

Prevalence of Symptoms and Risk Factors of Health Problems of Solid Waste Collectors in the Philippines

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Abstract – *Exposure to solid wastes may result to several health problems. Solid waste collection should be effectively done. However, in the Philippines, collection is done manually, exposing the solid waste collectors to health risks.*

In 2017, the authors made an initial study on respiratory health problems of solid waste collectors and found out that 19.29% of them experiences its symptoms [1]. On this study, the prevalence of symptoms and risk factors of the other most common health issues among these workers: musculoskeletal, gastrointestinal, and dermatological symptoms were examined.

The study found that in terms of prevalence of symptoms, the health problems are ranked as follows: MSD (39.55%), gastrointestinal (21.54%), and lastly, dermatological (12.86%). Significant factors found for MSD are the age of the worker, educational background, volume of alcoholic drinks consumed, perception of work demand (time pressure), long walks at work, and assignment to institutional biodegradable waste route. For gastrointestinal symptoms, the significant factors are hours of sleep, volume of alcoholic drinks consumed, frequency of taking baths, and perception of community support. Lastly, for the dermatological symptoms, the significant factors are sticks of cigarettes smoked per day, perception of work demand (time pressure), perception of work difficulty, perception of community support, and assignment to institutional non-biodegradable route.

Significant risk factors can be used as guide in improving the conditions of solid waste collectors. Logistic regression models were also constructed to predict the presence/absence of each health problem.

Keywords—solid waste collectors, musculoskeletal, gastrointestinal, dermatological, risk factors, logistic regression models

I. INTRODUCTION

1.1 Background and Significance of the Study

From the authors' previous study conducted in 2017, it was found that 19.29% of solid waste collectors were experiencing symptoms of respiratory problems [1]. It has been of interest to determine the other health issues these workers encounter.

Adverse health effects usually encountered among solid waste collectors include respiratory, musculoskeletal, dermal, gastrointestinal, irritation of the nose and eyes, fatigue, headaches, allergies, and psychological problems [2, 3]. According to a study at Addis Ababa City, Ethiopia [2], these workers are at risk from the exposure to the waste itself and the physical effort exerted when handling the waste.

The study will be focusing on three major health problems found among waste collectors in other countries: musculoskeletal disorders (MSD), gastrointestinal problems, and dermatological problems [4, 8]. The study only investigated the presence of the common symptoms of these health problems and can only identify them as self-reported symptoms by the workers and will not be a conclusive diagnosis of the disease.

MSD's, as defined by the World Health Organization (WHO) and the Occupational Safety and Health Administration (OSHA), are health problems of the locomotor apparatus such as muscles, tendons, the skeleton, cartilage, ligaments, and nerves [9, 10]. It includes all forms of ill health ranging

from light, transitory disorders, to irreversible, disabling injuries [9]. WHO listed the factors contributing to the development of MSD's are exertion of high-intensity forces, handling heavy loads over long periods of time, frequently repeated manipulation of objects, working in unfavorable posture, static muscular load, muscular inactivity, monotonous repetitive manipulations, application of vibration, physical environmental factors (e.g. temperature), and psychosocial factors [9, 10].

Meanwhile, gastrointestinal disorders or digestive diseases are defined as any condition or disease that occurs within the gastrointestinal tract, which is made up of the mouth, esophagus, stomach, small intestine, large intestine, and anus [11, 12]. The common symptoms of gastrointestinal problems are bleeding, bloating, constipation, diarrhea, heartburn, incontinence, nausea and vomiting, pain in the belly, swallowing problems, and weight gain or loss. Other conditions may have the same symptoms so medical investigations are required to come up with the diagnosis [11, 13].

Lastly, dermatological disorders are problems of the skin. These are conditions that irritate, clog, or inflame the skin and cause symptoms such as redness, swelling, burning, and itching [14]. Allergies, irritants, genetic makeup, certain diseases, and immune system problems can cause skin conditions [15].

To help protect the Filipino workers from such diseases, the government set in place regulations, some of which are the Labor Code of the Philippines, specifically under Book Four: Occupational Safety and Health [16] and The Occupational Health and Safety Standards (OSHS) of the Philippines Amended in 1989 which includes detailed guidelines on how workers should be protected in general work environments and high risk environments (boilers, confined spaces, etc.) [17]. These serve as guides to help companies minimize, if not eliminate the cases of work-related injuries, illnesses, and accidents.

Statistics of accidents, injuries, and illnesses at work can provide guidance for the Department of Labor and Employment (DOLE) to determine the preventive policies and programs that need to be created to protect the Filipino workers [18]. But according to the Occupational Safety and Health Center (OSHC), use of available data must be done with care since there are possibly unaccounted cases that escape reporting. Time series trends can be seen but it is not conclusive and enough to provide basis for the policies and programs needed to be implemented [18].

In relation to this, several agencies monitor the prevalence and incidence of occupational injuries in the Philippines but data from these only show major trends, causes, and severity. Detailed information per occupational group with risk factors associated would be more useful to facilitate development of guidelines and strategies that can be helpful in the prevention of work-related injuries in the Philippines [19]

Majority of researches on health risks of solid waste collectors uses a collection of data from several developing countries wherein there are possible differences in the methods and equipment/tools for waste collection. So far, limited studies were addressed to risk factors that contribute to the health problems of municipal solid waste collectors specifically in the Philippines.

Solid waste collectors in the Philippines are deemed at risk to several health problems. This study investigated the prevalence of other major health problems such as MSDs, gastrointestinal, and dermatological symptoms common among solid waste collectors. It also determined the risk factors that can cause certain injuries and illnesses to serve as guide in protecting this sector of the workforce. The study was done in one of the cities in Metro Manila.

1.2 Objectives of the Study

The objectives of the study are:

- a. to determine the prevalence of symptoms of MSD, gastrointestinal, and dermatological health problems among solid waste collectors, and
- b. to help determine the risk factors associated with these health problems.

1.3 Conceptual Framework

The conceptual framework of the study is on Figure 1. The potential risk factors were identified from previous studies through literature review and actual task observations. These factors were then categorized to four groups of independent variables namely: individual, behavioral, psychosocial, and work-related factors. The included factors in each category were discussed on the next part.

Then, data was gathered through a survey questionnaire and summarized to input to logistic regression. The significant risk factors from the logistic regression can be used as a guide for protecting the solid waste collectors.

Independent Variables

The independent variables (potential risk factors) were tabulated and discussed in this part. According to the World Health Organization (WHO), “A risk factor is any attribute, characteristic or exposure of an individual that increases the likelihood of developing a disease or injury. Some examples of the more important risk factors are underweight, unsafe sex, high blood pressure, tobacco and alcohol consumption, and unsafe water, sanitation and hygiene.” [20].

There were 49 independent variables used in the study but not all the factors were included in each model. The last column on Tables 1 to 4 indicate the models where the factor was included.

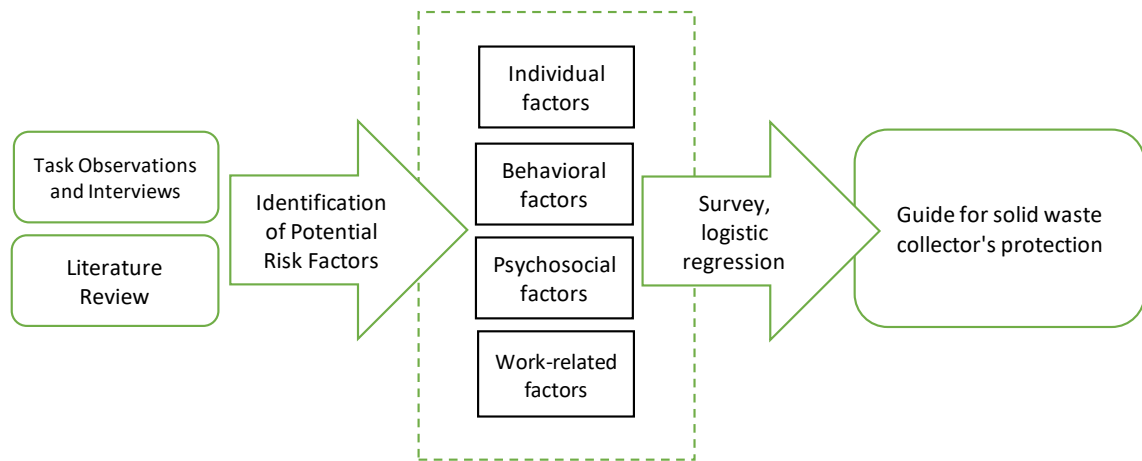


Figure 1. Conceptual framework of the study

Individual risk factors are mainly physical and socio-demographic characteristics of the respondents. Table 1 shows the individual risk factors included in this study. Most of the waste collectors are male so gender was not included on this list.

The first individual factor included is the age of the worker (x_1). Several studies found that age is associated with the risk of MSD. A study by Heiden et al. on nurses found that older nurses tend to have an increased risk of MSD compared to younger ones [21]. Another study in 2016 found that age (>40 years) was consistently associated with the prevalence of work-related musculoskeletal disorders (WRMSDs) and is a major risk factor in the prevalence of WRMSDs among butchers [22]. Ostrakhovitch and Tabibzadeh also stated that aging leads to cancer and multi-systemic disorders as well as chronic diseases [23]. Thus, the age of the worker was included in all three models as an individual factor.

The next factor is the marital status of the workers (x_2). This factor refers to the family context, a setting crucial to the care family members provide to each other and is therefore relevant for the control of a disease such as diabetes mellitus [24]. While a study on the association of marital status and the survival of astrocytoma (a type of cancer) found that married patients had a better prognosis

than others which could be due to the support that they get from the family [25]. The study would like to verify this for MSD, gastrointestinal, and dermatological problems.

Another factor is the educational background of the worker (x_3). It was included to check if the educational background of a worker can help avoid unhealthy practices in the workplace and reduce if not eliminate the symptoms of the health problems. In a study on diabetes mortality in Andalusia, a person's risk of death increases as the educational level decreased [24].

Standing height (x_4) was included to assess the possible effect of the loading height of garbage trucks. It is a factor that the researchers thought might influence the MSD symptoms presence in the workers. It was thought off during the observations of the actual solid waste collection activities of the workers. In ergonomics, specifically in anthropometry, it is essential that the body measurements of the users be considered to avoid design mismatch that would possibly cause difficulty for the user to perform the task or awkward postures for the user and later produce MSD.

Table 1. Individual risk factors included and their descriptions

Individual Risk Factors		Possible Values	Model Applicable
x_1	age (years)	number of years	All
x_2	marital status	single or married	All
x_3	educational level	Attended primary, secondary, or	All
x_4	height	height in meters	MSD
x_5	body mass index (BMI)	weight (in kg)/(height in m) ²	All
x_6	number of children	number of children	All
x_7	family medical history	number of health issues	All
x_8	worker residence	Within the barangay of the	All

The BMI or body mass index (x_5) of the worker which will be computed by dividing the weight (in kilograms) by the worker's height (in meters) squared. Studies found that there is a statistically significant positive relationship between the probability of musculoskeletal disorder and the level of obesity, measured by BMI [26, 27]. This factor was included in the study to verify its effect on MSD symptom's presence and include also on the other two health problems to check if an unhealthy BMI can affect the worker.

The next factor, number of children (x_6) was found to be positively associated with occupational injuries of solid waste collectors [2]. It is also related to another factor, marital status, which is on the family context. The study will determine if there is an association with the presence of symptoms of MSD, gastrointestinal, and dermatological problems.

Family medical history (x_7) was also included to determine how many types of health problems is the respondent susceptible to and to check whether the problem is related to the three health problems being studied.

Meanwhile, worker residence (x_8) was included in this study to determine whether living within the

vicinity where the collection trucks and the dump site are located is associated with the presence of health problems. The factor was included because of the observation that most workers reside in the dumpsite's vicinity and can possibly create immunity for the workers.

The next set of risk factors are the behavioral factors. These are factors stemming from human behavior. They might be due to personality, the situation, or are a reaction to the environment [28]. Table 2 lists the included factors for this category.

The first behavioral factor, the number of hours of sleep (x9), was used to determine if the workers are well-rested coming to work every day. According to Hirshkowitz et al. [29], an individual who intentionally restricts sleep over a prolonged period may be compromising his or her health and well-being. Aside from this, the authors noted during interview that sometimes there are workers who serve on three shifts to earn extra but without regard to the number of hours that they have slept or rested. Thus, the number of hours of sleep was included as a factor.

Smoking (x10) and alcoholic drinking frequencies (x11) and volume of drinks (x12) were also included since according to the workers they tend to smoke or drink to overcome the odor of the waste experienced at work. Cigarette smoking is known to be one of the leading causes of death and health problems [30, 31]. Also, a study [6] in 2012 found that smoking increases the risk of MSD. Meanwhile, according to Barr et al. [32] chronic heavy drinking leads to lower immunity and risk to bacterial and viral infections. The study will check their relationship with the three health problems.

There are personal protective equipment (PPEs) provided for the workers but there might be cases when they do not use them for reasons such as "discomfort, no access, and to save time" [2]. Thus, it will be explored as one of the factors: PPE use frequency (x13). The type of PPE used (x14 to x21) were also explored as possible factors. All these factors were included for input in creating the gastrointestinal and dermatological models except for the use of dustpan and broom (x21) which was only included for the MSD model. Those PPE types included for gastrointestinal and dermatological models were believed to be offering protection for the workers against exposure to bacteria and other microorganisms during waste collection.

The last three behavioral factors included were about the workers' hygienic habits before or after work: washing hands after work (x22), washing hands before eating (x23), washing implements used (x24), and taking baths (x25). These three factors were also included based on the observations done. Handling waste can transfer microorganisms to the hands of the workers. Also, from the findings of a study by Park et al. in 2011 [8], the faces and clothing of the waste collectors have microorganisms after handling wastes. These can be transferred to the hands of the workers if they do not wash them properly and they can be at risk of gastrointestinal and dermatological problems.

The third category of factors are the psychosocial risk factors are those that may affect workers' psychological response to their work and workplace conditions such as working relationships between supervisors and colleagues. It can lead to stress, a known hazard to MSD's. [33]. There are six factors included under this category as shown in Table 3. These psychosocial factors were included in the creation of the three models since stress that can come from these can increase the rate of wear and tear in the body that can lead to health issues [34, 35].

Decision latitude (x26) and work demand (x27 and x28) were used in a study in Egypt and only the decision latitude or the level of freedom that the workers have at performing their tasks was found to be statistically significant to the presence of musculoskeletal complaints in waste collectors [6]. Meanwhile, it was observed that work demand (psychological) is a possible reason for the impaired health-related quality of life (HRQoL) among municipal waste collection workers in Germany [36]. These three factors were included, and further descriptions were provided on Table 3.

Table 2. Behavioral risk factors included and their descriptions

Behavioral Risk Factors		Possible Values	Model Applicable
x ₉	Sleep hours daily	number of hours	All
x ₁₀	Cigarette sticks consumed daily	number of sticks	All
x ₁₁	Alcohol consumption frequency	occasional/once a month, twice monthly, once a week, 2-3 times a week, daily	All
x ₁₂	Volume of alcoholic drinks consumed	volume in ml	All
x ₁₃	Frequency of PPE use	always, often, sometimes, seldom, never	All
x ₁₄ to x ₂₁	PPE used: facemask, gloves, closed shoes, boots, cap, raincoat, uniform, dustpan & broom	Yes or No	All
x ₂₂	Washing of hands after work	always, often, sometimes, seldom, never	Gastrointestinal and Dermatological
x ₂₃	Washing hands before eating	always, often, sometimes, seldom, never	Gastrointestinal and Dermatological
x ₂₄	Washing implements used	Water only, water and soap, water and others	Gastrointestinal and Dermatological
x ₂₅	Frequency of taking baths	Before work, after work, both	Gastrointestinal and Dermatological

Work support (x₂₉ and x₃₀) were significant factors in a study on Chinese hospital nurses' MSD [37]. Community support (x₂₉) refers to the perceived cooperation that the workers receive from the members of the community that they serve. This could be in terms of segregating the solid wastes they have generated according to type (biodegradable, nonbiodegradable, recyclables), putting them outside their door during time of collection, and handing over to the collectors only the type of waste scheduled to be collected that day. This factor was included since it would create stress on the workers if the people in the community did not follow the segregation and collection schedule. Stress is one form of risk factor that contributes to the MSD of workers according to WHO [9]. Another factor, the Social support from co-workers (x₃₀) was also found significantly associated with MSD [37], is based on each worker's perception that is like the community support factor and can create stress on a worker if not perceived as good.

Management feedback (x₃₁) refers to the proper flow of communication from the management to the workers and vice versa. It was observed by the researchers that the workers tend to be stressed when changes on their shift and route was made by the management due to their low performance but without informing them. This factor would cover those aspects of the communication between management and the workers.

Table 3. Psychosocial risk factors included and their descriptions

Psychosocial Risk Factors		Description	Possible Values	Model Applicable
x ₂₆	Decision latitude	the amount of input that the workers perceive they have over their work	always, often, sometimes, seldom, never	All
x ₂₇	Work demand 1	how frequent the worker perceives that the deadline of the job cannot be reached	always, often, sometimes, seldom, never	All
x ₂₈	Work Demand 2	how frequent the worker perceives that the physical requirement of the job cannot be reached	always, often, sometimes, seldom, never	All
x ₂₉	Community support	how frequent the community members cooperate to their job aims (waste segregation and collection)	always, often, sometimes, seldom, never	All
x ₃₀	Social support from co-workers	how frequent the worker receive help from superiors and co-workers when they encounter work problems	always, often, sometimes, seldom, never	All
x ₃₁	Management feedback	the perception of the workers to the frequency of feedback that the workers get from their superiors and co-workers on their job performance	always, often, sometimes, seldom, never	All
x ₃₂	Discrimination	due to the nature of their job, this variable will be probing if there were experienced discrimination from the community	always, often, sometimes, seldom, never	All

Lastly, for the psychosocial factors, discrimination (x₃₂) was added to include aspects relating to the workers' sense of being treated fairly by the people in the communities that they meet. In Egypt [6], waste collectors are considered by many people as nuisance or a job that is a source of shame. These people are subject social stigma and are usually from marginalized groups. In another study [38], social prejudices towards waste pickers in India continue. Even in Japan [39], strong prejudice and discrimination is being experienced by waste management workers. This study tried to determine if the workers experience discrimination being a solid waste collector just like what waste pickers in other countries experience.

The last category of possible risk factors are work-related risk factors which are characteristics of the tasks and the nature of the physical job that they perform. Most of the factors included here were based on the observations done. There are 17 factors included under this category and were described in Table 4.

The first work-related factor, performing other jobs (x₃₃) aside from being a waste collector was included to check whether the worker might be affected by other activities aside from waste collection or not.

Next, the number of shifts (x₃₄) workers may be assigned is two to receive minimum wage pay, the third shift will be considered overtime (OT) pay if ever they will serve for it. The shift schedule may be in the morning (5AM to 11AM), midday until afternoon (12NN to 4PM), or at night (9PM to 12MN). This factor is related to the amount of rest the workers have each day.

The years of service (x₃₅) was included to check if the length of time that the workers serve as a waste collector affect his susceptibility to work-related illnesses. According to a study in 2016 [40], the rate of work-related illnesses varies along with the work experiences; 41.7% of them occurred in 5-10 years of experience. While Abou El Wafa et al. [6], as the number of years serving as a solid waste collector increases, the risk of MSD also increased.

Next are the trainings that the workers went through namely: job training (x₃₆), safety training (x₃₇), and company policies training (x₃₈). These three were included by the authors to determine if the workers receive the necessary information and knowledge to perform their job safely and properly.

The factors x39 to x44 are those related to the physical nature of the job. Perception (estimate) of loads lifted/pushed/pulled (x39) was included since handling heavy objects over long periods of time can lead to degenerative diseases of the lumbar spine and was found to be a risk factor of MSD [9].

Experienced awkward postures (x40) in the performance of their work is a risk factor according to studies [9, 40]. These postures may be a heavily bent or twisted trunk, hands or arms above the shoulders, etc. It was asked on the survey using illustrations so the workers would easily understand what an awkward posture is.

Duration of long walks (x41) was included by the authors after observation that waste collectors' activity requires walking through the community assigned to them to collect the solid waste from each house. While walking, two workers push a cart where the wastes are temporarily stored then transferred to the garbage truck on the way back. Walking for long periods of time was also found associated with MSD risk in a study in 2012 [6].

The factors duration of static loading (x42) and forceful exertions (x43) are risk factors of MSD according to Luttmann et al. [9]. Static loading is when a worker is in a limited or confined space to hold a posture or there is limited movement that can lead to overload of the muscles [9]. This was observed during the transport from the truck terminals going to the community. A truck usually carries five passengers and the workers are normally cramped in the driver/passenger compartment in front where there is limited space. Thus, static loading was included. Meanwhile, forceful exertions happen when workers lift, carry, push, or pull a heavy object and can lead to acute overloading of tissues [9]. This can be in the form of the workers pushing the cart during door-to-door collection.

Table 4. Work-related risk factors included and their descriptions

Work-related Risk Factors		Description	Possible Values	Model Applicable
x33	Other jobs	if the worker, aside from being a waste collector performs other jobs	Yes or No	All
x34	Number of shifts served	minimum of two shifts daily	1, 2, or 3	All
x35	Years in service	the length of time in years of the worker as a solid waste collector	Number of years	All
x36	Job training	whether the worker went through a training program on the job to be assigned to him beforehand or not	Yes or No	All
x37	Safety training	whether the worker went through a safety training program or not	Yes or No	All
x38	Company Policies training	whether the worker went through a company policies training program or not	Yes or No	All
x39	Perception of loads lifted/pushed/pulled	worker's perception of how heavy the load they are lifting, pulling, or pushing at work	Weight in kg	MSD
x40	Experienced awkward postures	whether or not the worker experienced awkward or undesirable postures at work	Yes or No	MSD
x41	Duration of long walks	estimated time of the continuous long walk	time (in hours)	MSD
x42	Duration of static loading	estimated time on how long he experiences static loading at work	time (in minutes)	MSD
x43	Forceful exertions	whether or not the worker experienced forceful exertions in performing work	Yes or No	MSD
x44	Collection vehicle	two types are used: compactor truck and dump truck	compactor truck or dump truck	MSD
x45 to x49	Route: residential-bio, residential-nonbio, institutional-bio, institutional-nonbio, commercial (residuals)	whether or not the worker has been assigned to a specific route	Yes or No	All

There are two types of collection vehicle (x44) that the workers can use, the compactor type and the dump truck. A compactor truck has a scraper that pulls in and compacts the wastes. It only requires the workers to load the wastes onto its rear sewage bin then will do the job. Meanwhile, a traditional dump truck requires a worker to throw into the truck the wastes or sometimes they need to climb to it to load the wastes. It was included to determine possible association with presence of MSD symptoms.

Lastly, for route assignment of the worker (x45 to x49), there are five possible routes: residential biodegradable wastes, residential non-biodegradable wastes, institutional biodegradable wastes, institutional non-biodegradable wastes, and commercial residual wastes. These factors were included to determine which route exposes the workers to possibly heavy loads that may lead to MSD or infections or allergens that may lead to gastrointestinal or dermatological complaints.

According to the Environmental Management Bureau (EMB) [41], residential wastes constitutes majority (56.7%) of the municipal solid wastes which includes kitchen scraps, yard waste, paper and cardboards, glass bottles, plastic containers and sando bags, foils, soiled tissues and diapers, and special wastes such as containers of household cleaning agents, batteries, and waste electrical and electronic equipment. Meanwhile, institutional wastes (12.1%) are those that come from government offices, educational, and medical institutions. And commercial wastes (27.1%) come from private or public markets, but only residual wastes are collected. Residual wastes are combinations of disposable wastes and inert materials [41].

Dependent Variables

There are three dependent variables identified based on the type of health problem experienced by the waste collectors namely: musculoskeletal complaints, gastrointestinal complaints, and dermatological complaints. Table 5 shows the list of the dependent variables with their possible binary values. These were the common health problems encountered by solid waste collectors based on studies from other countries.

Table 5. Dependent variables used in the study

Dependent Variable	Health Problem	Possible Values
y ₁	Musculoskeletal	Present/Absent
y ₂	Gastrointestinal	Present/Absent
y ₃	Dermatological	Present/Absent

1.4 Scope and Limitations of the Study

The study determined the presence of symptoms of the three health problems of interest namely: musculoskeletal, gastrointestinal, and dermatological health problems based on self-reported symptoms of the solid waste collectors. Further investigations and diagnosis by a medical practitioner are necessary for the diagnosis of the diseases.

1.5 Areas for Further Study

Cost-Benefit Analysis of the possible interventions to be done in improving the worker's conditions.

II. METHODOLOGY

2.1 Overview of Procedures

Collection of data was done through interviews, observation of actual solid waste collection activities, and conduct of a survey among solid waste collectors. Potential risk factors were determined by observing the actual solid waste collection and through the review of related works.

A survey questionnaire was constructed to determine individual, behavioral, psychosocial, and work-related characteristics of the workers. The last part of the questionnaire was used to determine the possible presence or absence of MSD-related, gastrointestinal, and dermatological symptoms, and other work-related injuries encountered by these workers.

2.2 Survey Design and Reliability

The study is of the cross-sectional type focusing on the solid waste collectors in the chosen municipality. The first part of the survey determines the individual, behavioral, psychosocial, and work-related factors that are present in the workers. Choosing the factors to include in each category was discussed in detail on Section 2.4 Several previously made survey questionnaires were benchmarked for the construction of the questions [42, 43, 44].

The next part of the survey probes on the different health problem symptoms that the workers experience. For the MSD symptoms the questions were based from the Standardized Nordic Questionnaires and the Discomfort Survey [45, 46]. Actual survey questionnaire administered is in Filipino to enable easier understanding by the respondents.

The survey questionnaire was checked by one of the statisticians from the Survey Sampling Division of the Institute of Statistics, UP Los Baños. For content validity, one of the authors being an Ergonomics expert, Dr. Matias, checked the survey questionnaire.

2.3 Sampling

During the study, there were 1196 solid waste collectors employed in the LGU. Using the formula from Cochran [47] with finite population correction, Eq. (1), the number of respondents to survey, n , was computed.

$$n = \frac{n_0}{1 + \frac{n_0}{N}} \quad (1)$$

where

$$n_0 = \frac{z^2 p (1 - p)}{e^2} \quad (2)$$

N is the population size

z is the standard normal variate based on the confidence coefficient

p is the estimate for P

e is the specified margin of error

Assuming a 95% degree of confidence, a 5% margin of error, assuming a conservative p of 50%, and knowing the N of 1196, the resulting n is 291.

2.4 Data Input and Analysis

Data from the survey was summarized using an MS Excel spreadsheet and data splitting was done: 70% for constructing the five models and the remaining 30% for validating the constructed models [1]. Through visual inspection, survey questionnaires with missing answers were sorted out. A total of 311 data points was left after sorting. From these, 70% or 221 were used for determining the predictors and 30% or 90 data points were used for the validation.

Charts were created for the gathered data and used to characterize the sample population being studied. Statistical method used is binomial logistic regression, Backward:LR type (Stepwise). Software used was SPSS Statistics version 23. This was used to have the full model first and avoid disregarding interactions among the variables [1]. The setup of the data was done using Laerd Statistics' Binomial Logistic Regression guide [48].

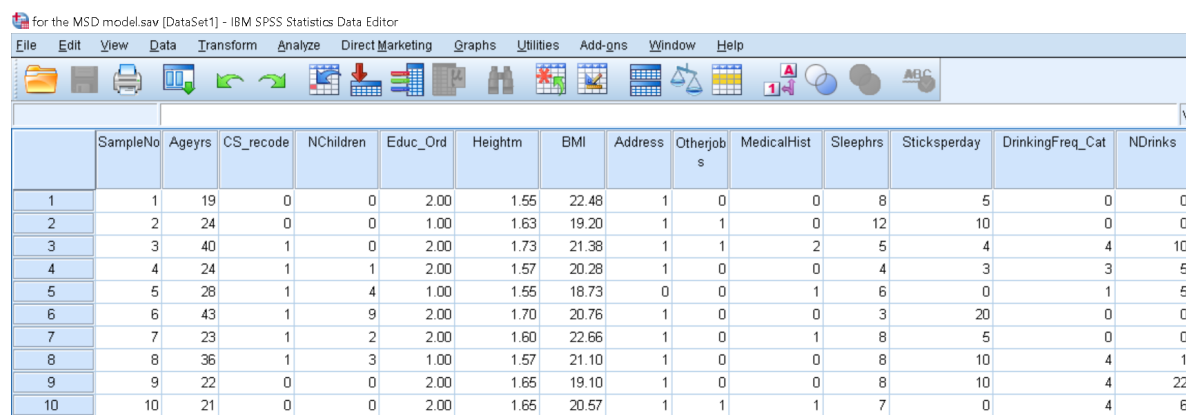
The types of variables were defined first on the "Variable View". After the setup process the Variable View window would look like the sample screen capture on Figure 2, which illustrates the setup for both the independent and dependent variables. Each row on the setup represents each variable; the sequence of the variables is irrelevant but most of the time, the dependent variables are on the last few rows.

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	SampleNo	Numeric	12	0	Sample #	None	None	6	Right	Scale	None
2	Ageyrs	Numeric	12	0	Age (yrs)	None	None	5	Right	Scale	None
3	CS_recode	Numeric	8	0	CS_recode	{0, single}..	None	7	Right	Nominal	None
4	NChildren	Numeric	12	0	No. of children (...)	None	None	8	Right	Nominal	None
5	Educ_Ord	Numeric	8	2	Educ_Ord	None	None	7	Right	Nominal	None
6	Heightm	Numeric	12	2	Height (m)	None	None	8	Right	Scale	None
7	BMI	Numeric	16	2	BMI	None	None	6	Right	Scale	None
8	Address	Numeric	7	0	Residence	{0, No}..	None	6	Right	Nominal	None
9	Otherjobs	Numeric	3	0	Other jobs	{0, No}..	None	5	Right	Nominal	None
10	MedicalHist	Numeric	12	0	Medical History...	None	None	9	Right	Nominal	None

Figure 2. Sample Variable View setup of variables in SPSS Statistics

The “Name” column represents the name of the variables entered. The next column, “Type” is where the data type of the variable was defined as either numeric, currency, string (text), etc. The “Measure” column on Figure 2 can have values either “Scale” or “Nominal”. Scale represents variables which were measured in a continuous scale such as age, height, and BMI. While Nominal variables are those that are categorical in nature such as marital status, number of children, and education of the respondents. The setup of the dichotomous dependent variables was the same as the nominal independent variables. The dependent variables’ values were assigned as “0” for the negative response (absence of disease), and “1” for the positive response (presence of disease).

After defining all the variables, the data entry was done on the “Data View” of SPSS Statistics. A sample Data View of the entered data is shown on Figure 3. The data were automatically displayed according to the sequence of entry on the Variable View. Data were entered on the cells under each column. Each row represents one case or one respondent in the survey.



	SampleNo	Ageyrs	CS_recode	NChildren	Educ_Ord	Heightm	BMI	Address	Otherjobs	MedicalHist	Sleephrs	Sticksperday	DrinkingFreq_Cat	NDrinks
1	1	19	0	0	2.00	1.55	22.48	1	0	0	8	5	0	0
2	2	24	0	0	1.00	1.63	19.20	1	1	0	12	10	0	0
3	3	40	1	0	2.00	1.73	21.38	1	1	2	5	4	4	10
4	4	24	1	1	2.00	1.57	20.28	1	0	0	4	3	3	5
5	5	28	1	4	1.00	1.55	18.73	0	0	1	6	0	1	5
6	6	43	1	9	2.00	1.70	20.76	1	0	0	3	20	0	0
7	7	23	1	2	2.00	1.60	22.66	1	0	1	8	5	0	0
8	8	36	1	3	1.00	1.57	21.10	1	0	0	8	10	4	1
9	9	22	0	0	2.00	1.65	19.10	1	0	0	8	10	4	22
10	10	21	0	0	2.00	1.65	20.57	1	1	1	7	0	4	6

Figure 3. Sample Data View of the data entered in SPSS Statistics.

The next part of the process is testing the assumptions of binary logistic regression. The seven assumptions for the binomial logistic regression were tested and were complied with [48]. These were the assumptions:

- Assumption 1: There should be one dependent variable that is dichotomous.
- Assumption 2: There are one or more independent variables that are nominal or continuous only.
- Assumption 3: The categories of each independent nominal variable and dependent dichotomous variable should be mutually exclusive and exhaustive.
- Assumption 4: There should be at least 15 observations per independent variable.
- Assumption 5: Linear relationship should be observed between the independent continuous variables and the logit transformation of the dependent variable. (Box-Tidwell approach.)
- Assumption 6: Test of Multicollinearity for the Models (Used the Variance Inflation Factor, VIF)
- Assumption 7: Checking of outliers or highly influential points (Used Cook’s Distance)

Assumptions 1 to 4 are dependent on the researcher’s study design and type of data measured. While the remaining three assumptions are dependent on the fit of the data to the said model.

After ensuring that the assumptions were met, the next step is to run the binary logistic regression. On the main menu of SPSS, the Analyze tab was clicked then Regression and next Binary Logistic (Figure 4). On the Logistic Regression dialogue box, shown on Figure 5, the dependent variables were entered on the “Dependent” box and the independent variables were entered on the “Covariates” box.

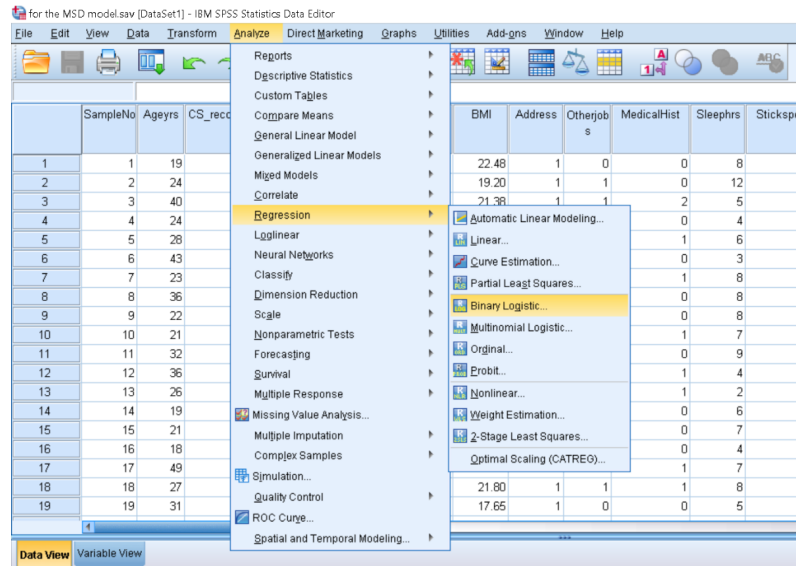


Figure 4. Main menu where binary logistic regression can be found

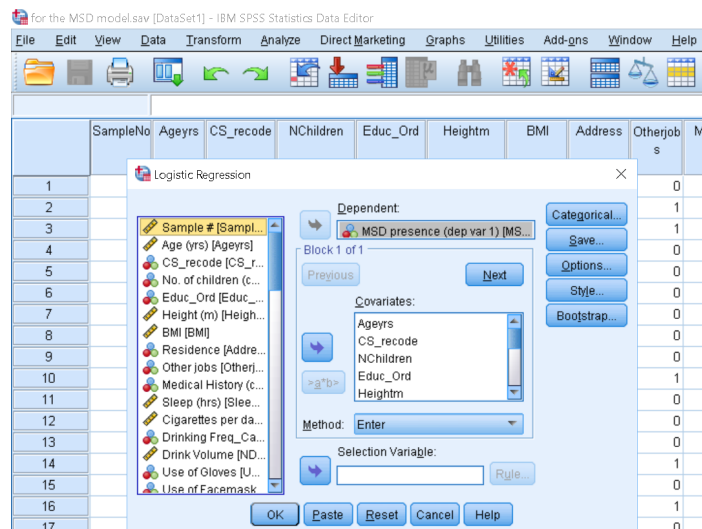


Figure 5. Logistic regression dialogue box

Afterwards, the “Options” button was clicked to enable which results will be included on the tables. The Classification plots, Hosmer-Lemeshow goodness-of-fit, Casewise listing of residuals, and CI for Exp(B) were enabled. It should look like Figure 6.

Next step is clicking “Continue” to return to the Logistic regression dialogue box and clicking the “Save” button shown on Figure 6. Enable the “Probabilities” checkbox under Predicted Values (Figure 7). Then, click continue to go back the Logistic Regression dialogue box and click “Ok” to generate the output of the binary logistic regression.

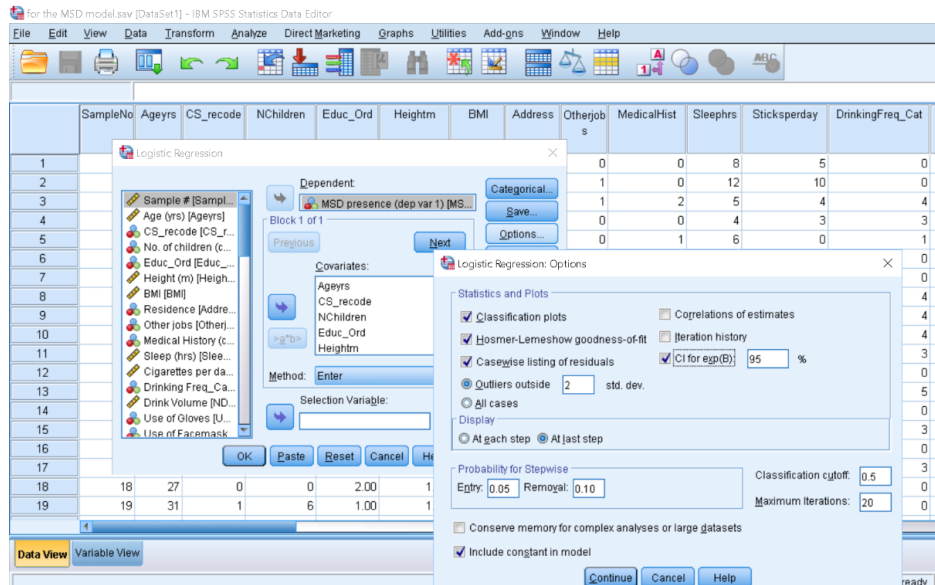


Figure 6. Logistic Regression “Options” menu

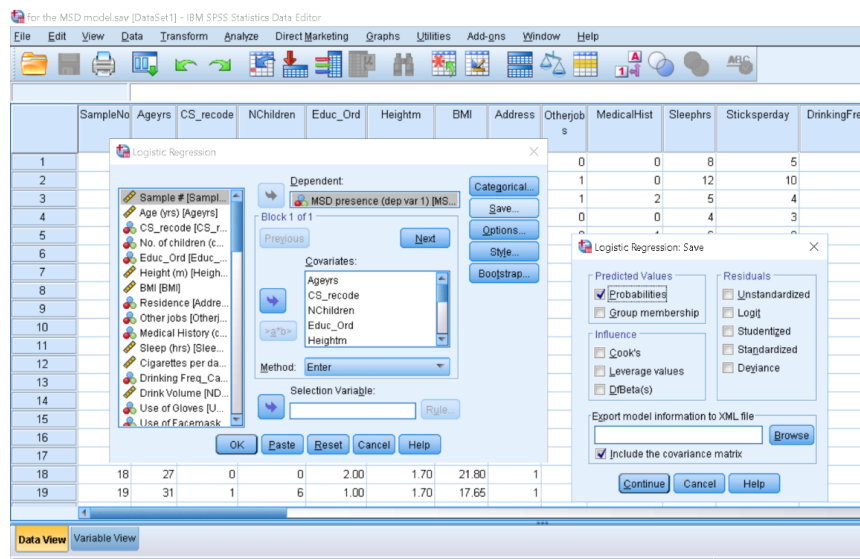


Figure 7. Logistic Regression “Save” menu

The outputs from SPSS were used to construct the logistic regression models [49] for each health problem using the general formula shown here as Equation 3.

$$y_i = \ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 x_1 + \dots + \beta_n \quad (3)$$

where y_i is the dependent variable

p_i is the probability of event i

β_0 is the intercept

β_n is the coefficient for each independent variable x_i

Meanwhile, for the validation part, the SPSS scoring wizard was used to check how these models can accurately predict the presence or absence of the health problems. The number of times out of the 90 validation points that the models correctly predicted the outcomes was used to determine the percentage of correctness of the models [1].

III. RESULTS AND DISCUSSION

The sociodemographic profile of the respondents was noted and presented in Figure 8. Majority of the workers are married with one to three children. The workers are also mostly young, aged 21 to 30 years old. And most of the workers reside on the barangay where the dumpsite and waste collection truck terminals are located.

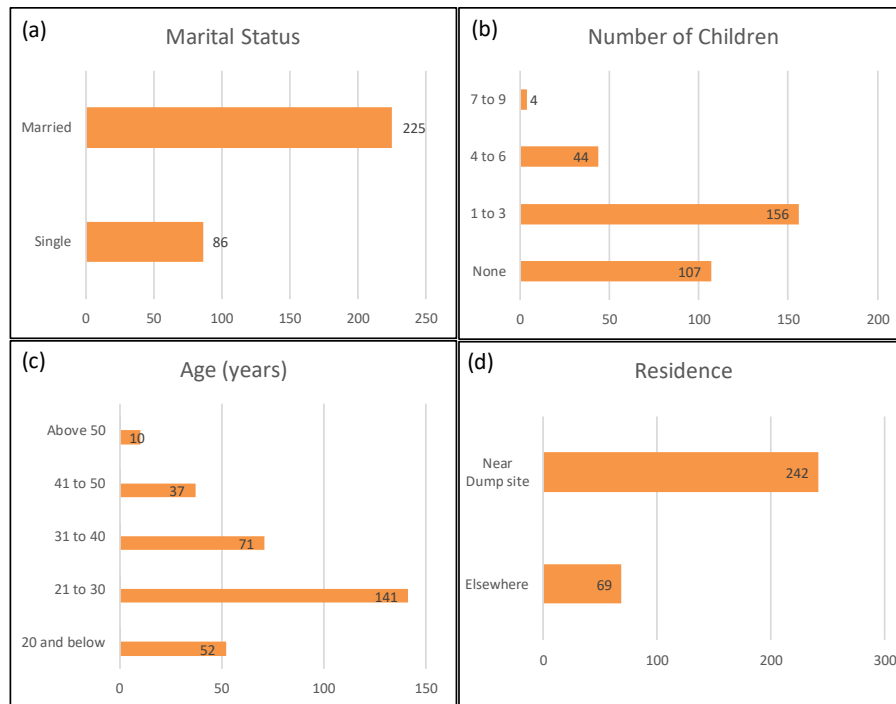


Figure 8. Distribution of respondents by socio-demographic characteristics

In terms of the workers' habits which are health-related, the amount of sleep they get on the average, their nutritional status in terms of the body mass index (BMI), the number of cigarettes consumed per day, and the frequency of consuming alcoholic drinks were summarized on Figure 3.

Young adults and adults, the age brackets in which the waste collectors belong to, need seven to nine hours of sleep daily [29]. The authors also added that sleeping habits too far outside of this recommended range might indicate health problems or if done by choice, would compromise health and well-being of the person. For the solid waste collectors, only 105 out of 311 are well-rested going to work based on Figure 9 (a). More than half of the respondents' sleeping hours lie outside the recommended range. It would be of interest to note its effect on the created models.

The information on the respondents' nutritional status based on their body mass index (BMI) is also shown on Figure 9 (b). It is worth noting that majority of them have normal weight based on their BMI measurement.

Next on Figure 9 (c), only 96 respondents do not smoke. According to studies [50, 51], there is no safe level of smoking and light smokers are still at risk of certain heart and lung diseases. Thus, anyone who smokes cigarettes is at risk.

In terms of consumption of alcoholic drinks, Figure 9 (d) shows quite a spread of the respondents in their frequency of drinking with once a week being the highest with 77 respondents. Almost one-third of the sample population was composed of non-drinkers. Chronic heavy drinking leads to lower immunity and risk to bacterial and viral infections [32]. Since solid waste collectors are exposed to different types of microorganisms that pose risk to their health, it is interesting if alcohol consumption would affect their health.

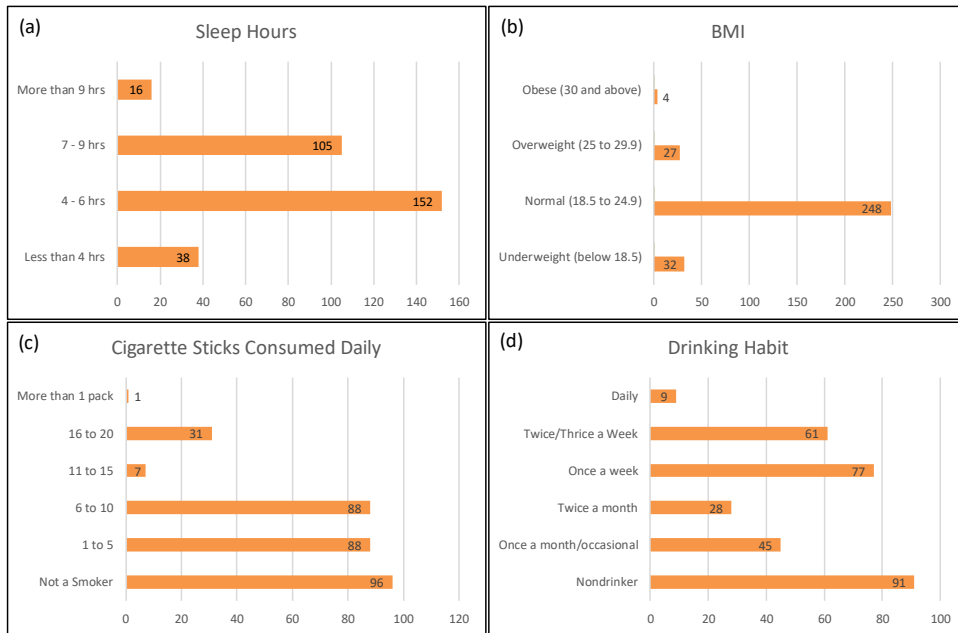


Figure 9. Distribution of respondents by health-related habits

There are five possible routes where a worker may be assigned as shown on Figure 10(a). Residential type route is when the truck goes through an area which are mostly households. Institutional type is where the hospitals and government offices are included. For commercial type, most of the collected wastes come from the public market and other commercial establishments. Both the residential and institutional types have the biodegradable and non-biodegradable routes while for commercial route, the waste type collected is residuals only. Most workers are assigned to residential routes followed by commercial and lastly, institutional routes.

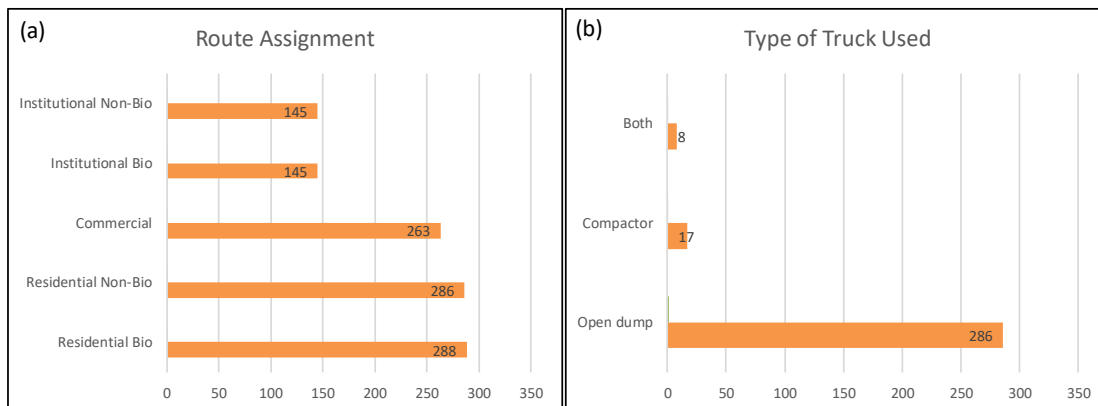


Figure 10. Distribution of workers based on work-related characteristics.

In terms of the type of truck used by the workers, it is apparent in Figure 10 (b) that most trucks used are open dump trucks.

3.1 Prevalence of Symptoms of the Health Problems among Solid Waste Collectors

The prevalence of the symptoms of each health problem among the solid waste collectors is presented on Table 6. The most prevalent among them is MSD symptoms at 39.44%, followed by gastrointestinal symptoms at 21.54%, and lastly, dermatological symptoms with 12.86%. The high prevalence of MSD symptoms may be accounted to the manual nature of the tasks such as lifting and hauling. Aside from these symptoms, majority of the workers (96%) surveyed stated that they have encountered injuries such as puncture wounds and cuts due to sharp objects in the trash.

Table 6. Distribution of respondents by health problems experienced (multiple response).

Self-reported Symptoms	Frequency	Percentage
Musculoskeletal Disorders (MSD)	123	39.55%
Gastrointestinal	67	21.54%
Dermatological	40	12.86%

Table 7 shows each model's adequacy, explained variation, and prediction correctness. The "Sig." column provides the overall statistical significance of the model (namely, how well the model predicts categories compared to no independent variables) [36]. For this type of binomial logistic regression, all the models are statistically significant ($p < 0.05$; "Sig." column).

Another way of assessing the adequacy of the model is to analyze how poor the model is at predicting the categorical outcomes. This is tested using the Hosmer and Lemeshow goodness of fit test results as found on column 3 of the same table. For this test, the resulting value should be greater than 0.05. Otherwise, it would indicate that the model is poor fitting [48]. From Table 7, all the resulting values of the Hosmer and Lemeshow Tests are greater than the alpha and indicates that the models are not of poor fit.

Meanwhile, the Nagelkerke R^2 is used to calculate the explained variation (it is not as straightforward to do this as compared to multiple regression). These values are sometimes referred to as pseudo R^2 values and will have lower values than in multiple regression. However, they are interpreted in the same manner, but with more caution [48]. For the MSD model, the Nagelkerke R^2 of 0.293 indicates that 29.3% of the variation in the dependent variable can be explained by the model. Additionally, the gastrointestinal and dermatological models have Nagelkerke R^2 values of 28.5% and 66.3%, respectively.

The models' prediction correctness can be measured using the Prediction Percentage Correct values in the last three columns of Table 7.

Table 7. Model adequacy, explained variation, and prediction

Model	Sig.	Hosmer and Lemeshow Test	Nagelkerke R^2	Prediction Percentage Correct		
				No	Yes	Overall
(1) MSD	0.000	0.378	0.293	79.7	56.8	70.6
(2) Gastrointestinal	0.000	0.413	0.285	95.4	29.5	82.1
(3) Dermatological	0.000	0.302	0.663	98.5	69.6	95.5

3.2 Risk Factors of Musculoskeletal Disorders (MSD)

The independent variables selected for the MSD model were entered to binary logistic regression using Stepwise regression method with Backward LR in SPSS. Table 8 shows the results and Equation 4 is the constructed model from the result of the binary logistic regression.

For the variables, the worker's age, his educational attainment, the number of drinks, work demand1 (time pressure), being assigned to institutional biodegradable waste route, and hours of walk at work add significantly to the prediction.

To interpret the odds ratios of the significant factors, the first significant factor is the worker's age, as the worker's age increases by one year, the odds of having MSD increases by 1.037 since the human body is more susceptible to disease as it ages. Next, the overall variable educational level attained is also statistically significant but none of the specific levels of this variable is statistically significant.

On the other hand, an increase in the number of alcoholic drinks taken by a worker increases his risk of having MSD by 1.047 times. The next variable is work demand in terms of due time needed to meet also affects the workers such that those who perceive that their tasks can be finished within the target due time "Seldom", the odds of having MSD is increased by 5.305 times as compared to those who "Sometimes" feel that way.

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Table 8. Binary logistic regression model for MSD presence.

Factor	Coefficient	P value	Odds Ratio	95% CI
Age (x_1)	0.036	0.045*	1.037	1.001 – 1.0075
Education Level (x_3)	-	0.041*	-	-
Attended Primary School	0.123	0.907	1.130	0.146 – 8.750
Attended Secondary School	1.045	0.301	2.844	0.393 – 20.568
Volume of Alcoholic Drinks Consumed (x_{12})	0.046	0.004*	1.047	1.015 – 1.080
Work Demand 1 (x_{27})	-	0.005*	-	-
Seldom	1.669	0.003*	5.305	1.747 – 16.110
Sometimes	-0.635	0.243	0.530	0.183 – 1.537
Work demand 2 (x_{28}) Seldom	1.091	0.088	2.978	0.849 – 10.444
Job Training (x_{32})	-0.837	0.084	0.433	0.167 – 1.120
Assigned to Institutional Biodegradable Route (x_{47})	0.758	0.024*	2.133	1.107 – 4.110
Duration of walk (x_{41})	0.269	0.021*	1.308	1.041 – 1.645
Residence (x_8)	0.639	0.095	1.895	0.895 – 4.015

* Significant

$$y_1 = \ln\left(\frac{p_1}{1-p_1}\right) = -23.983 + 0.036x_1 + 0.046x_{12} + 1.669x_{27} + 1.091x_{28} + 0.758x_{47} + 0.269x_{41} \quad (4)$$

Additionally, workers assigned on institutional biodegradable wastes for collection are with higher odds of developing MSD by 2.133. This includes wood and food wastes which are heavy when collected. For the number of hours walked at work, the higher the hours, the odds of having MSD increases by 1.308 which is identical to the findings of Abou-El Wafa [6].

3.3 Risk Factors of Gastrointestinal Problems

The next model is for the presence/absence of gastrointestinal problems. Table 9 shows the outputs from the SPSS run along with the Equation 5, the model constructed.

For this second model, the statistically significant variables are sleeping hours, number of alcoholic drinks, taking baths, and community support. As cited previously, the wellness of a person is sacrificed with less sleep. In this model, the reduction in the number of hours of sleep increases the odds of having gastrointestinal problems. On the other hand, increase intake of alcoholic drinks by one unit would increase the odds of having the disorder by 1.032. The other factor, taking baths, decreases the odds of having gastrointestinal problems. Workers who take baths before work only have higher odds of having gastrointestinal problems than those who take baths before and after work. Interestingly, the perception that the community they are serving often support them increases the odds of having gastrointestinal problems by 4.70.

Table 9. Binary logistic regression model for presence gastrointestinal problems.

Factor	Coefficient	P value	Odds Ratio	95% CI
Hours of sleep (x_9)	-0.287	0.004*	0.750	0.618 – 0.911
Volume of alcoholic drinks consumed (x_{12})	0.032	0.026*	1.032	1.004 – 1.062
Use of uniforms (x_{20})	-24.350	0.999	2.661×10^{-11}	0
Taking baths (x_{25})	-	0.019*	-	-
Before and after work (1)	-1.980	0.006*	0.138	0.034 – 0.563
Before work (2)	-0.211	0.610	0.810	0.360 – 1.820
Perception of community support (x_{29})	-	0.004*	-	-
Seldom (1)	0.164	0.912	1.178	0.064 – 21.854
Sometimes (2)	-19.419	0.998	3.684×10^{-9}	0
Often (3)	-0.458	0.409	0.633	0.213 – 1.878
Always (4)	1.548	0.001*	4.700	1.934 – 11.418

*Significant factor

$$y_2 = \ln\left(\frac{p_2}{1-p_2}\right) = 24.485 - 0.287x_9 + 0.032x_{12} - 1.980x_{25} + 1.548x_{29} \quad (5)$$

3.4 Risk Factors of Dermatological Problems

For the dermatological model, the statistically significant variables are the number of sticks of cigarettes consumed daily, work demands, community support, and assignment to institutional type of waste as shown in Table 10 and the model as Equation 6.

Interpreting the odds ratio for the cigarette sticks smoked per day, as the number of sticks increase by one, the odds also increases by 1.114. On the other hand, for the work demand in terms of time pressure, as the frequency of having the job within the deadline changes from “Seldom” to “Always” the odds increases. The same trend can be observed if the change is from “Sometimes” to “Always”. On the case of work demand in terms of capability to do the task, the odds also increase as the frequency of having the job within capability changes from “Sometimes” to “Always”.

Meanwhile, for community support, the odds is reduced as the workers perceive that the community that they serve cooperates with them in terms of the segregation of the solid wastes and on timely taking out of their trash.

Lastly, the assignment to institutional non-biodegradable wastes reduces the odds of having dermatological problems. This could be due to the lack of infectious and hazardous wastes included on this type.

Table 10. Binary logistic regression model for presence dermatological problems.

Factor	Coefficient	P value	Odds Ratio	95% CI
No. of children (x_6)	-	0.6590	-	-
1	13.637	0.9997	836539.254	0
2	11.300	0.9998	80884.950	0
3	14.073	0.9997	1293491.856	0
4	12.110	0.9998	181748.932	0
5	12.416	0.9998	246702.285	0
6	19.879	0.9996	429706633.7	0
7	-11.165	0.9998	1.416×10^{-05}	0
8	117.592	0.9984	1.173×10^{51}	0
Medical History (x_7)	-	0.7668	-	-
1	-17.582	0.9997	2.313×10^{-08}	0
2	-16.335	0.9997	8.049×10^{-08}	0
3	-64.554	0.9988	9.215×10^{-29}	0
4	-58.503	0.9989	3.911×10^{-26}	0
5	-39.730	0.9993	5.563×10^{-18}	0
Sticks of cigarettes consumed daily (x_{10})	0.107	0.050*	1.114	1.000 – 1.240
Use of Boots (PPE) (1) (x_{17})	-18.208	0.995	1.237×10^{-08}	0
Freq. of PPE use (x_{13})		0.448	-	-
Sometimes (2)	-16.416	0.999	7.42×10^{-08}	0
Often (3)	-32.007	0.994	1.257×10^{-14}	0
Always (4)	1.329	0.103	3.778	0.763 – 18.708
Taking baths (x_{25})		0.529	-	-
Before and after work (1)	-33.676	0.994	2.370×10^{-15}	0
Before work (2)	0.857	0.259	2.357	0.532 – 10.446
Work demand 1 (x_{27})	-	0.001*	-	-
Seldom (1)	2.603	0.012*	13.508	1.767 – 103.254
Sometimes (2)	4.675	0.0002*	107.238	8.867 – 1296.932
Work demand 2	7.445	0.0001*	1711.940	38.559 – 76007.021
Seldom (1) (x_{28})				
Community support (x_{29})	-	0.353	-	-
Seldom (1)	35.526	0.996	2.683×10^{15}	0
Sometimes (2)	-0.996	0.657	0.369	0.004 – 29.961
Often (3)	-1.937	0.130	0.144	0.012 – 1.768
Always (4)	-2.087	0.043*	0.124	0.016 – 0.938
Years as Solid waste collector (x_{35})	-0.175	0.097	0.839	0.683 – 1.032
Assigned to Institutional NonBio (x_{48})	-1.709	0.049*	0.181	0.033 – 0.994

*Significant factor

$$y_3 = \ln\left(\frac{p_3}{1-p_3}\right) = 18.896 + 0.107x_{10} + 2.603x_{27} + 4.675x_{27} + 7.445x_{28} - 2.087x_{29} - 1.709x_{48} \quad (6)$$

3.5 Summary of the Risk Factors

Tables 11 to 14 were provided to summarize the individual, behavioral, psychosocial, and work-related risk factors associated with the three health problems.

Table 11. Summary of individual risk factors for each health problem

Individual Risk Factors		Health Problem Associated		
		MS D	Gastrointestinal	Dermatological
x_1	age (years)	✓		
x_2	marital status			
x_3	educational level	✓		
x_4	height			
x_5	body mass index (BMI)			
x_6	number of children			
x_7	family medical history			
x_8	worker residence			

Table 12. Summary of behavioral risk factors for each health problem

Behavioral Risk Factors		Health Problem Associated		
		MSD	Gastrointestinal	Dermatological
x_9	Sleep hours daily		✓	
x_{10}	Cigarette sticks consumed daily			✓
x_{11}	Alcohol consumption frequency			
x_{12}	Volume of alcoholic drinks consumed	✓	✓	
x_{13}	Frequency of PPE use			
x_{14} to x_{21}	Use of facemask, gloves, closed shoes, boots, cap, raincoat, uniform, dustpan and broom			
x_{22}	Washing of hands after work			
x_{23}	Washing hands before eating			
x_{24}	Washing implements used			
x_{25}	Frequency of taking baths		✓	

Table 13 Summary of psychosocial risk factors for each health problem

Psychosocial Risk Factors		Health Problem Associated		
		MSD	Gastrointestinal	Dermatological
X ₂₆	Decision latitude			
X ₂₇	Work demand 1	✓		✓
X ₂₈	Work Demand 2			✓
X ₂₉	Community support		✓	✓
X ₃₀	Social support from co-workers			
X ₃₁	Management feedback			
X ₃₂	Discrimination			

Table 14 Summary of work-related risk factors for each health problem

Work-related Risk Factors		Health Problem Associated		
		MSD	Gastrointestinal	Dermatological
X ₃₃	Other jobs			
X ₃₄	Number of shifts served			
X ₃₅	Years in service			
X ₃₆	Job training			
X ₃₇	Safety training			
X ₃₈	Company Policies training			
X ₃₉	Perception of loads lifted/pushed/pulled			
X ₄₀	Experienced awkward postures			
X ₄₁	Duration of long walks	✓		
X ₄₂	Duration of static loading			
X ₄₃	Forceful exertions			
X ₄₄	Collection vehicle			
X ₄₅	Assigned to residential-bio route			
X ₄₆	Assigned to residential-nonbio route			
X ₄₇	Assigned to institutional-bio route	✓		
X ₄₈	Assigned to institutional-nonbio route			✓
X ₄₉	Assigned to commercial (residuals) route			

IV. VALIDATION OF MODELS

To validate the models, their parameters were saved and the Scoring Wizard in SPSS was applied. Predictions of the response variable values were taken from the results and compared with the actual values. Table 15 shows the results for all the three models created. The correct predictions (predicted vs. actual value) are highest in Model 3 at 72.22% and lowest at 56.67% in Model 1. However, the predicted probability for each model is high and is a good indication for the generated models. The lowest value percent correct value encountered is for the MSD model. This may due to the other factors related to MSD that were not captured using the data collection approach, i.e. posture of workers. Studies specific to MSD problems may be done to focus on the issues related to it.

Table 15. Results from the validation done using SPSS scoring wizard

Model	Average Predicted Probability	Average Selected Probability	Average Confidence	Percent Correct
(1) MSD	0.718	0.427	0.718	56.67%
(2) Gastrointestinal	0.791	0.233	0.791	66.67%
(3) Dermatological	0.812	0.276	0.812	72.22%

V. CONCLUSIONS AND RECOMMENDATIONS

The study found out that the prevalence of the health problems common in solid waste collectors in the Philippines, including the result of the previous study [1], are ranked as: MSD, gastrointestinal, respiratory, and dermatological problems. As compared to previous literatures, the top health problem is MSD followed by the others but no fixed trend in their prevalence ranking. An interesting finding also from the study is that 96.46% of the workers encounter work-related injuries such as cuts, punctures, and abrasions from sharp materials like broken glass, barbeque sticks, and opened cans. It would help if those materials are segregated from the rest of the wastes with label so that the collectors can safeguard themselves from injuries.

The workers should be strengthened to be able to mitigate the effects of the wastes and the nature of the job. In the physical aspect, it would be preferable to have younger workers. It was also found that around 10% of the respondents were underweight. The government should set up projects for work sectors such as this to improve their nutrition and health.

The workers should also be given proper information and education on the risks of drinking alcohol and proper hygiene. Trainings that would empower the workers, especially with their role in the society, should be conducted. There should also be better feedback system that would allow the workers to feel that they belong in the organization.

Since there are collection routes that are less hazardous to the health such as the non-biodegradable routes, the routes should be balanced so that there is no one worker who is exposed to the more hazardous types of wastes. It is also suggested that there be a review of the areas covered per truck so that the workload will be balanced among the workers.

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REFERENCES

- [1] L. Mariano and A. Matias. "Prevalence and Risk Factors of Respiratory Problems among Solid Waste Collectors in the Philippines," in *8th International Conference on Human Factors and Ergonomics: Advances in the Human Side of Service Engineering, Advances in Intelligent Systems and Computing*, Los Angeles, CA, 2017, Vol. 601, pp. 82– 89.
- [2] D. Bogale, A. Kumie, and W. Tefera. (2014, Feb). "Assessment of occupational injuries among Addis Ababa city municipal solid waste collectors: A cross-sectional study". *BioMed Central* [Online]. vol. 14, issue 169. Available: <http://www.ncbi.nlm.nih.gov/pubmed/24528849>
- [3] H. An et al. (1999, June). "Occupational health and safety amongst municipal solid waste workers in Florida". *Waste Management and Research* [Online], vol. 17, issue 369. Available: <http://wmr.sagepub.com/content/17/5/369.full.pdf>
- [4] M. S. H. Aminuddin, and H. A. Rahman. (2015, Aug). "Health risk survey for domestic waste management agency workers: Case study on Kota Bharu Municipal Council (MPKB), Kelantan, Malaysia". *International Journal of Environmental Science and Development* [Online], vol. 6, issue 8. Available: <http://www.ijesd.org/index.php?m=content&c=index&a=show&catid=68&id=1026>
- [5] R. Mehrdad et al. (2008, Jan). "Musculoskeletal disorders among municipal solid waste workers". *Acta Medica Iranica* [Online], vol. 46, issue 3. Available: <https://www.researchgate.net/publication/229001733>
- [6] H. S. Abou-ElWafa et al. (2012, Sep). "Musculoskeletal disorders among municipal solid waste collectors in Mansoura, Egypt: A cross-sectional study". *BMJ Open* [Online], vol. 2. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3467652/>
- [7] U. I. Ivens et al. (1999). "Exposure-response relationship between gastrointestinal problems among waste collectors and bioaerosol exposure". *Scandinavian Journal of Work Environment Health* [Online], vol. 25, issue 3. Available: <http://www.ncbi.nlm.nih.gov/pubmed/10450775>
- [8] D. U. Park et al. (2011, Oct). "An assessment of dust, endotoxin, and microorganism exposure during waste collection and sorting". *Journal of Air and Waste Management Association* [Online], vol. 61, issue 4. Available: <http://dx.doi.org/10.3155/1047-3289.61.4.461>
- [9] A. Luttmann et al. (2003). *Preventing musculoskeletal disorders in the workplace* [Online]. Available: https://www.who.int/occupational_health/publications/en/oehtmsd3.pdf
- [10] Occupational Safety and Health Administration. (OSHA). (19 Apr 2019). *Ergonomics* [Online]. Available: <https://www.osha.gov/SLTC/ergonomics/>
- [11] Drugs.com. (19 Apr 2019). *Gastrointestinal Disorders* [Online]. Available: <https://www.drugs.com/article/gastrointestinal-disorders.html>
- [12] MedlinePlus. (19 Apr 2019). *Digestive diseases* [Online]. Available: <https://medlineplus.gov/ency/article/007447.htm>
- [13] American College of Gastroenterology. (19 Apr 2019). *Common GI Symptoms* [Online]. Available: <http://patients.gi.org/topics/common-gi-symptoms/#tabs2>
- [14] MedlinePlus. (19 Apr 2019). *Skin Health and Skin Diseases* [Online]. Available: <https://medlineplus.gov/magazine/issues/fall08/articles/fall08pg22-25.html>
- [15] National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS). (19 Apr 2019). *Skin Diseases* [Online]. Available: <https://www.niams.nih.gov/health-topics/skin-diseases>
- [16] Department of Labor and Employment. "Book IV – Health, Safety and Social Welfare Benefits," [Online]. 2014. Available: <https://blr.dole.gov.ph/2014/12/11/book-iv-health-safety-and-social-welfare-benefits/>
- [17] Department of Labor and Employment. "Occupational safety and health standards," [Online]. 1990. Available: <http://www.oshc.dole.gov.ph/images/Files/OSH%20Standards%202017.pdf>
- [18] Occupational Safety and Health Center. "National profile on occupational safety and health," [Online]. 2006. Available: <http://www.oshc.dole.gov.ph/29/OSH-INFO-MATERIALS/>
- [19] J. L. D. Lu. (2014). "Trends of occupational injury in the Philippines: Implications for policy". *Occupational and Environmental Medicine* [Online]. vol. 71. Available: http://oem.bmj.com/content/71/Suppl_1/A57.1.abstract?sid=f108c4d1-28f6-4fab-9b35-c5a6e65a583c
- [20] World Health Organization. (2019 April 28). *Risk factors* [Online]. Available: https://www.who.int/topics/risk_factors/en/
- [21] B. Heiden et al. (2013, Feb). "Association of age and physical job demands with musculoskeletal disorders in nurses". *Applied Ergonomics* [Online]. vol. 44, issue 4. Available: https://www.researchgate.net/publication/235520697_Association_of_age_and_physical_job_demands_with_musculoskeletal_disorders_in_nurses

- [22] B. Kaka et al. (2016, Jan). "An analysis of work-related musculoskeletal disorders among butchers in Kano Metropolis, Nigeria". *Safety and Health at Work* [Online]. vol. 7, issue 3. Available: https://www.researchgate.net/publication/290623016_An_Analysis_of_Work-Related_Musculoskeletal_Disorders_Among_Butchers_in_Kano_Metropolis_Nigeria
- [23] E. A. Ostrakhovitch and S. Tabibzadeh (2019, Jan). "Homocysteine and age-associated disorders". *Ageing Research Reviews* [Online], vol. 49. Available: <https://www.sciencedirect.com/science/article/pii/S1568163718300771>
- [24] A. Escolar-Pujolar et al. (2018, Jan). "The effect of marital status on social and gender inequalities in diabetes mortality in Andalusia". *Endocrinología, Diabetes y Nutrición* [Online], vol. 65, issue 1. Available: <https://www.ncbi.nlm.nih.gov/pubmed/29233513>
- [25] J. Xie et al. (2018, Oct). "Marital status is associated with survival of patients with astrocytoma". *Journal of Clinical Neuroscience* [Online], vol. 56. Available: [https://www.jocn-journal.com/article/S0967-5868\(18\)30421-1/fulltext](https://www.jocn-journal.com/article/S0967-5868(18)30421-1/fulltext)
- [26] M. Kortt, and J. Baldry (2002, Feb). "The association between musculoskeletal disorders and obesity". *Australian Health Review* [Online], vol. 25, issue 6. Available: https://www.researchgate.net/publication/10942497_The_association_between_musculoskeletal_disorders_and_obesity
- [27] R. Shiri et al. (2010, Jan). "The association between obesity and low back pain: a meta-analysis". *American Journal of Epidemiology*, [Online]. vol. 171, issue 2. Available: https://www.researchgate.net/publication/40685737_The_Association_Between_Obesity_and_Low_Back_Pain_A_Meta-Analysis
- [28] I. C. Fischlmayr, "Synergy A Training Design for Behavioral Factors in Virtual Multicultural Teams," in *Handbook of Research on Electronic Collaboration and Organizational* [Online], T. Cable, N. Seattle-Murphy, V. Moxley, K. Hussin, C. Keirse, Eds. 2009. Available: <https://www.igi-global.com/chapter/training-design-behavioral-factors-virtual/20172>
- [29] M. Hirshkowitz et al. (2015, Dec). "National Sleep Foundation's updated sleep duration recommendations: final report". *Journal of the National Sleep Foundation* [Online]. vol. 1, issue 4. Available: <https://www.sciencedirect.com/science/article/pii/S2352721815001606>
- [30] P. Shorrocks and N. Bakerly. (2019, Feb). "Effects of smoking on health and anaesthesia". *Anaesthesia & Intensive Care Medicine* [Online]. vol. 20, issue 2, Available: [https://www.anaesthesiajournal.co.uk/article/S1472-0299\(18\)30277-7/abstract](https://www.anaesthesiajournal.co.uk/article/S1472-0299(18)30277-7/abstract)
- [31] K. E. Warner. (2015). "Smoking and Health". *International Encyclopedia of the Social & Behavioral Sciences (Second Edition)* [Online]. Available: <https://www.sciencedirect.com/science/article/pii/B9780080970868140498>
- [32] T. Barr et al. (2016, Feb). "Opposing effects of alcohol on the immune system". *Progress in Neuro-Psychopharmacology and Biological Psychiatry* [Online]. vol. 65. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4911891/>
- [33] Health and Safety Executive (HSE). (2019 May 16). *What are psychosocial risk factors?* [Online]. Available: <http://www.hse.gov.uk/msd/mac/psychosocial.htm>
- [34] L. Levi (2011 Jan 11). *Psychosocial Factors, Stress and Health* [Online]. Available: <http://www.iloencyclopaedia.org/part-v-77965/psychosocial-and-organizational-factors/theories-of-job-stress/58-theories-of-job-stress/psychosocial-factors-stress-and-health>
- [35] N. Schneiderman, G. Ironson, and S. D. Siegel. (2005). "STRESS AND HEALTH: Psychological, Behavioral, and Biological Determinants". *Annu Rev Clin Psychol.* [Online]. vol. 1. Available: <https://www.ncbi.nlm.nih.gov/pubmed/17716101>
- [36] M. V. Garrido et al. (2015). "Health status and health-related quality of life of municipal solid waste collection workers – a cross-sectional survey". *Journal of Occupational Medicine and Toxicology* [Online], vol. 10, issue 22. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4493964/>
- [37] D. R. Smith et al. (2004). "Musculoskeletal complaints and psychosocial risk factors among Chinese hospital nurses". *Occupational Medicine* [Online], vol. 54, issue 8. Available: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.565.8598&rep=rep1&type=pdf>
- [38] M. Snel. "Social stigmas and the waste collection scheme," in 25th WEDC Conference: Integrated Development for Water Supply and Sanitation. Addis Ababa, Ethiopia. 1999.
- [39] M. Tateda. (2008, June). "Commentary: identifying the fundamental key to improving the social status of waste management workers by examining the history of nursing". *Environmental Practice* [Online]. vol. 10, issue 2. Available: <https://www.tandfonline.com/doi/abs/10.1017/S1466046608080101>
- [40] B.Y. Jeong, S. Lee, and J. D. Lee. (2016) "Workplace Accidents and Work-related Illnesses of Household Waste Collectors". *Safety and Health at Work* [Online]. vol. 7, issue 2. Available: <https://www.ncbi.nlm.nih.gov/pubmed/27340601>

- [41] Environmental Management Bureau (EMB). "Solid Wastes," [Online]. Available: <https://emb.gov.ph/wp-content/uploads/2018/09/3-Solid-Waste-1.8.pdf>
- [42] C. P. Lugay, Jr., "Predictive model of loss time due to low back pain among garment sewers in Bulacan," Master's thesis, Dept. of IE-OR, UP Diliman, Diliman, Quezon City, 1999.
- [43] Health Improvement Organization. "Health at Work Profile Report: Results of the Comprehensive Workplace Health Needs Assessment Questionnaire (Sample report)," [Online]. Available: <http://www.myhio.org/sites/default/files/1.4sampleaggregate.pdf>
- [44] Health and Safety Executive. "Health and Safety Executive (HSE) Management Standards Indicator Tool," [Online]. Available: <http://www.hse.gov.uk/stress/standards/pdfs/indicatortool.pdf>
- [45] I. Kuorinka et al. (1987, Sep). "Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms". *Applied Ergonomics*. [Online]. vol.18, issue 3. Available: <https://www.sciencedirect.com/science/article/pii/000368708790010X>
- [46] Workplace Safety and Prevention Services (2011). "Discomfort Survey," [Online], October 2011. Available: http://www.wspss.ca/WSPS/media/Site/Resources/Downloads/Discomfort_Survey_final.pdf?ext=.pdf
- [47] W. Cochran, *Sampling Techniques*, 3rd Ed. New York: John Wiley and Sons, Inc., 1977.
- [48] Laerd Statistics (2019). *Binomial logistic regression using SPSS Statistics* [Online]. Available: <https://statistics.laerd.com>
- [49] NCSS.com. (n.d.). *Logistic regression* [Online]. Available: <https://ncss-wpengine.netdna-ssl.com/ncss/pdf/Procedures/NCSS>
- [50] Bjartveit, K., & Tverda, A. (2005, Oct). "Health consequences of smoking 1–4 cigarettes per day". *Tobacco Control*. vol. 14, issue 5. Available: <https://www.ncbi.nlm.nih.gov/pubmed/16183982>
- [51] R. E. Schane, P. M. Ling, and S. A. Glantz. (2010, Apr). "Health effects of light and intermittent smoking: A review". *NIH Public Access* [Online]. vol. 121, issue 13. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2865193/>

