

## Health Promotion Model Insights on Determinants of PPE Utilization in Occupational Settings

### Abstract

**Aims:** Occupational illnesses remain a pressing concern for workers exposed to hazardous materials in industrial settings. While Personal Protective Equipment (PPE) serves as a primary safeguard against such risks, its inconsistent utilization highlights critical gaps in understanding the determinants of PPE compliance. This study investigated personal and situational factors influencing PPE usage among employees handling organic solvents in three major industrial companies.

**Methods:** A cross-sectional survey of 340 workers was conducted, employing the Health Promotion Model (HPM) as the theoretical framework to identify predictors of PPE utilization. Data were analyzed using chi-square tests, t-tests, and two-level logistic regression.

**Findings:** Results revealed that only 47.9% of workers regularly used face masks, while 67.4% wore gloves, signifying substantial non-compliance. Among the HPM components, interpersonal factors, such as trust, mutual respect, and collegial relationships, were significantly associated with PPE adherence. Additionally, organizational factors, including workplace policies and support systems, strongly correlated with the use of protective gloves. These findings underscore the critical role of fostering interpersonal relationships and implementing robust organizational policies to promote PPE compliance.

**Conclusion:** The study demonstrates the applicability of the HPM in understanding PPE compliance within industrial settings. While the research was conducted in companies located within the same city, the findings emphasize the significance of interpersonal and organizational factors in promoting PPE usage. By offering actionable insights, this study provides a foundation for developing targeted interventions aimed at improving PPE adherence, ultimately reducing workplace-related health risks and enhancing worker safety.

**Keywords:** Personal Protective Equipment, Health Promotion Model, Occupational Exposure, Organizational Factors, Interpersonal Factors

## **1. Introduction**

### **1.1 Background**

In hazardous work environments, workers prioritize their protection against potential risks. At the same time, they develop a heightened sense of vulnerability due to prolonged exposure to these risks. To clarify, it refers to an increased awareness of potential dangers, which may lead to greater caution or stress over time [1]. This increased risk awareness is reflected in their behaviors and decision-making processes, underscoring the need for effective protective measures [2]. In addition, the perception of safety plays a crucial role in influencing workers' well-being, productivity, and adherence to safety protocols [3], therefore, it is essential to create environments where workers feel safe and healthy. By providing appropriate training and support, perceptions of safety risks caused by exposure to health and safety risks can be mitigated, leading to safer and more productive workplaces [4, 5].

Working in situations with hazards such as extreme noise, heat stress, and radioactivity can put workers at risk of developing severe occupational diseases. In recent years, occupational disease cases have increased, with noise-induced deafness, musculoskeletal disorders, and skin diseases being among the most prevalent. These rising cases highlight the critical role of PPE in mitigating occupational health risks [6-8]. Such alarming statistics underscore the critical role of PPE as a preventive measure in mitigating the prevalence of occupational diseases, particularly in high-risk industrial sectors. Despite the availability of preventive measures, including PPE, occupational diseases continue to pose a significant challenge in high-risk industries [9]. This highlights the necessity of identifying key determinants influencing PPE adherence and addressing barriers to its proper use.

Previous research has extensively examined workplace hazards and the importance of PPE; however, significant gaps remain in understanding the specific factors affecting compliance in different occupational settings. Also, exposure to multiple workplace hazards, such as heat stress and chemical agents, can amplify health risks, emphasizing the necessity of effective control measures and PPE usage [10, 11].

While risk management measures like elimination and engineering controls are preferred, their implementation is often limited by budget constraints, poor supervision, and workplace restrictions. In such cases, PPE serves as the last line of defense against occupational diseases [12-14]. PPEs might not be as effective as engineering controls, but they offer a significant layer of protection when other safety procedures fail [15, 16]. These essential tools act as a shield, protecting workers from probable hazards and decreasing the probability of getting hurt or sick. Depending on the particular risks in a workplace, PPE can consist of a range of items tailored to the risks at hand [17, 18].

Despite existing studies on PPE compliance, there is still a need for deeper investigation into the specific personal, organizational, and situational determinants influencing its utilization. In many workplaces, while production workers may use PPE, it's not rare to see some of them using equipment that isn't appropriately suited to the specific risks that they are exposed [19]. This could be due to a lack of appropriate training [20], misinterpretation of the hazards involved [21], or even the inaccessibility of the right type of PPE [22]. Moreover, using inappropriate PPE can significantly diminish its effectiveness, leaving employees vulnerable to the health and safety risks they are encountering [23].

PPE compliance is influenced by workers' perceptions of safety, personal attitudes, and social factors such as peer support and organizational policies [24]. Common barriers include discomfort, poor fit, and the belief that PPE interferes with work [25, 26]. However, many previous studies have not provided comprehensive solutions to overcome these challenges, underscoring the necessity for further research that identifies practical strategies to enhance PPE compliance.

Some workers might even think PPE isn't required if they don't perceive the instant risks or consider the benefits don't justify the hassle [27]. TKM Wong et al (2020) [17] suggests that by understanding and tackling these obstacles, we can encourage more regular use of PPE, ultimately leading to a safer and more safe work environment for everyone [28]. Also, when workers perceive that PPE makes their workplace safer and helps prevent incidents, they're more likely to be inspired to use them regularly. But, if they find the PPE uncomfortable or inconvenient, they might be less passionate about using it [29]. Furthermore, the use of PPE is shaped by several other key issues that can significantly influence safety at work including how employees perceive risk, age and experience, as well, it matters whether the employer affords the proper PPE. When businesses make sure their workforces have the right to use appropriate protective gear, it makes it easier for them to follow

safety rules. Ultimately, these elements all work together to improve better work safety. Other than the worker-related factors, a study by EL Larson et al (2011) [30] demonstrate that organizational factors are also significant in the level of wearing PPE by the workers. A study by A Sarfaraz et al (2020) shows that factors such as the availability of PPE, the quality of the gear, workplace safety policies, and safety training all play a significant role [31].

Experienced workers are more aware of PPE importance due to familiarity with workplace hazards, whereas younger or new employees often require additional training and supervision to enhance compliance [32]. This underscores the need for tailored safety programs that address the varying levels of awareness and compliance across different experience levels in the workforce [33, 34]. By exploring these multifaceted influences, this study aims to provide a deeper understanding of the determinants of PPE utilization, ultimately guiding the development of tailored interventions for diverse workplace settings. By explicitly addressing these gaps in previous studies, this research aims to provide new insights into the determinants of PPE utilization, ultimately guiding the development of targeted interventions for improving adherence in high-risk workplaces.

## **1.2. Literature Review**

A wide range of studies has highlighted a strong association between wearing PPE and the health promotion model (HMP). Things such as masks and gloves provide protection from hazardous materials and infectious agents, reducing the risk of illness or injury. The HMP focuses on encouraging preventive health behaviors by emphasizing the importance of PPE usage as a key strategy in mitigating health risks. Whether in healthcare settings, workplaces, or daily routines, PPE serves as a fundamental component of the HMP's approach to proactive health management, ensuring both individual and societal well-being. By promoting consistent and proper PPE use, the HMP helps reduce exposure to hazardous conditions, preventing illness and injury. This approach not only enhances workplace safety but also fosters a culture of prevention and resilience in public health [35-37]. Several research studies have investigated the use of the HPM in improving PPE adherence among workers, especially in industrial settings. AH Khoshakhlag et al (2024) research involving small and medium enterprises found that workers' attitude towards PPE and workplace safety training were strong predictors of PPE use. Workers with safety training were significantly more likely to use PPE consistently. The primary barriers to PPE utilization were lack of availability, poor comfort, and inadequate training [38]. Another study conducted among construction workers, factors like government oversight, the provision of safety briefs, and PPE training were found to substantially increase the likelihood of PPE use [39]. Thus, applying the HPM through targeted interventions such as workplace safety education and regular training can effectively increase PPE adherence and reduce occupational hazards. In another study, the application of the HPM was linked to better PPE usage in hazardous industries such as mining. In this study, the model was used to develop interventions focusing on perceived barriers and benefits, risk perception, and self-efficacy [40]. Additionally, the COVID-19 pandemic led to increased focus on PPE usage in healthcare settings [41]. GL Torre et al study (2021) indicates the use of PPE was associated with a 70% reduction in SARS-CoV-2 infections among healthcare workers, reinforcing the need for proper education and behavioral interventions based on the Health Promotion Model to improve consistent PPE use in various industries [42].

Studies showed that the HPM concentrates on improving workers' understanding, attitudes, and behavior toward safety and PPE use, highlighting aspects such as knowledge, perceived benefits, and self-efficacy [43]. A study performed in small and medium-sized enterprises (SMEs), found that workers' attitudes and risk perceptions significantly affected their PPE usage. The study highlighted the significance of training interventions to enhance knowledge and positively shape workers' perspectives towards PPE, merging these factors to higher rates of compliance [44]. Also, a study on construction employees in Addis Ababa, Ethiopia, underlined that elements such as the availability of safety training and knowledge on PPE use were crucial in boosting higher usage rates. Employees who received safety training were up to four times more likely to use PPE than those who did not. This study also highlighted the role of external enforcement, such as government supervision, in reinforcing PPE compliance [39]. A study conducted by N Alinejad et al. (2023) applies the Health Belief Model (HBM) to examine how training can improve PPE compliance in healthcare settings. The HBM is introduced here because it highlights psychological factors, such as perceived severity of health risks and perceived barriers to compliance, which influence individuals' decisions to use PPE. This contrasts with the HMP, which takes a broader approach by promoting preventive health behaviors as a proactive and structured strategy. While the HBM focuses on personal risk perception

and motivational barriers, the HPM emphasizes systematic and organizational measures to embed PPE use within daily routines [45]. These studies highlight both the practical and theoretical applications of health models in improving PPE adherence, crucial for understanding its determinants in various industries [46, 47].

### **1.3. Study Objectives and Significance**

The HPM provides a practical framework for addressing the research gap in understanding the integrated influence of personal and situational factors on PPE usage across various workplace settings. While previous studies tend to focus narrowly on either individual compliance or organizational safety practices, few investigate how these factors interact to shape PPE utilization. This study uniquely bridges the gap by simultaneously examining individual, interpersonal, and organizational dynamics, offering a holistic understanding of factors influencing PPE adherence in complex workplace environments."

Conducted by HPM's main elements, this study examines the interplay between employees' characteristics (such as experience and risk perception) and organizational factors (like PPE availability and safety training), offering an integrated perspective. The originality of this study also lies in study on the workers who are working in major companies that have established international standards on safety and health, such as ISO 45000, ISO 45001, ISO 14001, and HSE-MS, providing a unique perspective on PPE usage in settings with progressive occupational health protocols which workers are exposed with highly hazardous chemical materials such as BTEX (Benzene, Toluene, Ethylbenzene and Xylene) compounds.

Focusing on organizations with advanced safety standards not only highlights best practices but also uncovers persistent challenges, providing valuable lessons for less-regulated settings. By investigating PPE compliance within companies already committed to high safety and health measures, this research presents insights into how even well-regulated environments face challenges related to interpersonal and organizational characteristics. This context increases our understanding of PPE usage beyond regulatory adherence, underscoring nuanced factors of employee behavior and interaction that can affect safety and health practices even in optimal circumstances.

The findings are expected to inform policymakers and industry leaders in designing more effective, tailored interventions that enhance PPE adherence, even in high-risk and well-regulated industries. Through this approach, the study aims to determine targeted procedures to improve PPE adherence by considering interpersonal, situational, and organizational dynamics across different industries.

## **2. Methods**

### **2.1. Theoretical Framework**

The Health Promotion Model (HPM) [48] provides a theoretical framework for our study, which includes three main stages: modifying factors, cognitive-perceptual factors, and health-related behaviors (using PPE). These stages are particularly relevant to our study as they offer a structured approach to understanding how various influences shape PPE compliance in occupational settings. The model suggests that modifying characteristics, including demographic factors, peer support, and organizational culture, indirectly shape health-related behaviors by influencing cognitive-perceptual factors, such as perceived benefits, perceived barriers, perceived self-efficacy, and perceived susceptibility. These cognitive-perceptual factors are central to individual decision-making, as they determine whether a worker believes PPE use is beneficial, whether they perceive significant obstacles to its use, how confident they feel in using PPE correctly, and how vulnerable they think they are to workplace hazards [49]. This is crucial in our context, as PPE compliance is not only a matter of knowledge but also depends on workplace culture, individual motivation, and perceived risks. By incorporating both external influences and individual decision-making processes, the HPM provides a more comprehensive approach than other frameworks, such as the Knowledge, Attitude, and Practice (KAP) model [50] or the contextual framework. Unlike the KAP model, the HPM integrates both organizational and personal factors, making it well-suited for evaluating health-related behaviors like PPE use in occupational settings [51]. In addition, organizational factors, such as workplace policies, safety climate, and managerial support, create an environment that either facilitates or hinders PPE compliance [52]. Simultaneously, personal factors, including perceived self-efficacy, perceived risk, and individual motivation, directly influence a worker's willingness to adhere to PPE guidelines [53]. The interaction between these factors is critical, as PPE use is not solely an

individual decision but is shaped by the broader organizational culture [54]. By incorporating both levels of influence, the HPM provides a comprehensive understanding of the determinants of PPE adherence, making it a more robust framework for analyzing workplace health behaviors.

## 2.2. Procedure and participants

This research is a descriptive-analytical study based on positivism research philosophy carried out in which the samples were selected from three industrial businesses with higher rates of exposure to occupational disease. Furthermore, each of these companies strictly complies with internationally recognized occupational safety and health standards, such as OHSAS 18001, ISO 45003 and HSE-MS, ensuring a strong framework for managing workplace hazards. Compliance with these standards indicates a commitment to sustaining high levels of safety and health management, providing a consistent approach across industries to decrease occupational risks and enhance worker well-being. In addition, positivism is applied in this study to systematically analyze the quantitative factors influencing PPE usage [55]. By employing a structured methodological approach, this study uses measurable data to examine the associations between personal and situational factors and PPE compliance. The positivist approach ensures objectivity in data collection and analysis, reducing bias and enabling the generation of replicable and generalizable findings [56]. This methodological framework allows for the identification of key determinants affecting PPE use, providing empirical insights that can inform workplace health and safety policies [57]. This approach supports the study's objective of determining reliable predictors of PPE adherence that can be applied across diverse industrial environments, providing precise, actionable insights to enhance workplace safety. Green et al (2020) advocacy for incorporating transformative perspectives highlights the importance of investigating not only individual compliance but also the social and organizational contexts that shape safety behaviors. This process complements the Health Promotion Model by suggesting that promoting supportive interpersonal and organizational environments may play an equally crucial role in improving PPE adherence [58]. The data collection process was informed by the results of a pilot study survey [59]. Before the main study, the questionnaire was pilot-tested with a small group of workers from similar industries to evaluate its clarity and comprehension. This pilot test involved 40 participants who were asked to complete the questionnaire, provide feedback, and comment on the wording and structure of the questions.

The feedback highlighted several areas for improvement. Some technical terms were simplified to ensure accessibility for participants with varying education levels, and ambiguous phrasing in a few questions was clarified. Additionally, response scales were adjusted to enhance consistency and ease of interpretation. Based on these insights, adjustments were made to improve the clarity of the questions, ensuring they were easily understood by participants with different levels of education and language proficiency. These refinements helped enhance the questionnaire's reliability and validity for the main study.

This pilot testing procedure not only improved the reliability of the questionnaire but also helped to ensure that the questions effectively captured the intended information regarding PPE usage. Therefore, the final version of the questionnaire was refined and used for data collection in the main study.

where:

Confidence = 95%

$d = 0.05$ ,

$SD = 0.47$

$Z^2\alpha/2 = (1.96)^2$

In this equation:

Confidence = 95%: This is the confidence level, indicating that if the same study were repeated numerous times, 95% of the confidence intervals generated would contain the true population parameter. It's a common standard in research, reflecting a high degree of certainty.

$d = 0.05$ : This is the margin of error (denoted as  $d$ ). In this case, it is 0.05, meaning the results are expected to be within  $\pm 5$  percentage points of the true population value. It sets an acceptable level of precision for your estimate.

$SD = 0.47$ : The standard deviation (SD) measures how spread out the data points are around the mean. A value of 0.47 indicates moderate variability in the data. Standard deviation is essential for understanding how much variation there is in the data, which influences sample size requirements.



$Z^2(\alpha/2) = 1.96$ : This is the Z-score associated with a 95% confidence level. The Z-score corresponds to the number of standard deviations a data point is from the mean. For a 95% confidence level, the Z-score is 1.96, meaning that 95% of the data lies within 1.96 standard deviations from the mean in a normal distribution.

By replacing the above items, sample size estimated at 340 persons. The formula offers simplicity and accuracy in calculating sample size for quantitative studies by directly accounting for the confidence level, data variability, and desired precision. It ensures flexibility, allowing researchers to adjust the sample size based on study requirements while maintaining the desired confidence level. Additionally, it helps optimize resources by determining a sample size large enough to produce reliable results without being unnecessarily large. The selection of participants from each company was based on the relative size of their workforces. The number of employees chosen from each organization reflects the actual number of workers present in those companies, ensuring that our sample is representative of the broader workforce dynamics. Specifically, 120 employees were selected from the paint industrial plant, 100 from the plastic production company, and 120 from the petrochemical company.

This distribution was designed to capture a diverse range of experiences and exposure to PPE use in different manufacturing environments. By maintaining proportional representation, we aimed to ensure that the findings accurately reflect the practices and challenges faced by workers in each sector. Additionally, this approach allows for a more comprehensive understanding of how PPE usage may vary across different industries, enhancing the overall validity of the study.

The random sampling method was conducted using a systematic approach to ensure that each worker had an equal opportunity to participate. A comprehensive list of all employees from each company was obtained, and a random number generator was employed to choose participants from this list.

For the paint industrial plant and the petrochemical company, which had larger worker counts, at first, we ensured that the total number of workers was well-documented. After obtaining the worker list, we assigned a unique identification number to each worker. Then, using the random number generator, we established the required number of participants—120 from the paint plant and 120 from the petrochemical company.

In the case of the plastic production company, which had a smaller workforce, we directly randomized the employee IDs using the same random number generator until we achieved the target of 100 participants. This process not only provided an unbiased selection but also ensured that our sample was representative of the workforce across the three industries.

By employing this random sampling method, we aimed to eliminate any selection bias and improve the generalizability of our results across the various manufacturing settings.

The participants for this study are selected from the workers who meet the following criteria:

- a) worked on the production line for more than a year: As a selection criterion, participants must have worked on the production line for more than one year to ensure that they have adequate experience, knowledge and familiarity with the workplace environment, safety regulations, and probable hazards in their workplace.
- b) have consistent exposure to organic solvents: This consistent exposure provides that the study concentrates on workers who face a relevant occupational risk, providing a significant context for examining PPE usage and adherence. By choosing participants with regular contact with hazardous material, the study can more accurately evaluate the elements that affect protective equipment utilization in high-risk environments.
- c) completed the research consent form, and
- d) have access to the required PPE: This indicates that workers are required to use PPE that is appropriate for their specific working conditions and ergonomic conditions. However, this issue is always observed in all companies adhering to international safety and health standards.

The study excluded workers who could not read or answer the questionnaire due to poor language skills. For those with lower levels of education, the research group read the questionnaire clearly to ensure that all participants fully understand the questions.

The study received ethical approval from Tabriz University of Medical Sciences before data collection. This approval ensured that all research activities adhered to ethical standards and protected the rights of participants.

To ensure participant confidentiality, responses were anonymized by removing identifying information and assigning unique ID numbers. All data were securely stored in a password-protected

database accessible only to the research team. Reports and publications will present aggregated data to further protect individual identities. Participants were required to sign an informed consent document, which clearly outlined their rights, including the option to withdraw from the research at any time without any repercussions.

These ethical considerations were integral to the study design, ensuring that participant rights were respected and that the research adhered to ethical research practices.

At the sampling sites, authors clarified the study's purpose in clear and simple terms. They then distributed the questionnaires to the employees and collected them once they were finished. This careful and respectful approach guaranteed that every worker understood the study and contributed their experiences, leading to more accurate and meaningful results.

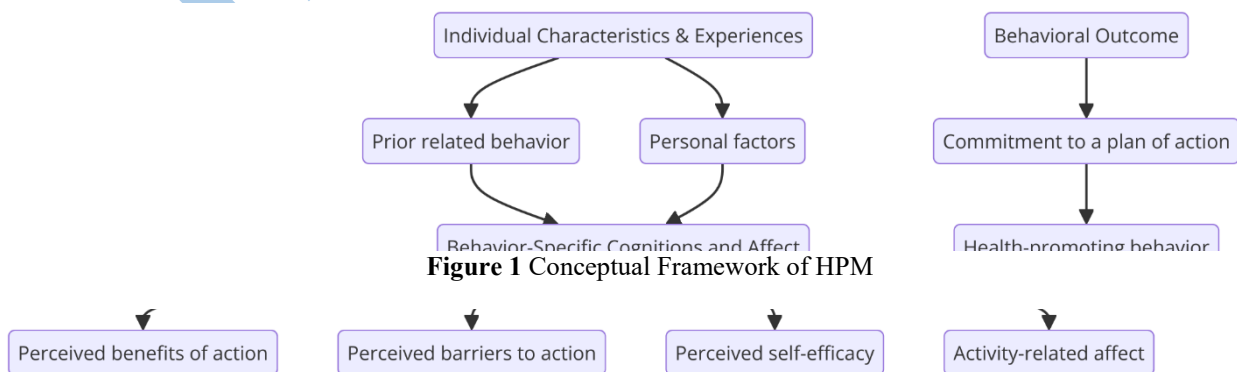
### 2.3. Measures

The primary data collection method in this study is a questionnaire survey, designed to assess PPE adherence among workers. The questionnaire was developed based on the studies of L. Lu (2015) [60] and K. Nichol (2008) [61] and structured to evaluate various factors influencing PPE usage. To ensure its accuracy and consistency, researchers assessed its validity and reliability, confirming that the tool effectively measures PPE adherence while maintaining stable results across different instances.

The questionnaire consists of five sections: personal demographic information, additional individual factors, interpersonal influences, organizational or situational elements, and the usage of PPE. The first section collects demographic details such as gender, age, work experience, marital status, education level, and exposure duration to organic solvents.

The remaining four sections (detailed in Table 1) are grounded in the Health Promotion Model (HPM) (Figure 1), which serves as the theoretical foundation for this study. These sections explore personal, social, and organizational factors influencing PPE adherence, offering a broader perspective on occupational safety decision-making. According to the HPM, modifying factors, such as demographic characteristics and interpersonal influences, indirectly shape cognitive-perceptual elements, which ultimately drive health-related behaviors [62]. The second section of the questionnaire examines personal factors influencing PPE compliance, including perceived benefits of PPE use (2 questions), barriers to PPE adherence (2 questions), and self-efficacy in PPE use (3 questions). Participants responded on a 5-point Likert scale. The third section focuses on social influences, assessing how role models (2 questions), social norms (3 questions), and peer support (3 questions) impact PPE adherence. Participants also responded using a 5-point Likert scale for consistency. The fourth section evaluates organizational factors affecting PPE compliance, particularly PPE accessibility and the organization's commitment to PPE enforcement.

Finally, the last section assesses actual PPE adherence, specifically the use of protective face masks and gloves. Participants answered questions such as "How often do you wear a protective face mask during work?" and "How often do you wear protective gloves while working?" to measure their compliance with PPE guidelines.



Construct	Item	Item text	Range	Alpha
Perceived benefits	1	It is possible to decrease exposure to toxic material if I use PPE during work	2-10	0.75
	2	Using PPE when exposed to toxic material can prevent occupational diseases		
Perceived barriers	1	I feel uncomfortable when using PPE	2-10	0.84
	2	I think using PPE will slow my work speed and therefore reduce my income		
Perceived self-efficacy	1	If using PPE were not uncomfortable, I would definitely use it	3-15	0.72
	2	If using PPE did not make me work slowly, I would definitely use it		
	3	If PPE was easy to obtain, I would definitely use it		
Social models for PPE	1	How often does my team leader use PPE when exposed to toxic substances?	2-10	0.60
	2	How often do my fellow workers use PPE when exposed to toxic substances?		
Social norms for PPE	1	What is the attitude of my co-workers towards my PPE use?	3-15	0.74
	2	What is the attitude of my family members towards my PPE use?		
	3	What is the attitude of my supervisor towards my PPE use?		
Interpersonal support for PPE	1	Do your coworkers encourage you to use PPE?	3-9	0.68
	2	Do your family members encourage you to use PPE?		
	3	Do your supervisors encourage you to use PPE?		
Organizational factors	1	I can obtain new PPE when I need to use or replace it	2-10	0.60
	2	My factory emphasizes on the use of PPE		

**Table 1** Questionnaire construct items

### 2.3. Statistical analysis

we examined the reliability of the questionnaire by looking at its internal consistency with Cronbach's Alpha. According to Sørensen and Slater et al study (2008), an alpha coefficient of 0.60 or higher indicates that the measure is reliable [63]. Our scales for perceived benefits (Table 1), barriers, self-efficacy, social modeling, social norms, interpersonal support, and organizational factors all met this standard, with alpha coefficients ranging from 0.60 to 0.84. We also evaluated the normality of our numeric variables by the Kolmogorov-Smirnov test. We presented our data as means and standard deviations for normally distributed numeric variables and medians with ranges for non-normal ones, while categorical data was shown as frequencies and percentages. To associate health promotion measures between those who wear PPE (like face masks or gloves) and those who don't, we used chi-square tests for categorical data and t-tests for normally distributed continuous data. A p-value of 0.05 or less was considered statistically significant [64].

Finally, we used a two-level logistic regression model to identify how different factors affected the use of PPE in the workplace, while adjusting for individual demographics. In the current research, we used a two-level logistic regression model because it accounts for the hierarchical structure of the data, such as individuals nested within groups (e.g., patients in clinics). This model captures both individual-level and group-level variations, handling unobserved heterogeneity at the group level while also accounting for correlations within clusters. Using logistic regression, it is suitable for



binary outcomes (e.g., health behaviors), providing more accurate estimates and improving the model's fit compared to single-level approaches. This provides more reliable and interpretable outcomes in contexts where both individual and group-level elements affect outcomes [65]. In all our analyses, we considered results with p-values under 0.05 as significant [66].

To assess the reliability of the scales used in this study, Cronbach's alpha values were calculated, as presented in Table 1. Cronbach's alpha is widely used to measure internal consistency, which reflects the degree to which items within a scale correlate with each other, thereby demonstrating that they collectively assess the same underlying construct. Normally, alpha values above 0.50 are considered acceptable, suggesting adequate reliability, whereas values exceeding 0.70 are generally seen as a solid indicator of reliability. In this context, Cronbach's alpha values help confirm that the variables included are suitable for further analysis and reliably represent factors influencing PPE usage.

For the analysis of categorical variables, we employed logistic regression, a statistical method designed to model binary outcomes. Logistic regression is particularly useful in this study, as it allows us to estimate the probability of PPE compliance as influenced by various predictor variables, such as interpersonal and organizational factors. This approach provides an understanding of how each independent variable contributes to the likelihood of PPE usage, yielding insights that can support targeted interventions aimed at improving compliance in industrial settings.

### 3. Results

Table 2 presents a closer look at the group's background. Most workers were men (95.9%), and a large majority were married (89.7%). Approximately half of them were in their 30 years old, specially aged 31 to 40 (46.1%), and had been employed for 10 to 15 years, presenting a fairly experienced group. Education-wise, a remarkable portion had reached junior secondary school (37.4%), giving us a glimpse of their academic situation. It's also essential to note that more than half were exposed to their work environment for over 8 hours each day (50.6%), indicating extended work shifts. Whereas most workers took precautions by wearing protective gloves (67.4%), more than half didn't use face masks (52.1%). This pattern indicates a gap in protective practices, especially when it comes to safeguarding against airborne hazards. These understandings emphasize the need for continuing attention to safety measures in the workplace.

Table 2 The characteristics of samples

Factor	Frequency(%)	Factor	Frequency(%)
<b>Age group (yr.)</b>		<b>Education</b>	
≤20	2(0.6)	Primary school or below	58(17.1)
21-30	61(17.9)	literate until junior secondary school	127(37.4)
31-40	157(46.1)	Senior secondary school	64(18.8)
41-50	100(29.4)	Junior college and above	91(26.8)
>50	20(5.8)		
<b>Work experience (yr.)</b>		<b>Exposure time</b>	
≤	52(15.3)	≤1 hr.	19(5.6)
5-10	79(23.2)	1-2 hrs.	25(7.4)
10-15	115(33.8)	2-8 hrs.	124(36.5)
15-20	30(8.8)	More than 8 hrs.	172(50.6)
>20	64(18.8)	<b>Gender</b>	
<b>Marital status</b>		Men	326(95.9)
Married	305(89.7)	Women	14(4.1)
Single	35(10.3)	<b>Use masks</b>	
<b>Use gloves</b>		Yes	163(47.9)
Yes	229(67.4)	No	177(52.1)
No	111(32.6)		

Table 3 show how various factors influence the use of PPE. Chi-square and T-test analysis reveals some interesting findings, which indicated that the education level was closely associated to their probability of wearing protective gloves. Moreover, the amount of time any worker is exposed to hazards has a significant role in whether they used face masks and gloves ( $p < 0.05$ ). When it comes to cognitive and perceptual factors, people who saw clear benefits and faced barriers in their work environment were more likely to use gloves. Moreover, those who felt confident in their ability to protect themselves were more inclined to use both of them ( $p < 0.05$ ). Social norms, or what's commonly accepted in one's social circle, were particularly influential in encouraging the use of both face masks and gloves. Lastly, organizational factors had a major influence on PPE usage ( $p < 0.05$ ). These results shed light on how education, personal beliefs, confidence, social influences, and workplace culture all play vital impacts in shaping protective practices. This underscores the need for targeted interventions that address these various factors to improve overall safety.

Table 3 Relationship between compliance with the use of PPE and individual demographics, cognitive-perceptual, interpersonal and situational factors.

Variables	Compliant (Y1 = wear face masks) Asymp. Sig	Compliant (Y2 = wear gloves) Asymp. Sig
<b>Demographic factors</b>		
Age	0.581	0.925
Work experience	0.521	0.166
Marital status	0.0650	0.054
Education	0.268	0.022*
Exposure time	0.032*	0.006*
Gender	0.925	0.985
<b>Cognitive-perceptual factors</b>		
Perceived benefits	0.087	0.018*
Perceived barriers	0.121	0.026*
Perceived self-efficacy	0.043*	0.005*
<b>Interpersonal factors</b>		
Social models	0.120	0.263
Social norms	0.015*	0.007*
<b>Interpersonal support</b>	0.154	0.230
<b>Organizational factors</b>	0.043*	0.019*

\* $p < 0.05$  (based on a Chi-square test for categorical measures and a T-test for continuous measures)

In the next stage of our study, we made a two-level logistic regression model that involved several explanatory issues. The results of this analysis are presented in Table 4. The data indicates a remarkable pattern: gender has a role in whether workers are likely to wear both face masks and protective gloves. After considering differences in demographics, the interpersonal factors from the Health Promotion Model HPM stood out as the most important drivers for PPE use. In contrast, cognitive-perceptual factors didn't look to have much of an impact. When we looked more carefully, interpersonal support and organizational factors were only associated to the use of gloves. For face mask use, workers with higher scores in social support networks were significantly more likely to use one, with an odds ratio of 3.51 (95% CI: 1.23-1.50). On the other hand, when it came to gloves, organizational factors were a powerful predictor, with a higher score in this area leading to an odds ratio of 3.15 (95% CI: 1.12-1.15) for increased use.

Our analysis illustrates that individual's PPE habits are influenced differently depending on the kind of them. Social factors seem to boost more face mask usage, while workplace or organizational support has a higher effect on whether somebody wears protective gloves. This suggests that tailored approaches may be required to develop overall PPE adherence.

Table 4 Factors associated with PPE Use: OR for fixed variables in logistic regression with random intercepts for enterprises

Variables	Y1 = wear face masks Odds ratio (95% CI)	Y2 = wear gloves Odds ratio (95% CI)
<b>Demographic factors</b>		
Age	1.23(0.81-1.88)	0.99(0.63-1.56)
Work experience	0.99(0.77-1.28)	0.997(0.74-1.30)

Marital status	0.89(0.39-2.01)	0.48(0.18-1.28)
Education	0.87(0.71-1.07)	1.04(0.89-1.23)
Exposure time	1.07(0.80-1.44)	1.18(0.84-1.63)
Gender	3.48(1.59-1.18)*	0.36(0.07-1.74)*
<b>Cognitive-perceptual factors</b>		
Perceived benefits	0.93(0.80-1.08)	1.06(0.91-1.24)
Perceived barriers	0.97(0.84-1.10)	0.99(0.86-1.104)
Perceived self-efficacy	0.99(0.90-1.09)	0.99(0.89-1.09)
<b>Interpersonal factors</b>		
Social models	3.51(1.23-1.50)*	3.09(1.33-1.50)*
Social norms	1.22(0.99-1.50)	2.03(1.99-2.20)*
<b>Interpersonal support</b>	1.50(0.99-1.24)	1.12(1.01-1.24)*
<b>Organizational factors</b>	2.00(1.50-1.66)	3.15(1.12-1.15)*

\*p<0.05

#### 4. Discussion

This study explains how the HMP model can help predict worker's attitudes toward using PPE. By looking at particular factors, the research demonstrates that the model is not only capable of predicting but also makes a deep understanding of how PPE is being used in the workplace. These findings have been verified by similar studies [25, 67, 68] where the HMP model was also employed to understand PPE use among workers. These studies emphasize the importance of using predictive models for methods of improving workers' safety and health.

When the right PPE is chosen and used properly, it can aid reduce workplace accidents rate, occupational exposure and severity of potential risks. Properly using PPE is an imperative part of improving workers safety and decreasing the probabilities of serious harm on the job [25, 69]. There is little information about use PPE among worker, but our findings show that only few of worker use PPE. Shamsi et al. (2013) study on attitude and behaviors related to using PPE in employees of constructing subway stations, showed that the using of PPE by the staff is not desirable [70]. This study presents practical wisdom into the attitudes and behaviors affecting PPE usage among construction workers, underscoring the significance of audience analysis for developing useful behavior change interventions. Their findings underscore that organizational culture, perceived risk, and the availability of PPE significantly impact compliance, aligning with the HPM's elements in our study. Also, another study by Moshashaei et al. showed that among the components of safety and health, clothing components and other personal protective equipment like as mask with a score below 20% were one of the most undesirable components of safety and health [18]. Another study which is conducted by R Sehsah et al (2020) among construction workers showed that safety and health training can improve worker's attitudes and believe toward using PPE and it will be affected occupational accidents and injuries. In addition, authors declared that main causes for not using PPE is rooted in the lake of knowledge, fitting problem with worker posture [71]. The results of his study are in line with the findings of this study. Mahmood et al. (2020) study emphasize the importance of proper training for healthcare workers in donning, doffing, and safely handling PPE to minimize the risk of self-contamination [72]. This result of their study are align with our results about using HPM to adopting proper training to promote using PPE among employees.

Many workers have stated that PPE tends to decrease their efficiency and slow down their work. In some cases, they find PPE annoying or restrictive, which makes it durable for workers to move easily and reduce their performance. This view demonstrates the continuing challenge of ensuring safety while also improving productivity. These findings have confirmed by several studies [68, 73, 74]. The results of our study showed that about 25% of the academic education workers do not have enough access to personal protective equipment due to economic and financial limitations. This issue is seen in many companies that work with limited financial margins, but still, they try to provide enough safety equipment [75]. Not only does this put workers' health at risk, but it also highlights the broader challenge of ensuring worker safety in the face of economic pressures. These findings are consistent with several studies [76-78]. In our study, utilization rates for face masks were 47.9% and gloves were 67.4%. Previous studies have found the compliance rate of PPE use to be between 40% and 70% [79, 80]. Also, the results of Lu et al.'s research showed that 54% of the people used face masks and 77% of gloves, which was similar to our utilization rates. Face masks are used less than gloves

due to the inadequate supply of face masks and presumably the uncomfortable feeling associated with wearing one [68]. While our findings indicate high compliance with glove usage, the relatively lower face mask compliance warrants further exploration.

Several elements may contribute to this gap in face mask usage. First, the perceived risk associated with the tasks performed may affect employees' attitudes toward PPE. For instance, if employees believe that their primary exposure risks are linked to skin contact rather than inhalation of hazardous substances, they may prioritize gloves over masks. This perception could arise from insufficient education or communication regarding the specific health and safety hazards posed by hazardous organic solvents [81, 82].

Second, comfort and convenience play a vital role in PPE compliance. Face masks can often be perceived as uncomfortable, particularly during prolonged use, leading employees to forgo them in favor of gloves, which are generally easier to wear and adjust. Employers should consider evaluating the kinds of masks provided to ensure they are comfortable and appropriate for the tasks at hand [83].

Finally, social influences and workplace culture may impact PPE adherence [84]. If face mask usage is not visibly reinforced by managers or supervisors, employees may feel less compelled to wear them [85]. Cultivating a workplace culture that prioritizes comprehensive PPE usage, including face masks, is crucial for bridging this compliance gap [86].

Our results show the interpersonal factors effect in forecasting acceptance with PPE usage. The parameter of social norms questioned workers about how much their colleagues, family and supervisors supposed that respondents must use PPE. Parameter of social models involved of questions about how much workers believed their team leader and colleague used PPE when exposed to hazardous agents. Parameter of interpersonal support questioned workers whether colleague, your family and supervisor advised them to use PPE. Workers' interpersonal factors was more powerful associated to their use of PPE than any personal or organizational characteristics [37, 67]. Neves et al. (2011) underscore that ensuring the safety of nursing staff requires more than just the provision of PPE. It also involves addressing interpersonal, organizational, and educational determinants of PPE use. The study advocates for a holistic approach to improve adherence, ensuring the well-being of healthcare workers while minimizing occupational risks [87]. This finding is in line with results of our study.

Interpersonal support has more management efforts than other parameter, therefore it is practical that interpersonal support is related with the agreement of PPE use, but some study reported self-efficacy is important factor to PPE use [88-90]. It is interpreted user ability and comfort ability of PPE have important role to use it.

In this study, cognitive-perceptual factors (perceived benefits, barriers, and self-efficacy) did not significantly predict PPE adherence. This may be due to workers' reliance on external influences, such as workplace policies, peer behaviors, and organizational support, rather than personal beliefs. Additionally, inadequate training and awareness of occupational hazards may limit the impact of cognitive-perceptual factors on PPE use. Lu et al. 2015 showed some cognitive parameter such as perceived benefit and barrier use of PPE and self-efficacy don't have significant association with wearing PPE and suggest that interventions should focus more on strengthening interpersonal and organizational support rather than solely addressing individual perceptions [60]. Workers have not enough confidence and persistence to use PPE, it may be due to lack an awareness of workplace hazards and the benefits and barriers of PPE use due to insufficient OH&S education and training. Our findings in this regard are align with result of Budhathoki et al. (2014) study [91]. The results of this study showed that while many workers were aware of various occupational hazards, their actual use of safety measures was inadequate. Elements affecting safety practices included education status, training on occupational safety and health, and access to appropriate PPE. The study concludes that improving awareness and providing adequate access to safety training and PPE are vital for enhancing the health and safety of workers.

According to the results obtained of our study, several solutions can be proposed to improve the use of personal protective equipment by workers. These include, increased mutual supervision of the use of PPE by workers, Provide training programs to enhance peer-group support and supervision of PPE use and development OH&S policy [92, 93]. This study summarizes several key recommendations for implementing organizational modifications aimed at enhancing and promoting PPE usage. These recommendations, outlined in the figure below, address critical areas such as training, accessibility, policy evaluation, and fostering interpersonal support.

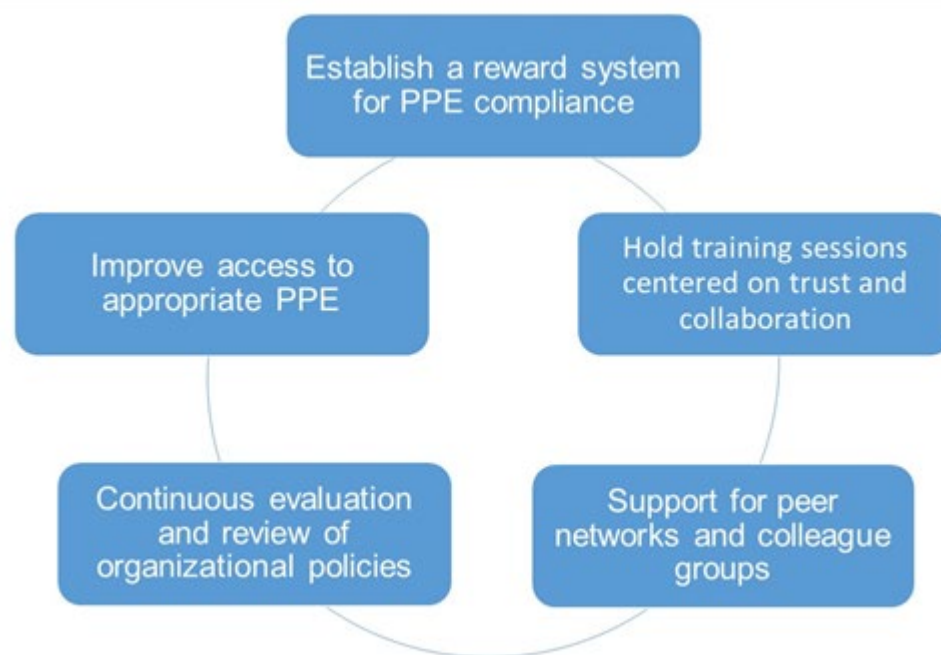


Figure 2 Recommendations for Improving and Promoting PPE Usage

It can be argued that our study is one of the first studies in Iran to apply the HPM model to analyze potential determinants of PPE use among workers of major industrial companies exposed to organic solvent hazards.

Finally, our research highlights this findings:

- 1- PPE usage indicated gaps, with only 47.9% wearing face masks compared to 67.4% for gloves, underscoring a disparity in PPE compliance, especially for airborne hazards.
- 2- Higher education levels correlated with better glove use, because of increasing awareness about the nature of hazards, while longer exposure to hazards was linked to increased PPE usage.
- 3- Perceived benefits and barriers, along with self-efficacy, played a role in glove use. Confidence in self-protection was significant for both gloves and masks.
- 4- Social norms and organizational characteristics extremely affected PPE adherence, particularly mask use, showing how workplace culture shapes protective behavior.
- 5- Interpersonal and organizational characteristics were the most effective in PPE use, specifically social models for mask use (odds ratio of 3.51) and organizational factors for gloves (odds ratio of 3.15).
- 6- Organizations and managers should encourage a culture of safety through continuous evaluations, policy reviews, and supervisor-led reinforcement.
- 7- To improve PPE adherence, peer-group support, training programs, establishing reward systems, and ensuring easy access to appropriate PPE can enhance PPE usage.

### Conclusion

This study indicates the application and potential of the HPM in predicting and understanding workers' perspectives on safety and the use of PPE. The model effectively underscores how personal beliefs, perceived benefits and barriers, self-efficacy, and interpersonal influences shape workers' safety behaviors. By determining key interpersonal and organizational factors, such as peer support, management commitment to safety, and access to training, this study emphasizes the critical role of supportive environments in enhancing PPE compliance. The results indicate that promoting a workplace culture that prioritizes safety, through leadership involvement and collaborative efforts, can significantly improve the probability of workers adhering to safety protocols. Like many other studies, ours has its limitations. One of the important challenges of this study was the restricted access to certain companies, as some managers refused to permit research activities and data collection within their facilities. This issue reduced the number of potential study sites and the diversity of organizational settings that could have enriched the findings. The reluctance of some managers may be rooted in concerns about confidentiality, potential disruptions to workflow, or



apprehension about revealing workplace procedures. This barrier highlights the significance of building trust and transparent communication with management in future research, ensuring companies understand the value of such studies in improving occupational safety and health. This naturally limits the range of the associations we were able to discover within the model. Moving forward, future research should consider including a wider range of variables so we can better understand the different factors at play. Another significant point is that because our study was cross-sectional, we can't draw firm conclusions about cause and effect. We were able to classify relations among variables, but it's hard to say for sure what's driving what, or if there are other unmeasured influences at work. One of the limitations of this study is that the questionnaire does not explicitly assess the role of necessary training, the establishment of mandatory rules, and the provision of PPE by companies. While organizational factors related to PPE accessibility were considered, aspects such as formal training programs, regulatory enforcement, and company policies were not directly measured. These factors are crucial in shaping workers' adherence to PPE usage, as proper training enhances awareness, mandatory rules reinforce compliance, and PPE availability ensures accessibility. Future research should incorporate these elements to gain a more comprehensive understanding of PPE adherence. Qualitative methods, such as interviews or focus groups, could provide deeper insights into how company policies and training initiatives influence workers' behavior. Additionally, including specific survey items on training frequency, enforcement of PPE regulations, and company-provided PPE resources would help capture these dimensions more effectively.

To really get to the bottom of these relationships, future studies could use a longitudinal approach. This would allow researchers to track changes over time, giving us a much clearer picture of cause and effect. On top of that, focusing on specific interventions whether through programs or policies could really help pinpoint what actually improves workers' use of personal protective equipment (PPE). But it doesn't stop there. Evaluating these interventions and conducting thorough policy analyses could provide valuable insights that not only help individual organizations but also shape wider policy decisions.

By addressing these limitations using more data, following people over time, and experimenting with targeted strategies we can build a deeper understanding of how to improve PPE use in the workplace. Ultimately, this will help create safer work environments, where workers are better protected, and health outcomes are significantly improved. By taking these steps, future research can play a critical role in shaping both theory and practical solutions for workplace safety.

Despite these limitations, our study shows that the HPM framework is relevant in different cultural contexts. Also, our study showed the importance of interpersonal and organizational factors to other variables in the use of PPE. We hope that the focus of the organizations on the important variables in the use of PPE will help to further improve this.

Future studies should adopt more comprehensive variables and designs to strengthen the understanding of cause-and-effect relationships. Ultimately, increasing the use of PPE through targeted interventions and policy support can lead to safer work environments and better health outcomes for workers.