

The relationship between socio-demographic characteristics, safety awareness, and safety behaviors among workers in e-waste recycling shops in Thailand

Decharat S¹, Kiddee P²

¹Department of Occupational Health and Safety, Faculty of Health and Sports Science, Thaksin University, Thailand

²Department of Biological and Environmental Sciences, Faculty of Science, Thaksin University, Thailand

Corresponding author:

Somsiri Decharat PhD
Associate Professor,
Department of Occupational
Health and Safety, Faculty of
Health and Sports Science,
Thaksin University, Thailand
E-mail: somsiri_9@hotmail.com
ORCID: <https://orcid.org/0000-0001-7621-2008>

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ABSTRACT

Introduction: Safety behavior is an approach to workplace safety that focuses on workers' behavior as the cause of most work-related injuries and illnesses. Some of the effects of e-waste recycling may occur on health.

Methods: A cross-sectional study was conducted between January and July 2021, with e-waste workers living in Southern Thailand. The study was conducted among 272 e-waste workers who worked in 136 recycling shops in Southern Thailand. The average score value was interpreted using the interpretive criteria divided into three levels. Descriptive and multilinear regression analyses were done and p-value < 0.05 was considered statistically significant.

Results: This study found that the majority of e-waste workers were male (96.30%). E-waste workers who smoked cigarettes, drank alcohol, worked ≥ 8 hours per day, ≥ 6 days/week, and had worked for >13 years had significantly lower safety behavior practice levels compared to e-waste workers who did not smoke cigarettes, did not have drank alcohol, worked < 8 hours per day, < 6 days/week, and ≤ 13 years. Health effects on e-waste workers in e-waste recycling shops were significantly associated with hours worked per day, days worked per week and the use of masks and gloves. In addition, a significant relationship was found between safety behaviors and safety awareness ($F: 597.457; p < 0.001$).

Conclusions: Safety behavior is very important. Meanwhile, raising awareness with safety factors in mind is important because it makes safety behaviors sustainable.

Keywords: E-Waste Workers, Safety Awareness, Safety Behaviors, Socio-Demographic Characteristics

Introduction

Safety is hard to focus on the tasks when you have to be concerned about threats of injury or harm. Safety awareness is the mindset that determines employee perceptions and judgments about personal abilities and responsibilities to avoid workplace hazards. Safety behavior (SB) is the behavior of an individual according to safety policies and procedures.¹ It is an approach to workplace safety that focuses on workers'

behaviors the cause of most work-related injuries and illnesses.² The e-waste process involves many steps, including weighing, recording, and sorting products, disassembling, smash-grinding, component sorting, breaking into small pieces, and the extraction/fragmentation of precious metals, respectively. Some of the effects of e-waste recycling on health include nasal irritation, coughing/sneezing, inconvenient

breathing/jamming symptoms, peeling of skin, and muscle aches.^{3,4} To minimize the potential risks among e-waste workers, it is necessary to comply with applying quality management systems that reveal the current situation regarding employee health and safety and to raise the safety awareness of e-waste workers. In the real state of Thailand, most e-waste businesses are informal and operate as family-owned businesses, so there is a gap in the control or management in terms of ensuring that the business is legally appropriate and reduces the impact on health and the environment, as well as there being little access to safety knowledge among this group of workers. This research is thought to contribute to providing the necessary information to fill this gap. Thus, the objectives of this study are to examine the relationship between socio-demographic characteristics and health effects among e-waste workers, and their refer to the socio-demographic behaviors influence safety awareness and safety behaviors among e-waste workers in e-waste recycling shops in Thailand.

Methods

This is a cross-sectional descriptive study and comprised of 272 e-waste workers who worked in 136 recycling shops in Southern Thailand. The study sample was selected by multi-stage sampling method by randomization of e-waste recycling shops located in the Mueang districts of all 14 provinces in Southern Thailand. There were 212 shops in total. The calculation of sample size used the Krejcie and Morgan method, at a confidence level of 95% and a confidence interval of 5.⁵ A total of 136 recycling shops were assigned a purposive sample of two employees per shop. Therefore, 272 e-waste workers were in this study. The e-waste workers were aged between 20 and 60 years old, had been working with recycling shops for at least one year, and agreed to participate in the research. The data was collected between January and July 2021 and ethical approval was obtained from The Ethics Committee of the Institute of Research and Development, Thaksin University (COA No. TSU 2021-037 REC No.0019).

The questionnaire included three sections: 1) socio-demographic characteristics (14 items); 2) safety awareness (20) items; and 3) safety behaviors (20 items). Data were collected from e-waste workers. The questionnaire has shown internal consistency and had a very high Cronbach's value of 0.870. For the safety awareness and safety behaviors toward hazardous waste variables among e-waste workers, the cumulative scores were high, moderate, and low, measured on a 3-point Likert scale scoring 1, 2, and 3, respectively.⁶ The average score value was interpreted using the interpretive criteria divided into three levels as follows:

An average score of between 2.34 and 3.00 means the levels of safety awareness and safety behaviors are high; an average score of between 1.68 and 2.33 means the levels of safety awareness and safety behaviors are moderate; and an average score of between 1.00 and 1.67 means the levels of safety awareness and safety behaviors are low.

Chi-square tests were used to compare the differences between e-waste workers with differences in socio-demographic factors. The multilinear regression model was used to find the relationship between safety behaviors and safety awareness.

Results

This study showed that the majority of e-waste workers were male (96.30%) and 77.21% had an education to a high school level. Half of the e-waste workers (50%) smoked cigarettes and 60.29% drank alcohol. The majority of e-waste workers (73.53%) worked 8 hours per day and 6 days per week (65.80%). Most of the e-waste workers (63.24%) had a mean(SD) of 13(3.52) years of working with e-waste. With regard to personal hygiene behavior, this study showed that the e-waste workers used masks, gloves, safety boots, and safety glasses (63.97%, 72.79%, 57.72%, and 31.99%, respectively). The e-waste workers always washed their hands before lunch (46.69%), washed their hands with detergents (49.26%), and changed clothes after work (19.49%).

Table 1: Socio-demographic characteristics and the percentages of safety awareness of the e-workers

Items	Number (%)	Safety Awareness (n = 272)			Average of safety awareness (SD)	p-value
		Low (n=142)(%)	Moderate (n=64)(%)	High (n=66)(%)		
Sex						
Male	262(96.30)	141(51.84)	57(20.96)	64(23.53)	1.40(0.21)	<0.001*
Female	10(3.67)	1(0.36)	7(2.58)	2(0.73)	2.30(0.11)	
Education levels						
High school education level	210(77.21)	140(51.47)	60(22.06)	10(3.68)	1.45(0.19)	<0.001*
More than high school education level	62(22.79)	2(0.74)	4(1.47)	56(20.59)	2.58(0.14)	
Cigarette smoked						
Yes	136(50.00)	96(35.29)	22(8.09)	18(6.62)	1.49(0.11)	<0.001*
No	136(50.00)	46(16.91)	42(15.44)	48(17.65)	2.29(0.13)	
Drank alcohol						
Yes	108(39.71)	90(33.09)	10(3.68)	8(2.94)	1.47(0.13)	<0.001*
No	164(60.29)	52(19.12)	54(19.85)	58(21.32)	2.27(0.12)	
Occupational lifestyle						
Hours worked						
per day 8 hrs.	200(73.53)	75(27.57)	61(22.43)	64(23.53)	2.31(0.14)	0.028*
≥ 8 hrs.	72(26.47)	67(24.63)	3(1.10)	2(0.74)	1.47(0.16)	
Days worked per week						
6 days/week	179(65.80)	55(20.22)	62(22.79)	62(22.79)	1.99(0.12)	<0.001*
≥6 days/week	93(34.20)	87(31.99)	2(0.74)	4(1.74)	1.24(0.11)	
Years of worked						
≤13 years	172(63.24)	88(32.35)	24(8.82)	60(22.07)	1.89(0.10)	<0.001*
>13 years	100(36.76)	54(19.85)	40(14.71)	6(2.20)	1.21(0.09)	
Mean±SD;13±3.52 years						

*Significantly association at 0.05

This study found that most males had a low percentage of safety awareness (51.84%) when compared with females and percentages of other levels of safety awareness, and e-waste workers who had high school education levels also had a low percentage of safety awareness (51.47%) when compared with e-waste workers who had more than a high school education level. Most of the e-waste workers who smoked cigarettes had a low percentage (35.29%) of safety awareness when compared with those who did not smoke

cigarettes, and e-waste workers who drank alcohol had a low percentage (33.09%) of safety awareness when compared with those who did not drink alcohol. Most of the e-waste workers who worked 8 hours per day, ≥6 days per week, and ≤ 13 years of work had low percentages (27.57%, 31.99%, and 32.35%) of safety awareness when compared with e-workers who worked <8 hours per day, ≤ 6 days/week, and ≤13 years of work, respectively. Regarding socio-demographic characteristics of the e-waste workers, it was

found that safety awareness levels differed significantly; e-waste workers who were male had significantly higher safety awareness levels compared to those who were female ($p<0.001$). E-waste workers who had high school education level / vocational certificate levels showed significantly lower safety awareness levels compared to those who had more than a high school education level / vocational certificate ($p<0.001$). E-waste workers who smoked cigarettes and drank alcohol had significantly lower safety awareness levels compared to those who did not smoke or drink alcohol ($p<0.001$). In addition, e-waste workers who worked ≥ 8 hours per day, ≥ 6 days per week, and > 13 years of work showed significantly lower safety awareness levels

compared to those who worked ≤ 8 hours per day, days per week and working years ($p=0.028$, $p<0.001$, $p<0.001$), respectively (Table 1).

Concerning socio-demographic characteristics of the e-waste workers, it was found male participants and those with high school education levels had significantly higher safety behavior practice levels compared to females and those with high school education levels. In addition, e-waste workers who smoked cigarettes, drank alcohol, worked ≥ 8 hours per day, ≥ 6 days per week, and >13 years had significantly lower safety behaviors practice levels compared to e-waste workers who did not smoke cigarettes or drink alcohol, worked < 8 hours per day, < 6 day/week, and ≤ 13 years ($p<0.001$) (Table 2).

Table 2: Socio-demographic characteristics and the percentages of safety behaviors of the e-workers (n = 272)

Items	Number (%)	Safety behaviors						
		Used mask (n=174) (%)	Used gloves (n=198) (%)	Used boot safety (n=157) (%)	Used glasses safety (n=87) (%)	Washed hands with detergent (n=127) (%)	Washed hands before lunch (n=134) (%)	Change cloth after worked (n=53) (%)
Sex								
Male	262 (96.30)	172 (63.24)	193 (70.96)	156 (57.35)	85 (31.25)	120 (44.11)	127 (46.69)	51 (18.75)
Female	10 (3.67)	2 (0.74)	5 (1.83)	1 (0.36)	2 (0.73)	7 (2.57)	7 (2.57)	2 (0.73)
Education levels								
High school education level	210 (77.21)	118 (43.38)	136 (50.00)	132 (48.53)	60 (22.06)	85 (31.25)	71 (26.10)	32 (11.76)
More than high school education level	62 (22.79)	54 (19.85)	62 (22.97)	25 (9.19)	27 (9.93)	42 (15.44)	63 (23.16)	21 (7.72)
Cigarette smoked								
Yes	136 (50.00)	84 (30.88)	74 (27.21)	45 (16.54)	19 (6.99)	22 (8.09)	20 (7.35)	24 (8.82)
No	136 (50.00)	90 (33.09)	124 (45.59)	112 (41.18)	68 (25.00)	105 (38.60)	124 (45.59)	29 (10.66)
Drank alcohol								
Yes	108 (39.71)	83 (30.51)	84 (30.88)	26 (9.56)	28 (10.29)	13 (4.78)	29 (10.66)	22 (8.09)
No	164 (60.29)	91 (33.45)	114 (41.91)	131 (48.16)	59 (21.69)	114 (41.91)	105 (38.60)	31 (11.39)

Occupational lifestyle								
Hours worked per day								
8 hrs.	200 (73.53)	142 (52.21)	148 (54.41)	107 (39.34)	67 (24.63)	103 (37.87)	110 (40.44)	5 (1.84)
≥8 hrs.	72 (26.47)	58 (21.32)	50 (18.38)	50 (18.38)	20 (7.35)	24 (8.82)	34 (12.50)	48 (17.65)
Days worked per week								
6 days/week	179 (65.80)	149 (54.78)	142 (52.21)	124 (45.59)	69 (25.37)	117 (43.01)	112 (41.18)	23 (8.46)
≥6 days/week	93 (34.20)	25 (9.19)	56 (20.59)	33 (12.13)	18 (6.61)	10 (3.68)	22 (8.09)	30 (11.03)
Years of worked								
≤13 years	172 (63.24)	154 (56.62)	145 (53.31)	130 (47.79)	45 (16.54)	108 (39.71)	114 (41.91)	25 (9.19)
>13 years	100 (36.76)	20 (7.35)	53 (19.49)	27 (9.93)	42 (15.44)	19 (6.99)	20 (7.35)	28 (10.29)
Mean±SD;13±3.52 years								
Total average of safety behaviors (SD)	272 (100)	1.98 (0.12)	1.68 (0.10)	1.43 (0.08)	1.45 (0.11)	2.08 (0.17)	2.14 (0.18)	1.23 (0.07)

To explore the factors associated with the health effects of e-waste workers, a chi-square test was first done to compare the differences between e-waste workers with differences in socio-demographic factors. The result of this study showed that differing sexes and high school education levels were found to be statistically associated with the health effects among e-waste workers, including illness due to an accident, injury/cuts with sharp objects, muscle aches, cough/sneeze, nasal irritation/nasal sting, skin rash/inflammation, eye irritation, at $p<0.001$. The result of this study showed that differing drinking alcohol and working ≥ 6 days per week were found to be statistically associated with the health effects among e-waste workers, including accidental illness, injury/pricking with sharp objects, and muscle aches, at $p<0.001$. In addition, the differences between those who worked ≥ 8 hours per day and those who worked ≥ 13 years were shown to be statistically significantly associated with the health effects among e-waste workers, including accidental illness, injury/pricking with sharp objects, muscle aches, cough/sneeze, nasal

irritation/nasal sting, skin rash/inflammation, eye irritation, at $p<0.001$. Personal hygiene behavior factors concerning differing masks, gloves, and boot safety use were found to be statistically significant and associated with the health effects among e-waste workers, including accidental illness or injury or pricking with sharp objects, at $p<0.001$. Personal hygiene behavior factors concerning differing mask use were found to be statistically significant and associated with the health effects among e-waste workers, including cough/sneeze, and nasal irritation/nasal sting, at $p<0.001$. In addition, glasses safety, washing hands before lunch, and washing hands with detergents were shown to be statistically significant and associated with the health effects among e-waste workers, including eye irritation, at $p<0.001$. For hygiene behavior, washing hands before lunch, washing hands with detergents, and changing clothes after work were shown to be statistically significant and associated with the health effects among e-waste workers, including skin rash/inflammation, at $p<0.001$ (Table 3).

Table 3: Frequency and prevalence of health effects of e-waste workers by socio-demographic characteristics factors, occupational lifestyle, and personal hygiene behavior (n=272)

Information	Health effects					
	Accidental illness, injury/pricking with sharp objects (n=188)(%)	Muscle aches (n=188)(%)	Cough/sneeze (n=181)(%)	Nasal irritation/ nasal sting (n=176)(%)	Skin rash/inflammation (n=174)(%)	Eye irritation (n=170)(%)
Sex						
Male (n=262)	188(71.76)	188(100.00)	181(100.00)	176(100.00)	174(100.00)	170(100.00)
Female (n=10)						
p-value	<0.001*					
Education levels						
High school education level/ Vocational certificate (n=210)	156(82.98)	148(71.48)	151(74.91)	147(70.00)	150(71.43)	155(73.81)
More than high school education level / Vocational certificate (n=62)	32 (51.62)	40(64.52)	30(48.39)	29(46.78)	24(38.71)	15(24.20)
p-value	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Cigarette smoked						
Yes (n=136)	96(70.59)	95(69.86)	96(70.59)	88(64.71)	89(65.45)	87(63.97)
No(n=136)	92(69.65)	93(68.39)	85(62.50)	85(62.50)	85(62.50)	83(61.03)
p-value	0.520	0.550	0.502	0.547	0.485	0.425
Drank alcohol						
Yes (n=108)	105(97.23)	104(96.30)	69(63.89)	75(69.45)	73(76.60)	70(64.82)
No (n=164)	83(50.61)	84(51.22)	112(68.30)	101(61.59)	101(61.59)	100(60.98)
p-value	<0.001*	<0.001*	0.210	0.066	0.059	0.076
Occupational lifestyle						
Hours worked per day						
8 hrs. (n=200)	118(59.00)	117(58.50)	110(55.00)	106(53.00)	104(52.00)	98(49.00)
≥8 hrs. (n=72)	70(97.23)	71(98.62)	71(98.62)	70(97.23)	70(97.23)	72(100.00)
p-value	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Days worked per week						
6 days/week (n=179)	101(56.43)	95(53.08)	122(68.16)	114(63.69)	114(63.69)	113(63.13)
≥6 days/week (n=93)	87(93.55)	93(100.00)	59(63.44)	62(66.67)	60(64.52)	57(61.29)
p-value	<0.001*	<0.001*	0.458	0.420	0.419	0.250
Years of worked						
≤13 years (n=172)	99(57.56)	93(54.07)	94(54.66)	96(55.82)	89(51.75)	86(50.00)
>13 years (n=100)	89(89.00)	95(95.00)	87(87.00)	80(80.00)	85(85.00)	84(84.00)
Mean±SD; 13±3.52 years						
p-value	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*

Personal hygiene behavior; Always personal protection equipment used						
Mask						
Yes (n=174)	101(58.05)	120(68.97)	97(55.75)	96(55.18)	118(67.82)	110(63.22)
No (n=98)	87(88.78)	68(69.39)	84(85.72)	80(81.64)	56(57.15)	60(61.23)
p-value	<0.001*	0.623	<0.001*	<0.001*	0.120	0.350
Gloves						
Yes (n=198)	117(62.2)	133(70.75)	132(66.67)	128(64.65)	126(63.54)	123(62.13)
No(n=74)	71(95.95)	55(74.33)	49(66.22)	48(68.87)	48(64.87)	47(63.52)
p-value	<0.001*	0.214	0.521	0.322	0.211	0.145
Boot Safety						
Yes(n=157)	80(50.96)	113(71.98)	110(70.07)	105(66.88)	102(64.97)	102(64.97)
No(n=115)	108(93.92)	75(65.22)	71(61.74)	71(61.74)	72(62.61)	68(59.13)
p-value	<0.001*	0.058	0.075	0.105	0.205	0.0745
Glasses Safety						
Yes(n=87)	54(60.07)	56(64.37)	65(74.72)	62(71.27)	60(68.97)	26(29.89)
No(n=185)	134(72.44)	132(71.36)	116(62.71)	114(61.63)	114(61.63)	144(84.71)
p-value	0.068	0.052	0.074	0.051	0.059	<0.001*
Always washed hands before lunch						
Yes(n=127)	80(63.00)	85(66.93)	84(66.15)	78(61.42)	34(26.78)	32(25.20)
No(n=145)	108(74.49)	103(71.04)	97(66.90)	98(67.59)	140(96.56)	138(95.18)
p-value	0.058	0.069	0.250	0.054	<0.001*	<0.001*
Washing hands with detergents						
Yes (n=134)	92(68.66)	93(69.41)	84(62.69)	85(63.44)	54(40.30)	55 (41.05)
No (n=138)	96(69.57)	95(68.84)	97(70.29)	91(65.95)	120(86.96)	115(67.65)
p-value	0.230	0.250	0.301	0.310	<0.001*	<0.001*
Change cloth after working						
Yes (n=53)	39((73.59)	39((73.59)	39(73.59)	39(73.59)	12(22.65)	37(69.82)
No (n=219)	149(68.04)	149(68.04)	142(64.84)	137(62.56)	162(73.98)	133(60.73)
p-value	0.240	0.240	0.055	0.120	<0.001*	0.057

*Significant association at 0.05.

The multilevel logistic regression model was conducted using socio-demographic factors, such as sex, education, cigarette and alcohol use, occupational lifestyle, and personal hygiene behaviors (including PPE use and personal hygiene behaviors) as independent variables (Table 4).

The results showed that the health effects of e-waste workers in e-waste recycling shops were

significantly associated with hours worked per day, days worked per week and the use of masks and gloves. According to the findings of the multilinear regression model, a statistically significant relationship was found between safety behavior and safety awareness (F: 597.457; $P < .001$). Additionally, e-waste workers who had high safety awareness positively raised the level of safety behavior as well (β : 0.876; $P < .001$) (Table 5).

Table 4: Multilevel models on factors related to health effects of e-waste workers in e-waste recycling shops, Thailand

Variable	β	SE	OR (95% CI)	p-value
Education levels				
High school education level	0.364	0.218	1.462(0.34-2.39)	0.096
More than high school education level	0.451	0.111	1.0	
Cigarette smoked				
Yes	0.410	0.114	1.435(0.35-2.09)	0.056
No	0.427	0.128	1.0	
Drank alcohol				
Yes	0.415	0.108	1.523(0.24-2.31)	0.114
No	0.412	0.113	1.0	
Hours worked per day				
≥ 8 hrs.	-0.009	0.004	3.221 (1.15-4.89)	0.042*
8 hrs.	0.240	0.109	1.0	
Days worked per week				
≥ 6 days/week	-0.012	0.008	3.245(1.15-5.19)	0.028*
6 days/week	0.158	0.107	1.0	
Years of worked				
>13 years	0.425	0.151	1.528(0.29-2.33)	0.250
≤ 13 years	0.237	0.102	1.0	
Mask				
No	-0.046	0.014	2.987 (0.75-2.86)	0.021*
Yes			1.0	
Gloves				
No	-0.016	0.009	3.998(0.69-2.74)	0.032*
Yes			1.0	
Boot Safety				
No	-0.032	0.209	1.159(0.17-2.37)	0.139
Yes			1.0	
Glasses Safety				
No	-0.035	0.214	1.147(0.14-2.29)	0.145
Yes			1.0	
Always washed hands before lunch				
No	-0.029	0.268	1.125(0.28-2.41)	0.120
Yes			1.0	
Washing hands with detergents				
No	-0.029	0.113	1.125(0.32-2.32)	0.078
Yes			1.0	
Change cloth after worked				
No	0.395	0.117	1.428(0.31-2.19)	0.059
Yes			1.0	

*Significant at 0.05.

Table 5: Multiple linear regression model of relationships between safety awareness and safety behavior

Model	Regression Model Summary				
	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	p-value
(Constant)	0.593	0.121		4.798	<0.001
Safety awareness	0.883	0.029	0.876	25.361	<0.001

Dependent Variable: Safety behavior including occupational lifestyle and personal hygiene behavior

Discussion

All of the e-waste workers in this study were informal workers (100%). The results showed that the type of health effects among e-waste workers in e-waste recycling shops was significantly associated with hours worked per day and days worked per week. These results were supported by Chu who reported that long working hours are closely associated with chronic diseases, poor mental health, unhealthy behaviors, injuries, poor physical health, alcohol consumption, physical inactivity, and depression.⁷⁻¹⁰ In addition, Chu reported that long working hours had a more negative influence on male workers' self-rated health (SRH) level.¹¹

This study showed masks and gloves use were significantly associated with the health effects of e-waste workers in e-waste recycling shops. The results supported by the Occupational Safety and Health Administration (OSHA) showed that personal protective equipment was worn to minimize exposure to hazards, and not wearing it, caused serious workplace injuries and illnesses.¹² These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. This study found that socio-demographic characteristics factors of the e-waste workers influenced the levels of safety awareness differences, statistically significant at 0.05. The results of this study showed that gender factors were related to the health effects of e-waste workers. These results are supported by Quinn and Smith who reported that women and men have biological differences, and thus can have

different experiences of work exposures and health due to their sex, or their gender, referring to socially constructed differences.¹³ In addition, education levels were related to the health effects of e-waste workers. These results are supported by Robroek, et al. who suggested that low education was one of the most important determinants of employment status.¹⁴ Moreover, numerous studies have shown that low educational attainment and poor health can interact to exacerbate their impact on unemployment beyond the sum of their individual.^{15,16} Hours worked per day and years of work related to health effects of e-waste workers. These factors are supported by Wong K, et al. who reported that long working hours were shown to adversely affect the occupational health of workers.¹⁷ The workplace may also pose a risk factor for harmful alcohol consumption. The result of this study showed that drinking alcohol-related health effects on e-waste workers, which was supported by Ronksley that working when under the influence of alcohol, could put your safety and health, and that of your co-workers, at risk of alcohol-related harm.¹⁸ In addition, days worked per week related to accidental illness, injury/pricking with sharp objects ($p < 0.001$), and muscle aches ($p < 0.001$). These results are supported by Dembe, et al. who reported a strong dose-response effect that observed that injury increased in correspondence to the number of hours per day (or per week) in the workers' customary schedule.¹⁹ The study showed that although masks were rarely used, nevertheless, the e-waste workers chose masks for high-risk procedures that made them vulnerable to

chemical exposure, such as the extraction of metals, etc. They know that masks can reduce the potential impact on themselves at work. The mask use among e-waste workers is associated with accidental illness ($p < 0.001$), cough/sneeze ($p < 0.001$), and nasal irritation/nasal sting ($p < 0.001$). These results are supported by Wachinou, et al. who reported chest tightness (11.8% vs 2.1%; $p = 0.003$) and breathlessness (6.8% vs 1.4%; $p = 0.018$) were the most reported symptoms by e-waste workers.²⁰ From the interview and observation in this study, the e-waste workers used gloves in the smash-grinding process and chose to wear safety boots in weighing and sorting products. Gloves and boot safety were also found to be associated with accidental illness, and injury/pricking with sharp objects ($p < 0.001$). Thus, gloves and boot safety can protect against cuts and injuries at work. Glasses safety was found to be associated with eye irritation ($p < 0.001$). This result was supported by Lombardi, et al. who reported that about 60% of work-related eye injuries were related either to the lack of usage or to the wrong choice of PPE at the time of injury.²¹ All e-waste recycling processes involve dangerous particles or chemicals that could be floating around in the workplace. Thus, safety glasses can prevent foreign objects or debris from damaging workers' vision. Mahmoud, et al. reported that eye injuries occur in the workplace.²² In addition, hands should always be washed with detergents before lunch, and clothes should be

changed after work with regard to skin rash/inflammation and eye irritation ($p < 0.001$). This result showed that all of the e-waste workers know that handwashing with soap and water can protect themselves and others from a range of infectious diseases and chemicals during work.²³ However, most of the recycling shops did not have support for this behavior or lacked hand hygiene facilities. E-waste workers who had high safety awareness also raised the level of safety behavior positively as well ($\beta: 0.876$; $P < .001$). These results are supported by previous studies on safety awareness and safety behavior levels.^{24–}

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Conclusions

Socio-demographic characteristics, occupational lifestyle, and personal hygiene behavior were related to health effects, safety awareness, and safety behaviors among e-waste workers in e-waste recycling shops. In addition, safety behavior is very necessary. Meanwhile, raising safety awareness with these factors in mind is important because it makes safety behaviors sustainable.

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