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ABSTRACT

BACKGROUND: Personal protective equipment (PPE) is one of the safeguards to protect workers from occupational risks. The aim of this study was to assess the utilization of PPE and associated factors among large-scale factory workers in Debre Berhan city administration, Ethiopia.

METHODS: An institutional-based cross-sectional study was conducted using stratified sampling among large-scale factory workers in the Debre Berhan city administration. Four hundred thirty-two employees were interviewed using a stratified sampling technique from 7 large-scale factories. Logistic regression analysis was used to identify factors affecting the utilization of PPE. The strength of association between variables was measured using the odds ratio with 95% confidence intervals at a *P*-value of .05.

RESULTS: A total of 413 respondents were included in the study, with a response rate of 95.6%. Two hundred and eighty-two (68.3%) of the participants were males. The mean age of the respondents was 28.37 ± 7.33 years. The PPE utilization was 35.43% (95% CI: 0.31, 0.40). Accordingly on job training (AOR = 8.85; 95% CI: 5.52, 14.28), previous history of injury (AOR = 0.23; 95% CI: 0.14, 0.36), workplace supervision (AOR = 14.08; 95% CI: 7.87, 25.0), and availability of guideline (AOR = 4.62; 95% CI: 2.51, 8.49) were statistically significant with utilization of PPE among large scale factory workers at a *P*-value < .05.

CONCLUSION: Utilization of PPE is low. Previous history of injuries, on-the-job training, supervision, and the availability of guidelines were all independent predictors of PPE utilization. As a result, job training, workplace supervision, root-cause learning, and the availability of guidelines should all be considered.

KEYWORDS: Utilization, personal protective equipment, factory worker, large scale factory

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Introduction

The use of personal protective equipment (PPE) is an important strategy to prevent occupational injuries and illnesses resulting from exposure to workplace hazards.¹ These injuries and illnesses may result from direct contact with chemicals, radiological, physical, electrical, mechanical, or other workplace hazards.^{1,2} Employers must conduct workplace hazard assessments to identify the type of protective apparel, engineering controls, and safe work practices that are required, as well as providing training and equipment. Employees are responsible for acting safely in accordance with the equipment and training they have received.³ One of the most significant methods for protecting workers' health and safety in the workplace against potential risks or hazards is the use of PPE.⁴ In this regard, numerous institutions across a wide range of industries have begun to develop suitable workplace health and safety requirements, the most important of which is the official approval of

workers' use of PPE.⁴ This had brought a tremendous impact on the performance of workers apart from its intended goal of protecting workers from potential risks.

This is evidenced by an improvement in worker efficiency as a result of increased worker confidence as a result of a sense of security in their workplaces, as well as a reduced rate of employee absenteeism and turnover among those who have adopted proper health and safety measures.⁵ PPE such as helmets, gloves, face shields, respirators, dust masks, safety shoes, and safety glasses are often very effective in preventing foreign body, chemical, hot particle, and radiation exposure or impact to various body parts and reducing the severity of exposure or impact when exposure or impact occurs when used and well fitted.⁶ Recently, it has been confirmed that about 65% of workers in industries suffer from a high rate of injuries due to poor compliance to PPE use in their workplace. While employers strive to procure and provide PPE as required by legislation



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for employees, the equipment is not used effectively, and this is further compounded by lack of information about PPE, negative attitudes toward using them, or lack of encouragement from management.^{7,8} Others blame workers' ignorance for the rise in workplace injuries and illnesses.⁷

According to a study, more than 90% of workplace injuries can be avoided by implementing safety measures and using PPE. Furthermore, studies have found that failure to utilize PPE is a major factor to worker exposure to risks that can lead to accidents and illnesses in a variety of occupations.⁹ The Occupational Safety and Health Administration (OSHA) set standards and guidelines for businesses to follow in order to promote workplace health and safety and reduce the number of injuries and illnesses,¹⁰ due to a lack of emphasis from concerned authorities. To overcome the various health and safety risks that arise as a result of a lack of awareness in the use of PPE, it is necessary to examine the level of PPE utilization and related factors, facilitate the implementation of appropriate techniques for the introduction of PPE, improve the quality of service they provide, and minimize the various direct and indirect risks that are associated with the lack of proper PPE utilization. As a result, the goal of this study was to assess the amount of PPE utilization and the factors that influence it among workers in large-scale industries in Debre Berhan City Administration, North Shoa, Ethiopia.

Methods and Materials

Study area

The study was conducted at Debre Berhan town, North Shoa, Amhara regional state, which is 130 km north of Addis Ababa. It is divided into 9 kebeles, each with an estimated population of 110 000. Males make up 52 800 (48%) and females make up 57 200 (52%) of the total. There are different small-scale and large-scale factories in the town. According to a source from the Debre Berhan city administration Labor and Social Affairs Office, the brewery factories (Dashen and Habesha), the Debre Berhan blanket factory, the Debre Berhan wood processing, the Debre Berhan leather processing, Aqua-safe water bottling, and Ethal aluminum manufacturing were all operational. At the moment, 1633 manufacturing workers are employed in large-scale factories. There are 1110 (68.0%) males and 523 (32.9%) females among large scale factory workers.

Study design and period

An institutional based cross-sectional was conducted between March and April 2020 to assess the utilization of PPE and its associated factors among large-scale factory workers in Debre Berhan City Administration, North Shoa, Amhara Regional State, Ethiopia.

Source population

The target populations were all workers in large scale factories in Debre Berhan city administration.

Study population

Selected factory workers from large-scale factories were the study population.

Sample size determination and sampling procedure

According to a study conducted in the Arbaminch town textile sector, the sample size was calculated using the single population proportion calculation with a 20% PPE utilization rate, a 95% confidence interval, and a 4% margin of error.¹¹ The total sample size was 432 after accounting for a 10% non-response rate. The data was obtained from each job category using the stratified sampling technique, guaranteeing that all large-scale factory workers were included. The sample size was distributed among the 7 factories in a proportional manner. A simple random sample procedure was used to identify study participants from the employees' database (Figure 1).

Inclusion and exclusion criteria

Inclusion criteria: Workers must have worked in the selected industries for at least 6 months to be eligible to participate in the survey. They must be blue-collar workers who have interaction with operating machines, instruments, processing, and manufacturing areas, and they must be on the payroll list for 6 months.

Exclusion criteria: The office and managerial employees (all white) were excluded since they might develop biases. They have no direct touch with machines or workplace risks because they are not involved in the manufacturing process. Because of illness, workers who were unable to participate in the study were not counted.

Variables

Dependent variables: Utilization of PPE.

Independent variables: Socio-demographic parameters make up the study's independent variables (age, sex, educational level, religion, marital status, monthly income, employment pattern, and service year).

Individual determinants (knowledge of hazards and PPEs, risk perception, and injury history).

Behavioral aspects (drinking alcohol, smoking cigarette, chewing chat, use of guideline).

Organizational and environmental factors (social support, safety supervision, nature of task, availability of PPE, safety training, safety orientation, good light, work rotation, work shift, and job satisfaction).

Data collection and data quality control

Data was collected using a pretested and standardized self-administered questionnaire. To maintain uniformity, the questionnaires were written in English and then translated into

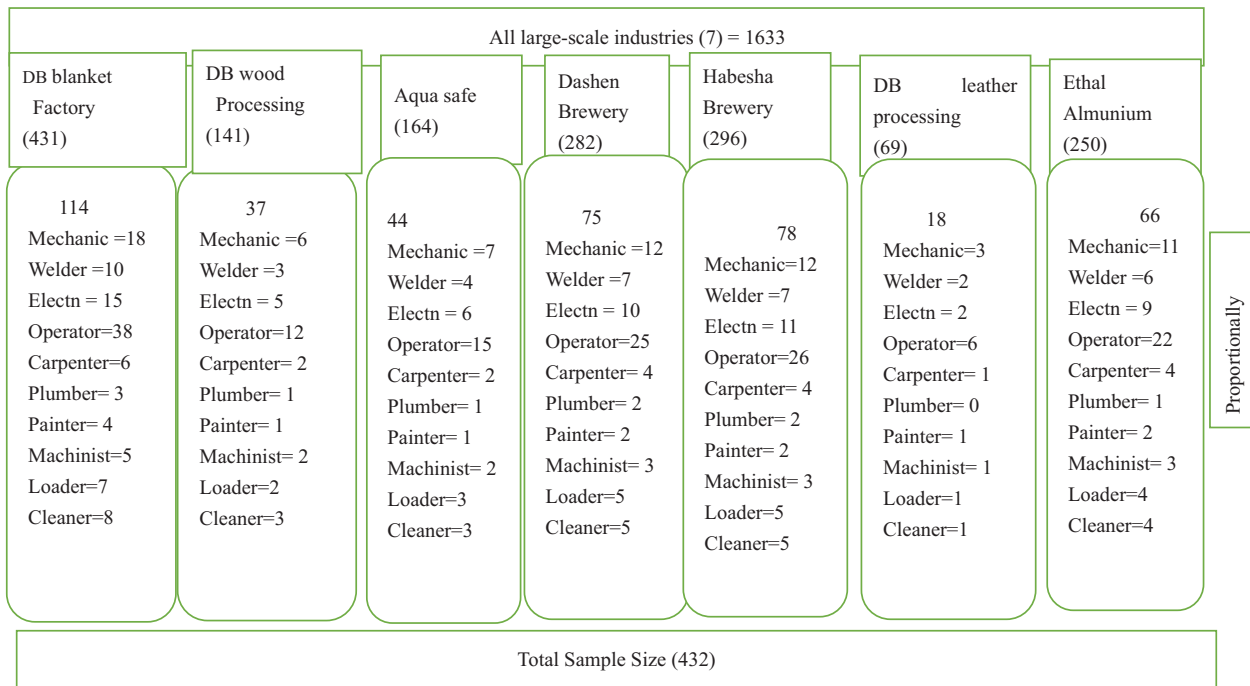


Figure 1. A schematic presentation of sampling procedure for study site and participants, 2019.

Amharic and returned to English by independent language specialists. Sociodemographic characteristics, behavioral qualities, working environment, PPE utilization, and associated factors in large-scale industrial workers were the primary topics of the questionnaire. In addition, data on the workplace environment and PPE utilization was collected using an observation checklist developed from literature.

The factory’s human resources department double-checked employee statistics to ensure that all job categories were represented. The presence of safety guidelines, the presence of a safety committee, meeting minutes, and training were all reported; the availability of PPE with budget and usage, workplace monitoring, and inspection plans were all observed.

Data management and statistical analysis

The data was entered into EpiData version 3.1 before being transferred to a social sciences statistical tool for analysis (SPSS, version 24). The link between the outcome variable and the independent variables was also investigated using logistic regression (bivariate and multivariate analysis). Socio-demographic data such as the worker’s age, sex, educational level, service years, monthly income, and employment pattern were examined at a *P*-value less than .25 during bivariate logistic regression analysis. However, multivariable logistic regression analysis was used just to the employment pattern. The usage of recommendations, smoking behaviors, khat chewing, and alcohol use pattern were all examined in terms of behavioral features. Then, with a *P*-value smaller than .25, alcohol intake and Khat chewing were found to be significant. Individual, environmental, and organizational aspects were also investigated. The presence of guidelines, safety supervision,

work rotation, past injury history, and on-the-job training were then subjected to a multiple logistic regression analysis. Multicollinearity was assessed using a variance inflation factor (*VIF* > 5) to prevent redundant information across independent variables, and it was found to be within the limit. Multivariate logistic regression was also used to control the impact of confounding variables. To avoid missing factors related with the use of PPE, all variables having a *P*-value of .25 in the bivariable analysis were put into the multivariable logistic regression model, and a *P*-value of .05 was used to declare statistical significance.

Ethical clearance

The study received ethical approval from the Debre Berhan University College of Health Science ethical review board, as well as an official support letter from the North Shoa Zone Industry Office. After obtaining clearance from each industry office, data collecting began. The study’s aim was explained to each participant, and they were only asked for information after they had given their consent.

Results

Socio-demographic characteristics of respondents

Four hundred thirty-two workers from 7 large-scale factories were included to participate in this study, of which 413 participated with a response rate of 95.6%. Two hundred eighty-two (68.3%) of the respondents were males, and 131 (31.7%) of them were females. The mean age of the respondents (\pm SD) was 28.37 ± 7.33 years. One hundred eighty-eight (45.5%) of the respondents were in the age group of 18 to 25 years. Three

hundred eighty-seven (93.7%) of those polled were adherents of the orthodox Christian religion. Two hundred thirty-eight (57.6%) of the respondents have attended TVET school. The majority of them (62.2%) were single. Three hundred sixty people (87.2%) were permanent employees, and 138 (33.4%) were machine operators. Three hundred and fifty-two respondents (85.2%) had a monthly salary of more than 1500 ETB. Operators made up the majority of the occupational categories (33.4%). The majority of respondents (86.0%) have 1 to 10 years of job experience (Table 1).

Distribution of workers by factories and job. Based on workers job category, 138 (33.4%) of workers are operators, 66 (15.9%) are mechanics, and 56 (13.6%) are electricians (Table 2).

Behavioral characteristics of respondents

Twenty-one (5.1%), 22 (5.3%), and 199 (48.2%) of the participants said they smoked cigarettes, chewed khat, and drank alcohol, respectively (Table 3).

Utilization of personal protective equipment

One hundred forty-six (35.4%) (95% CI: 30.7%, 39.9%) of the participants were reported as using all the job-demand PPE during work time. Of whom 103 (70.5%) and 43 (29.5%) were males and females, respectively. The majority, 48.6%, of them belonged to the age group of 26 to 35 years. Nearly 65% of the workers reported that they did not use all the necessary PPE during work. The reasons for not using PPE were (non availability 86.9%), not being comfortable to use (70.8%), to save time (50.9%), and negligence from the workers' side (35.6%). Non-availability and discomfort are the major reasons for non-utilization (Figure 2).

Environmental and organizational factors

Four hundred four of the respondents (97.8%) reported that the factories provide some PPEs which are not used for complete protection. Fifty-one (12.3%) of the workers revealed that they bought PPEs by themselves, while 2 (0.5%) reported that they borrowed some PPEs from their co-workers for common use. As indicated in the table below, the majority (392 [94.9%], 387 [93.7%], and 292 [70.7%]) perceived their work to be risky, might be exposed to harmful hazards, and had injury history, respectively.

Three hundred fourteen (76.0%) of the participants mentioned that their co-workers were using PPEs. But the number of PPEs used is very small. Two hundred seventy-two (65.9%) of participants reported that there was encouragement from their co-workers to use PPE. Two hundred twelve (51.3%) respondents replied that they took pre-job safety training before starting the job, and 127 (30.8%) reported that they took on-the-job training. Two hundred twenty-eight (55.2%) of the

Table 1. Socio-demographic characteristics of the respondents among large scale factory workers, Debre Berhan town, Ethiopia, 2020.

VARIABLES	FREQUENCY (%)
Sex	
Male	282 (68.3)
Female	131 (31.7)
Age in years	
≤25 years	188 (45.5)
26 to 35 years	185 (44.8)
>36 years	40 (9.7)
Religion	
Orthodox	387 (93.7)
Muslim	17 (4.1)
Others	9 (2.2)
Educational status	
Able to read and write	8 (2.0)
Primary school (1-8)	22 (5.3)
Secondary school (9-12)	95 (23.0)
Technical and vocational	238 (57.6)
Degree and above	50 (12.1)
Marital status	
Married	150 (36.3)
Single	257 (62.2)
Others	6 (1.5)
Employment pattern	
Permanent	360 (87.2)
Temporary	53 (12.8)
Job category	
Mechanic	66 (15.9)
Welder	37 (8.9)
Operator	138 (33.4)
Carpenter	23 (5.6)
Plumber	9 (2.2)
Painter	13 (3.1)
Machinist	18 (4.4)
Loader/off loader	25 (6.1)
Cleaner	28 (6.8)
Service year	
1 to 10 years	355(86.0)
> 10 years	58(14.0)

(Continued)

Table 1. (Continued)

VARIABLES	FREQUENCY (%)
Monthly income in ETB	
≤ 1000 ETB	26 (6.3)
1001 to 1500 ETB	35 (8.5)
> 1500 ETB	352 (85.2)

respondents reported that there was workplace safety supervision during work.

One hundred forty-one (34.1%) of the respondents reported that there was safety training for new processes and 152 (36.8%) safety orientation before starting a job. Three hundred sixteen (76.5%) of the respondents reported that there was shift work and 147 (35.5%) replied that there was work rotation. The majority (92.7%) of them reported that their work environment was bright (Table 4).

Factors associated with utilization of PPE

With a *P*-value of .25, the bivariate logistic regression analysis demonstrated that employment pattern, on-the-job training, previous injury, safety supervision, availability of guidelines, rotation of work, smoking, and alcohol use were all substantially linked with PPE utilization. The 8 variables stated above were entered into a multiple binary logistic regression analysis to control the confounding effects of independent variables. Then, with a *P*-value of less than .05, 4 factors remained statistically significant (Table 5).

Accordingly, at a *P*-value of .05, job training (AOR = 2.05; 95% CI: 1.09, 3.86), previous history of injury (AOR = 0.32; 95% CI: 0.18, 0.58), workplace supervision (AOR = 5.89; 95% CI: 3.04, 11.40), and availability of guidelines (AOR = 4.62; 95% CI: 2.51, 8.49) were statistically significant with PPE utilization among large scale factory workers (Table 5).

Discussion

In this study, the magnitude of PPE utilization among factory workers was 35.4%, which is in line with the studies from Asia and Africa.^{12,13} A study on the utilization of PPE among industrial workers in Egypt,¹⁴ showed that PPE utilization was 31.4%, which is close to this study. In Nigeria,¹⁵ it was 50%, which is different from this study. In this cross-sectional study, the magnitude of PPE utilization was less than the study in Nepal,³ (87.2%), in which (61.1%) of the participants were using all relevant PPE at work regularly and more than half (57%) used PPE when they needed it. A study was done in Dukem town,¹⁶ revealed that factory workers' magnitude of PPE utilization was 62.3%. A study was done in Addis Ababa,¹⁷ (78.2%), in Adwa town (54%)¹⁸ and in Iran,¹⁹ industrial workers proportion of PPE utilization was 41.7%. It is also by far

lower than the textile workers in Hawassa, at 82.4%.¹² The possible reasons for differences in the utilization of PPE might be associated with work-related safety culture, sample size differences between studies, study methods, the difference in study population, place, and level of awareness of the employees about occupational hazards.

This study showed that reasons given by respondents for not using PPE at work were mostly not available (86.9%), causing discomfort (70.8%), saving time (50.9%), and negligence (35.6%), which is comparable with the study done in Addis Ababa,¹⁷ which showed a lack of PPE was 74.5% for not using PPE. This study is also in line with the study done in Nigeria,¹⁵ which showed that the reason for not using PPE was being uncomfortable, oversized/undersized. Such types of reasons might be due to lack of interest and awareness from workers, lack of concerned responsible bodies, lack of budget, lack of comfort, and advanced PPEs. Among the respondents, 97.8% got the PPEs from factories which were consistent with the study done in the United Arab Emirates.²⁰ Most information about PPEs is heard from factories that are comparable with the study done in Kenya.²¹ This study also showed as 55.2% of the respondents' workplace was supervised which is similar with the study done in metal factories of Addis Ababa which is 55.1%.²²

One important finding of this study was the identification of independent predictors influencing PPE utilization. This study showed that as having no the previous history of injury, job training, guideline availability, and workplace Safety supervision were significantly associated with PPE utilization.

The odds of PPE utilization among workers who were getting on job training was 2.05 times when compared to those who did not (AOR: 2.05, 95% CI: 1.09, 3.86), this is also in line with a study conducted in Hawassa, Addis Ababa, and Kombolcha.^{12,17,23} The reason could be training to the workers ensures workers to remain enforced and motivated to follow the safety instructions by creating better cooperation between workers, managers, and the safety committee of the factory. This signifies that there is a need for planning training for factory workers to utilize PPEs better.

Injury history showed a significant association with PPE utilization. The odds of PPE utilization among previously injured was 68% times less likely utilized PPEs when compared to their counterparts (AOR: 0.32, 95% CI: 0.18, 0.58) which is similar with study in the USA.²⁴ This might be since injury history is a learning point to improve unsafe behaviors. As a result of this fact, the factory's safety policy should consider the root cause analysis for injuries at the workplace to prevent reoccurrence and to get learning points.

Workplace supervision was significant organizational factor for PPE utilization (AOR: 5.89; 95% CI: 3.04, 11.40). The odds 6 of PPE utilization among workers whose workplace supervised was about 5.9 times when compared when compared to workers whose workplace did not supervise.²⁵ This

Table 2. The distribution of workers selected by factory and job in the large-scale factory workers of Debre Berhan town, Ethiopia, 2020.

WORKERS BY JOB CATEGORIES	TYPES OF FACTORIES							TOTAL
	BLANKET FACTORY	WOOD PROCESSING	AQUA SAFE FACTORY	DASHEN BREWERY	HABESHA BREWERY	LEATHER PROCESSING	ETHAL ALUMINUM FACTORY	
Mechanics	15	6	7	12	12	3	11	66
Electrician	13	5	6	10	11	2	9	56
Welder	8	3	4	7	7	2	6	37
Operator	32	12	15	25	26	6	22	138
Carpenter	6	2	2	4	4	1	4	23
Plumber	2	1	1	2	2	0	1	9
Painter	4	1	1	2	2	1	2	13
Machinist	4	2	2	3	3	1	3	18
Loader/off loader	5	2	3	5	5	1	4	25
Cleaner	7	3	3	5	5	1	4	28
Total	96	37	44	75	77	18	66	413

Table 3. Behavioral characteristics of workers at large-scale factory workers, Debre Berhan Town, Ethiopia, 2020.

VARIABLES	TOTAL (N=413)	
	YES, N (%)	NO, N (%)
Smoke cigarette	21 (5.1)	392 (94.9)
Chew khat	22 (5.3)	391 (94.7)
Drink alcohol	199 (48.2)	214 (51.8)

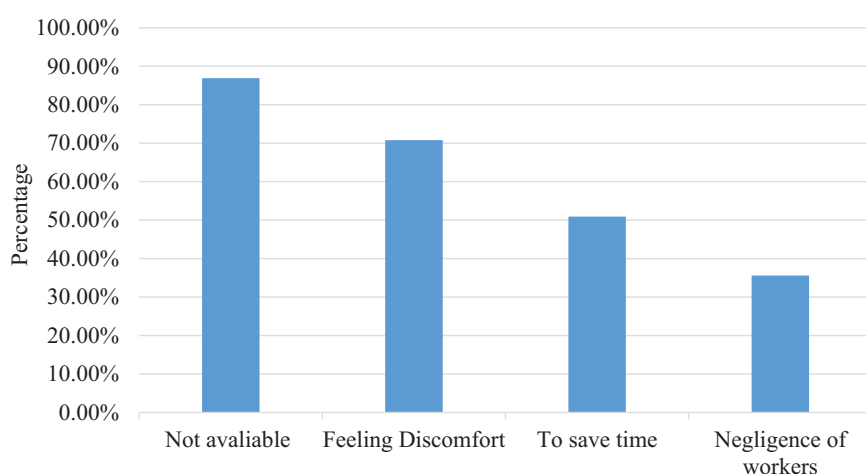
**Figure 2.** Reasons for not using PPEs workers at large scale factory, Debre Berhan Town, Ethiopia, 2020.

Table 4. Environmental and organizational factors for PPE utilization in large-scale factory workers, Debre Berhan Town, Ethiopia, 2020.

VARIABLES	UTILIZATION OF PPE		
	YES, N (%)	NO, N (%)	TOTAL (%)
Source of PPE			
Institution	145 (35.1)	259 (62.7)	404 (97.8)
Self-bought	10 (2.4)	41 (9.9%)	51 (12.3)
Borrowed	1 (0.25)	1 (0.25)	2 (0.5%)
Worker's perception to risks			
At-risk to get an injury	131 (31.7)	261 (63.2)	392 (94.9)
Might be exposed to hazard	128 (31.0)	259 (62.7)	387 (93.7)
Had injury history	74 (17.9)	218 (52.8)	292 (70.7)
Social support			
Utilization by coworkers	137 (33.1)	177 (42.9)	314 (76.0)
Encouragement by coworkers	128 (31.0)	144 (34.9)	272 (65.9)
Training			
Pre-job training	100 (24.2)	112 (27.1)	212 (51.3)
On job training	88 (21.4)	39 (9.4)	127 (30.8)
Safety supervision	130 (31.5)	98 (23.7)	228 (55.2)
Safety training for new process	100 (24.2)	41 (9.9)	141 (34.1)
Safety orientation before starting job	103 (24.9)	49 (11.9)	152 (36.8)
Shift work	103 (24.9)	213 (51.6)	316 (76.5)
Work rotation	69 (16.7)	78 (18.9)	147 (35.6)
Light in the workplace	139 (33.6)	244 (59.1)	383 (92.7)

Table 5. Factors associated with the utilization of PPE among large-scale factory workers in Debre Berhan Town, Ethiopia, 2020.

VARIABLES	UTILIZATION OF PPE		COR, 95% CI	P-VALUE	AOR, 95% CI
	YES	NO			
Employment pattern					
Temporary	29	24	2.51 (1.34, 4.50)	0.002	
Permanent	117	243	1		1.90 (0.87, 4.12)
On job training					
Yes	88	39	8.85 (5.52, 14.28)	<0.001	2.05 (1.09, 3.86)*
No	58	228	1		
Past injury					
Yes	74	218	0.23 (0.14, 0.36)	<0.001	0.32 (0.18, 0.58)*
No	72	49	1		1

(Continued)

Table 5. (Continued)

VARIABLES	UTILIZATION OF PPE		COR, 95% CI	P-VALUE	AOR, 95% CI
	YES	NO			
Supportive supervision					
Yes	130	98	14.08 (7.87, 25.0)	<0.001	5.89 (3.04, 11.40)*
No	16	169	1		1
Availability of guideline					
Yes	107	57	10.10 (6.32, 16.12)	<0.001	4.62 (2.51, 8.49)*
No	39	201	1		1
Work rotation					
Yes	69	78	1	<0.001	1.44 (0.81, 2.57)
No	77	189	0.46 (0.30, 0.70)		1
Current smoking habit					
Yes	4	17	1	0.011	1
No	142	250	2.41 (0.79, 7.31)		3.33 (0.82, 14.28)
Alcohol use					
Yes	60	139	1	0.033	1.62 (0.91, 2.89)
No	86	128	1.55 (1.03, 2.34)		1

Abbreviations: COR, crude odds ratio; CI, confidence interval; AOR, adjusted odds ratio.

*Indicates statistical significance at a *P*-value less than .05.

might be due to the supervision of workplaces identifying hazards and monitors non-compliances. As a result of this, workplace safety programs should be emphasized on supervision of working place to identify hazards and to improve PPE utilization. PPE utilization was significantly influenced by the availability of guidelines (AOR=4.62; 95% CI: 2.51, 8.49). As a result, workplace safety programs place a premium on following the guidelines' processes.

Limitation of the study: Workers may describe socially acceptable responses rather than their actual day-to-day practice, which is a potential problem in self-reported studies. Furthermore, there could be a healthy worker bias.

Conclusion

This study has declared that only 34.5% of workers use PPE, which is low. The majority of respondents mentioned different reasons for not using PPEs on their sites. These are the non-availability of PPEs, the discomfort of PPEs, saving time, and the negligence of workers. PPE use among large-scale factory workers in Debre Berhan municipal administration was substantially associated with on-the-job training, prior injury history, workplace safety supervision, and availability of guidelines. To ensure PPE usage, factory management and workers should consider job training, workplace supervision, learning from fundamental causes, and the availability of guidelines.

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Author Contributions

BFB, BT, and MFB design the research work and guided the data analysis, edited the manuscript. AT drafted the manuscript and interpreted the results.

Data Availability

The data that supports the finding of this study is included in the manuscript.

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