 수집, 분류 및 거리청소와 같은 다양한 업무를 수행하는데, 업무 형태에 따라 유해물질에 노출되고, 장기간 지속 시 심각한 호흡기 및 자극 증상을 일으킬 수 있다. 따라서 이 연구의 목적은 환경미화원이 느끼는 호흡기 및 자극 증상의 유병률을 조사하고, 직업적 요인들이 호흡기 및 자극 증상과 연관성이 있는지 평가하고자 한다.

방법: 본 연구는 환경 미화 관련 30 개 협력 업체와 16 개 지방자치기관 소속으로 쓰레기 수집, 분류, 및 거리 청소 업무를 담당하는 1,055 명의 환경미화원들을 대상으로 설문 조사를 실시하였다. 인구사회학적 요인은 연령, 성별, 경력, 그리고 임금 이었고, 업무환경적 요인은 일일 평균 업무시간,

주중근무일수, 교대근무, 회사형태, 그리고 직무형태 이었다. 업무환경적 요인들은 더 나은 통계 분석을 위하여 범주형 변수로 적절하게 구분하였다. 환경미화원들이 주로 호소하는 증상들 중 호흡기 및 자극 증상에 대해 설문 조사하였다. 호흡기 증상들은 기침(cough), 호흡곤란(dyspnea), 그리고 숨가쁨(wheeze) 이었고, 자극 증상들은 눈 자극(eye irritation), 피부 자극(skin irritation), 코 자극(nose irritation) 이었다. 카이제곱 통계분석(Chi-square test, χ^2)을 이용하여 인구사회학적, 업무환경적 요인들과 호흡기 및 자극 증상들에 대한 통계학적 차이를 보았다. 그리고 p 값이 0.25 보다 작은 변수들을 이용하여, 다중 로지스틱 회귀분석(Multiple logistic regression)을 실시하였고, 교차비(Odds ratio, OR) 및 교차비의 95% 신뢰구간(95% Confidence Interval, 95% CI)을 구하였다.

결과: 본 연구 대상자들의 평균 연령은 48.7 세(n=993, SD: 7.5 세)이고, 범위는 26-68 세이었다. 평균 경력은 9.2 년(n=1,033, SD: 6.0 년)이었고, 범위는 1 개월에서 28 년까지 넓었다. 평균 임금은 219 만원(n=966, SD: 456 만원)이었고, 범위는 80 만원에서 330 만원까지였다. 성별에서 남성은 986 명(93.4%), 여성은 46 명(4.3%)이었다. 일일 평균 근무시간에서 8 시간 이하 근무자는 153 명(14.5%), 8 시간 초과 근무자는 696 명(66.0%)이었다. 교대근무에서 야간 근무자는 352 명(33.4%)이고, 주간 근무자는 703 명(66.6%)이었다. 주중근무일수에서 5 일 이하 근무자는 435 명(41.2%)이고, 5 일 이상 근무자는 574 명(54.4%)이었다. 직영 근로자는 647 명(61.3%)이고, 비직영 근로자는 403 명(38.2%)이었다. 직무형태에서

각각 거리청소 근로자는 400 명(37.9%)이었고, 생활쓰레기 수집 근로자는 565 명(53.6%), 쓰레기 분류 작업 근로자는 71 명(6.7%)이었다. 호흡기 및 자극 증상에 대한 유병률을 구하였다. 호흡기 증상 중 기침, 호흡곤란, 그리고 숨 가쁨 증상은 각각 42.2%(n=445), 19.2%(n=203), 13.0%(n=137)이었다. 그리고 자극 증상 중 눈, 피부, 그리고 코 자극은 각각 49.1%(n=518), 14.3%(n=151), 그리고 28.6%(n=302)이었다. 카이제곱 통계분석을 이용하여 업무환경적 요인들과 호흡기 및 자극 증상들에 대한 통계학적 차이를 보았다. 기침 증상은 임금, 경력, 일일 평균 근무시간, 직무, 그리고 주중근무일수 요인들에 따라 유의한 차이가 있었다($p < 0.05$). 호흡곤란 증상은 경력, 임금, 회사형태, 일일 평균 근무시간, 그리고 교대근무 요인들에 따라 유의한 차이가 있었다($p < 0.05$). 숨 가쁨 증상은 업무환경적 요인에 따른 통계학적 차이가 없었다. 눈 자극 증상은 성별, 직무에 따라 유의한 차이가 있었다($p < 0.05$). 피부 자극 증상은 경력, 임금, 회사형태, 일일 평균 근무시간, 직무, 그리고 교대근무 요인들에 따라 유의한 차이가 있었다($p < 0.05$). 코 자극 증상은 연령, 경력, 교대근무, 그리고 주중근무일수 요인들에 따라 유의한 차이가 있었다($p < 0.05$). 다중 로지스틱 회귀분석을 이용하여, 환경미화원들의 호흡기 및 자극 증상들에 대한 직업적 요인들이 미치는 영향을 평가하였다. 기침 증상에서 거리 청소 근로자는 생활쓰레기 수거 근로자 보다 상당히 낮은 위험성을 보였다(OR: 0.53, 95% CI: 0.36-0.77). 야간 근로자는 주간 근로자 보다 덜 위험하였다(OR: 0.57, 95% CI: 0.37-0.89). 주중 5 일 초과 근로자의 기침 증상은 5 일 이하 근로자 보다 상당히

낮게 보였다(OR: 1.62, 95% CI: 1.18-2.23). 호흡곤란 및 숨 가쁨 증상에서는 직업적 요인들과 통계학적 연관성이 없었다. 눈 자극 증상에서 생활 쓰레기 분류 근로자의 위험은 거리 청소 근로자 보다 2.18 배 높게 보였다(OR: 2.18, 95% CI: 1.16-4.09). 피부 자극 증상은 직업적 요인들과 통계학적 연관성이 없었다. 주간 근로자의 코 자극 증상 위험은 야간 근로자 보다 상당히 낮게 보였다(OR: 0.44, 95% CI: 0.27-0.72). 그리고 5 일 초과 근로자의 코 자극 증상 위험은 5 일 이하 근로자 보다 상당히 낮게 보였다(OR: 1.90, 95% CI: 1.32-2.72).

결론: 본 연구는 환경미화원의 직무 및 업무환경과 호흡기 및 자극 증상과의 연관성 조사뿐만 아니라 향후 환경미화원들의 호흡기 및 자극 증상 유병률에 대한 기초 자료를 제공하는데 의의가 있었다. 호흡기 및 자극 증상 유병률은 환경미화원의 직무 및 업무환경과 유의한 영향이 있었다. 환경미화원은 업무 환경에 따라 호흡기 및 자극 증상과 관련된 유해한 물질들의 노출 수준이 각각 다르다. 따라서, 호흡기 및 자극 증상 유병률을 줄이기 위하여, 업무 환경과 관련된 요인들은 고려되어야 하며, 지방 자치 기관 및 민간 업체들은 관련된 업무 환경들을 관리할 필요가 있는 것으로 판단된다.

핵심어: 환경미화원, 호흡기 증상, 자극 증상, 생활쓰레기, 직무, 업무환경요인