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Adverse Health Effects among Household Waste Collectors in Taiwan

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Household waste collectors (HWCs) are potentially exposed to a variety of bioaerosols and toxic materials. Collection of household waste is also a job which requires repeated heavy physical activity such as lifting, carrying, pulling, and pushing. The object of this study was to assess whether there is an excess of adverse health outcomes among HWCs. The subjects were all current employees of the Household Waste Collection Department in the County of Kaohsiung, Taiwan. The survey questionnaire was completed by 533 HWCs and 320 office workers. Our data indicate that household waste collection presents a risk for the development of chronic respiratory symptoms (cough, phlegm, wheezing, and chronic bronchitis), musculoskeletal symptoms (low back pain and elbow/wrist pain), and injuries caused by sharp objects.

Key Words: **household waste collectors; musculoskeletal complaints; respiratory symptoms; occupational epidemiology.**

INTRODUCTION

Collection of household waste is hard work and can be dangerous. It involves working on a vehicle that moves through traffic during all seasons (Ivens *et al*., 1998). As handling of waste may cause microorganisms and dust to become aerosolized, household waste collectors (HWCs) also are at risk of being exposed to bioaerosols generated from the waste (Nielsen *et al*., 1997). Moreover, the efficiency of household waste collection is assumed to depend on work rate and rhythm. These factors make injuries common in HWCs (Poulsen *et al*., 1995; Ivens *et al*., 1998).

Only a few studies have investigated the adverse health effects among HWCs. Ivens *et al*. (1997) found that waste collectors were more likely to report gastrointestinal symptoms (nausea and diarrhea) than municipal workers. The investigation of Thorn *et al*. (1998) suggested that certain dusts from household waste may cause airway inflammation and that the effects were associated with higher (1→3)-B-D-glucan levels. Ivens *et al*. (1998) and Robazzi *et al*. (1997) noted that working as a waste collector is associated with a high risk of occupational injuries. The incidence of work-related pulmonary, gastrointestinal, and skin problems may be greater in waste collectors than in the general work force (Poulsen *et al*., 1995).

So far, the sparse data on adverse health effects in relation to waste collection are from Sweden (Thorn *et al*., 1998), Denmark (Nielsen *et al*., 1997; Ivens *et al*., 1997, 1998; Poulsen *et al*., 1995), and Brazil (Robazzi *et al*., 1997). This study was conducted to further examine the potential adverse health effects among HWCs. We investigated the prevalence of respiratory symptoms, gastrointestinal symptoms, acute irritative symptoms, musculoskeletal symptoms, and injuries among HWCs in the County of Kaohsiung, Taiwan.

MATERIALS AND METHODS

Household Waste Collection

This study was carried out in Kaohsiung County from which 27 municipalities (administrative districts) were included. Household waste collection in this county is performed in a traditional way, with most household waste products being mixed together. The mixed domestic waste (unseparated waste generated in homes) is stored in plastic bags, some in paper bags, and collected every day by waste collectors. The waste collectors work in crews of three to four persons operating one vehicle. The

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most widely used vehicle for waste collection is compactor truck which has a closed container for storage of the waste and a lift at the rear for automatic emptying of bins and waste containers into a scoop fitted to the container of the vehicle. When loading sacks into compactor trucks, the worker lifts the waste sack manually into the scoop. The collector is responsible for driving the vehicle, loading full containers, unloading empty containers, and emptying the contents of the container at the disposal site.

Study Subjects

The study was approved by the Bureau of Environmental Protection, Kaohsiung County. Household waste collection sections in the 27 municipalities were contacted and asked to participate in the study by a document describing the purpose of the study. The chiefs of these sections encouraged the employees to respond to the questionnaire and helped in the distribution and collection of the questionnaire.

The study comprised all current workers who were employed by the 27 municipal household waste collection departments. A total of 1032 full-time employees were included in the study population. The questionnaire was answered by 82.6% ($n = 853$) of the 1032 people. We classified the workers who answered the questionnaire into two occupational groups by specific exposures on the basis of the recorded designation of their specific task. Group 1 (exposure group) included those working in the collection of mixed domestic waste, front runner or loader, collection of separated waste and special kinds of domestic waste (paper, glass, etc.), garden waste, bulky waste for incineration, and the vehicle driver. Group 2 included accountants, timekeepers, canteen staff, personnel, and other office workers. In this study, group 1 was used as the exposed workers and group 2 as the controls. In all, 533 made up the exposed group and 320 served as controls.

Study Questionnaire

A modified version of the American Thoracic Society Questionnaire (adult version) (Ferris, 1978) was administered to all study subjects by trained interviewers. This questionnaire has been used in our previous investigations (Yang *et al*., 1996, 1997). Interviewers had been trained prior to the study through lecture sessions as well as practice administration of the questionnaire. The survey, including the administration of questionnaires, was carried out between December 1998 and March 1999.

The health questionnaire inquired about chronic respiratory symptoms such as coughing, phlegm production, wheezing, shortness of breath, and chronic bronchitis. The chronic respiratory symptoms concerned were defined as follows: chronic cough, coughing part of the day or the entire day for at least 3 months a year; phlegm production, phlegm production during a part of the day or for the entire day for at least 3 months a year; wheezing, a condition causing a wheezy or whistling sound on inspiration at least occasionally, apart from that caused by a cold or acute upper respiratory infection; chronic bronchitis, a cough and/or phlegm on most days for 3 months or more a year; and dyspnea, having to stop for breath when walking at one's own pace on level ground.

A second set of questions focused on acute symptoms including irritation of the eyes, secretions, dryness, or congestion of the nose, and irritation or dryness of the throat occurring within the previous month. These questions about acute symtpoms were developed in our previous study (Yang *et al*., 1997). Questions were also posed on nausea and diarrhea during the 1-month period prior to the date on which the questionnaire was completed. The questions about musculoskeletal complaints were worded as follows: do you suffer regularly from low back, elbow, or wrist complaints during the past month (yes/no)? Finally, participants were asked to recall the frequency of injuries (bumped into or hit by sharp objects, stepped on or any other contact with a sharp object, or prick from needles) in the past 12 months. Cases were defined as those study subjects who reported having injuries ≥ 3 times in the past 12 months. The questionnaire was pretested in one of the 27 municipal household waste collection departments. Although no validation analysis was conducted, information from the interview was considered to be of good quality.

Statistics

Data from the completed questionnaires were entered into a personal computer. Analyses were performed with the Statistical Analysis System (SAS) software. Prevalences for each of the respiratory symptoms, gastrointestinal symptoms, acute irritative symptoms, musculoskeletal symptoms, and injuries were calculated for the exposure and control groups. Demographic factors were compared using the χ^2 test. Odds ratios and 95% confidence intervals (95% CIs) were calculated using unconditional logistic regression models. All analyses were adjusted for age (<40 or ≥ 40 years), sex, education ($<$high

school or ≥ high school), smoking status (current smokers or ever/never smokers), and duration of employment (<8 or ≥8 years). Values of P less than 0.05 were considered statistically significant.

RESULTS

The demographic characteristics of the exposed and control populations are shown in Table 1. The two groups were comparable with respect to duration of employment, but the control group had a significantly higher proportions of males, younger workers (<40 years), more highly educated workers, and current smokers (56.3% vs 39.2%).

Data on the prevalence of reported symptoms are presented in Table 2. Symptoms in general were more prevalent among the waste collectors, in particular, a high prevalence of coughing, phlegm, chronic bronchitis, low back pain, elbow and wrist pain, and injuries caused by sharp objects. The adjusted odds ratios resulting from outcomes of the multiple logistic regression analyses are also presented in Table 2. All respiratory symptom prevalences, except dyspnea, were significantly higher in the exposed group. The adjusted odds ratios ranged from 1.91 for wheezing to 2.41 for chronic bronchitis. No significant differences were found in the prevalence of gastrointestinal symptoms. All other symptoms occurred more frequently in the exposed group than in the control workers, including low back pain (OR = 2.16, 95% CI = 1.51–3.09), elbow and wrist pain (OR = 2.34, 95% CI = 1.55–3.53), and injuries caused by sharp objects (OR = 3.26, 95% CI = 2.12–5.02).

TABLE 1
Demographic Characteristics of Exposed and Control Workers

	Exposed (n = 533)	Controls (n = 320)
Sex (%)		
Male	52.7	80.6*
Female	47.3	19.4
Age		
<40 years	24.2	35.2*
≥40 years	75.8	64.8
Education ≥ high school (%)	23.2	55.5*
Duration of employment ≥ 8 years (%)	59.4	60.3
Current smokers (%)	39.2	56.3*

*P < 0.05.

DISCUSSION

This is the first comprehensive investigation of adverse health effects among HWCs that included respiratory, gastrointestinal, acute irritative, and musculoskeletal symptoms and injuries caused by sharp objects among HWCs. Our data indicate that household waste collection increases the risk of development of chronic respiratory symptoms (cough, phlegm, wheezing, chronic bronchitis), musculoskeletal symptoms (low back pain and elbow/wrist pain), and injuries caused by sharp objects.

The job description of these HWCs may differ, to some extent, from those of HWCs employed in other countries. Data pertaining to specific bioaerosol or chemical exposure were not available in this study. However, the authors believe that the HWCs in this study are exposed to noxious agents similar to those encountered by HWCs employed in other countries.

The study covers the HWCs in Kaohsiung County only and this fact may restrict somewhat the generalizability of these findings to all of Taiwan but should not affect the internal validity of the study.

Gastrointestinal symptoms such as diarrhea and nausea are well-known problems among occupational groups exposed to high concentrations of airborne gram negative bacteria (Ivens *et al*., 1997). This is especially the case among sewage workers (Lundholm and Rylander, 1983), wastewater treatment workers (Khuder *et al*., 1998), and compost workers (Lundholm and Rylander, 1980). To our knowledge there is only one study examining the gastrointestinal symptoms among HWCs. Ivens *et al*. (1997) showed a causal relation between gastrointestinal symptoms and working as a waste collector. As handling and collection of waste may cause microorganisms and dust to become aerosolized, waste collectors are at risk of being exposed to bioaerosols generated from the waste (Nielsen *et al*., 1997). In this study, however, we did not find any excess of gastrointestinal symptoms among the HWCs. A possible explanation may be that the concentration of bacteria in the waste is not high enough to induce gastrointestinal problems.

Studies have shown an increased prevalence of acute eye, nose, and throat symptoms among workers in wastewater/sewage treatment plants (Scarlett-Kranz *et al*., 1987; Elia *et al*., 1983; Lundholm and Rylander, 1983) and garbage handling and recycling plants (Sigsgaard *et al*., 1997). The investigation of the above-mentioned symptoms demonstrated no significant differences between the HWCs and the control groups. The authors considered that the hazards of acute mucosa irritation

TABLE 2

Prevalences and Odds Ratios (OR) for Selected Health Outcomes among Household Waste Collectors and Control Workers

Symptom	Exposed	Controls	Crude OR	Adjusted ORs (95% CI[a])[b]	
Respiratory symptoms (%)					
Cough	17.3	12.2	1.51[c]	2.14	(1.39–3.32)
Phlegm	14.3	8.8	1.73[c]	2.17	(1.33–3.55)
Wheezing	15.4	11.3	1.43	1.91	(1.19–3.08)
Dyspnea	11.1	7.2	1.59	1.33	(0.75–2.36)
Chronic bronchitis	6.6	3.4	2.00[c]	2.41	(1.13–5.13)
Gastrointestinal symptoms (%)					
Diarrhea	13.4	15.6	0.98	1.09	(0.71–1.67)
Nausea	8.6	7.2	1.22	1.15	(0.64–2.05)
Acute irritative symptoms (%)					
Eyes	5.8	5.3	1.10	0.89	(0.45–1.77)
Throat	16.1	18.8	0.83	1.05	(0.70–1.57)
Nose	32.3	32.5	0.99	1.18	(0.84–1.65)
Musculoskeletal symptoms (%)					
Low back pain	42.0	21.8	2.58[c]	2.16	(1.51–3.09)
Elbow/wrist pain	31.1	14.4	2.69[c]	2.34	(1.55–3.53)
Injuries caused by sharp objects (%)	37.0	11.9	3.50[c]	3.26	(2.12–5.02)

[a]95% confidence interval.

[b]Odds ratios were adjusted for age (<40 or ≥ 40 years), sex, education (<high school or $\geq$ high school), smoking status (current smokers or ever/never smokers), and duration of employment (<8 or ≥ 8 years).

[c]$P < 0.05$.

(eye, nose, throat) from working as a household waste collector were quite small compared with those from working at wastewater/sewage treatment plants or garbage handling and recycling plants.

The number of blood lymphocytes was higher among waste collectors and were dose-related to the airborne (1→3)-B-D-glucan levels at the workplaces (Thorn *et al*., 1998). Also, the levels of inflammatory markers (eosinophilic protein and macrophage) were lower among waste collectors than among controls (Thorn *et al*., 1998). There are currently no available data on the respiratory symptoms of HWCs. In our study, we found a significantly higher prevalence of respiratory symptoms such as cough, phlegm, wheezing, and chronic bronchitis. In a study of street cleaners who were exposed to air pollution from traffic that approximated but did not exceed the WHO-recommended threshold values, Nielsen *et al*. (1995) found that respiratory symptoms were associated with work as a street cleaner. These symptoms included coughing, phlegm, and chronic bronchitis. Our study findings are in accordance with this study. However, confounding due to the fact that HWCs are exposed to diesel fumes and other exposures found on the roadways (whereas the control group may not be so exposed) needs to be considered. However, HWCs perform physical labor close to traffic. The nature of these symptoms are compatible with exposure to a respiratory irritant and, whereas a fuel or fume effect cannot be discounted, the possibility that the results found in this study suggest that traffic-related air pollution may be an occupational health hazard to HWCs cannot be excluded.

The role of ergonomic factors of the workplace in the development of regional musculoskeletal disorders has been a topic of considerable interest in recent years. Riihimaki (1991) described a variety of work-related factors associated with back pain. These include heavy physical work such as lifting, carrying, pulling, and pushing. Our study showed that the odds ratio of low back pain (2.16) was almost as high as that of elbow and wrist pain (2.34) for HWCs compared with the controls. There is no surprise for this finding because collection of household waste is work which needs repeated movements and force requirements. To the authors knowledge there are no other studies in which musculoskeletal complaints were investigated in HWCs.

In this study, we also found that there were around three times as many injuries caused by sharp objects among HWCs compared to controls. This finding is in accordance with the studies of Ivens

et al. (1998) and Robazzi *et al*. (1997), which also observed increased reporting of injuries by waste collectors.

In conclusion, our study showed that occupational traffic-related air pollution may be a respiratory health hazard to HWCs. This study also showed that the job as a household waste collector is associated with a high risk of experiencing an occupational injury. Furthermore, this survey is the first to find that the work as a household waste collector is associated with self-reported musculoskeletal pain. The mechanism presumably involves repeated movements involved in household waste collection. It seems worthwhile to pay more attention to musculoskeletal complaints among HWCs in the future (i.e., further study on refinement of dimensions of ergonomic stressors among HWCs are needed).

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