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# COMPLIANCE WITH PERSONAL PROTECTIVE EQUIPMENT USE AMONG CHEMISTRY LABORATORY STUDENTS: THE ROLE OF KNOWLEDGE, ATTITUDE, AND AVAILABILITY OF FACILITIES

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**ABSTRACT**

***Compliance with Personal Protective Equipment Use Among Chemistry Laboratory Students: The Role of Knowledge, Attitude, and Availability of Facilities.*** *Compliance with personal protective equipment (PPE) usage is an important indicator of occupational safety implementation in chemistry laboratories, which carry high risks of accidents and hazardous material exposure. This study aimed to analyze the relationship between knowledge, attitude, and PPE availability with compliance among students of the Environmental Health Department at Poltekkes Kemenkes Banjarmasin. A cross-sectional study design with a quantitative approach was employed. The study sample consisted of 80 students, including 40 students from the Diploma Three Program, 4th semester, and 40 students from the Applied Bachelor Program, 6th semester, selected using total sampling. Data were collected through direct observation and structured questionnaires, then analyzed using the Chi-square test at a 0.05 significance level. The results showed that knowledge (p=0.539) and attitude (p=1.000) were not significantly associated with PPE compliance. PPE availability also did not show a significant relationship (p=0.164); however, there was a tendency for higher compliance when PPE was adequately available (65.7%) compared to insufficient availability (40.0%). These findings align with the PRECEDE–PROCEED model, which emphasizes the role of enabling factors in shaping health behaviors. The results highlight that improving compliance cannot rely solely on education and positive attitude formation but also requires adequate PPE provision, continuous supervision, and the establishment of a safety culture in the educational environment.*



## INTRODUCTION

The chemistry laboratory is an educational facility with a high risk of occupational accidents and exposure to hazardous materials. Practical activities involving chemicals, hot equipment, and certain reactions can trigger serious hazards, such as fires, explosions, skin and eye irritation, burns, and respiratory problems due to toxic gas exposure. A study in Lebanon involving 220 laboratory workers reported that 45% had experienced accidents, with 73.7% caused by chemical exposure, primarily via inhalation (45.4%)[1]. Meanwhile, data from the Laboratory Safety Institute indicate that 25–38% of laboratory workers have experienced accidents or injuries, and only approximately 40% consistently use personal protective equipment (PPE) while working[2].

A notable accident in Indonesia occurred in 2015 at the Chemistry Laboratory of the Faculty of Pharmacy, University of Indonesia, where an explosion caused by negligence in controlling equipment temperature resulted in injuries to 14 students[3]. This incident underscores the urgency of implementing strict occupational safety protocols in educational laboratories. One key indicator of such implementation is the proper and consistent use of PPE, which protects the body from chemical exposure, heat, or splashes that may cause injuries.

Suboptimal PPE use can be influenced by both individual and environmental factors. Individual factors such as knowledge play a role in increasing awareness of occupational risks and the benefits of PPE use. Students with higher knowledge about chemical hazards and safety procedures tend to exhibit better compliance[4,5]. However, studies indicate that while knowledge improves compliance, it is not always the dominant factor compared to peer support as a reinforcing factor[6,7].

Attitudes toward PPE and risk perception also affect safe behavior. Workers with positive attitudes toward safety practices are generally more compliant in using PPE [8]. Nevertheless, perception alone shows a weak correlation with compliance[6] . A study at Blora Community Health Center demonstrated that attitude did not have a significant relationship with PPE usage behavior (p=0.662), unlike the availability of PPE, which was highly significant (p=0.000, correlation 0.866) [9].

Adequate availability of PPE enables individuals to protect themselves as needed. Conversely, limited quantity or quality of PPE can hinder compliance, even when knowledge and attitudes are sufficient. Previous research shows that ensuring PPE is available and easily accessible can enhance compliance[10].

Theoretically, the PRECEDE–PROCEED model, developed by Lawrence W. Green, explains that health behavior is influenced by three main components: (1) predisposing factors, such as knowledge and attitude; (2) enabling factors, such as availability of facilities; and (3) reinforcing factors, such as regulations, supervision, and social support[11,12]. In the context of educational laboratories, these three factors work synergistically. Good knowledge and attitudes need to be supported by adequate PPE availability and reinforced by supervision from lecturers or laboratory technicians, as well as the implementation of strict sanctions.

At the Environmental Health Department of Poltekkes Kemenkes Banjarmasin, the chemistry laboratory is routinely used by Diploma Three and Applied Bachelor students. Preliminary observations revealed that not all PPE was adequately available, and some students did not comply with PPE usage standards. This condition potentially increases the risk of accidents and exposure to hazardous materials, such as hand injuries, skin burns, or inhalation of chemical fumes due to negligence in PPE use. Based on this background, this study aimed to analyze the relationship between knowledge, attitude, and PPE availability with compliance among chemistry laboratory students at the Environmental Health Department of Poltekkes Kemenkes Banjarmasin. The study's findings are expected to provide recommendations for improving occupational safety strategies through education, positive attitude development, adequate PPE provision, and the strengthening of a safety culture in the educational environment.

## MATERIALS AND RESEARCH METHODS

This study employed a cross-sectional design with a quantitative approach to examine the relationship between independent variables—knowledge, attitude, and availability of personal protective equipment (PPE)—and the dependent variable, which is compliance with PPE use among students. This design allows for the measurement of all variables simultaneously without any intervention. The study population comprised all students of the Environmental Health Department at Poltekkes Kemenkes Banjarmasin who were participating in chemistry laboratory practicums during the even semester of the 2024/2025 academic year.

The study sample consisted of 80 students, including 40 Diploma Three (D3) students in semester IV and 40 Applied Bachelor (S.Tr.) students in semester VI. A total sampling technique was used, in which all students meeting the inclusion criteria were involved. Inclusion criteria included active students participating in chemistry laboratory practicums during the study period and willing to participate by signing informed consent. Exclusion criteria comprised students who were absent during data collection or who did not complete the questionnaires.

The research instruments included a multiple-choice knowledge questionnaire to assess students' understanding of PPE and laboratory safety; a Likert-scale attitude questionnaire to evaluate students' views and perceptions regarding the importance of PPE use; a PPE availability questionnaire to identify completeness and condition of PPE in the laboratory; and an observation sheet to assess PPE compliance behavior directly during laboratory activities. The instruments were validated for content by occupational safety and environmental health experts and tested for reliability on 49 respondents outside the study sample, with Cronbach's alpha values ≥0.7.

Data collection was conducted in several stages. The preparation stage included the development of questionnaires, pilot testing of instruments, and obtaining institutional research approval. The implementation stage began with respondents completing the questionnaires in the classroom prior to the laboratory practicum, followed by direct observation of PPE usage during laboratory activities. Upon completion, the questionnaires and observation sheets were checked for completeness before data processing.

Data analysis was performed using statistical software. Univariable analysis was conducted to describe the frequency distribution and percentage of respondent characteristics and each study variable. Bivariable analysis was carried out to examine the relationship between independent and dependent variables using the Chi-square test at a significance level of 0.05.

Ethical approval for this study was obtained from the Health Research Ethics Committee of Poltekkes Kemenkes Banjarmasin. All respondents were provided with information regarding the study objectives and procedures, participated voluntarily, and signed informed consent. Confidentiality was maintained, and the data were used solely for research purposes.

## RESEARCH RESULTS AND DISCUSSION

Univariate analysis was conducted to describe the characteristics of the respondents and the distribution of each study variable. Respondent characteristics included gender, level of knowledge, attitude toward the use of personal protective equipment (PPE), perception of PPE availability, and compliance with PPE usage.

Table 1. Distribution of Respondent Characteristics and Study Variables

| **Variable** | **Total** | Percentage |
|---|---|---|
| Gender | | |
| • Male | 17 | 21% |
| • Female | 63 | 79% |
| Knowledge | | |
| • High | 67 | 84% |
| • Low | 13 | 16% |
| Attitude | | |
| • Positive | 78 | 98% |
| • Negative | 2 | 3% |
| PPE Availability | | |
| • Adequate | 70 | 88% |
| • Inadequate | 10 | 13% |
| Compliance | | |
| • Compliant | 50 | 63% |
| • Non-compliant | 30 | 38% |

Based on the analysis presented in Table 1, the majority of respondents were female (79%), while males accounted for only 21%. This indicates that practical sessions in the Chemistry Laboratory of the Environmental Health Department at Poltekkes Kemenkes Banjarmasin are predominantly attended by female students. Regarding knowledge, 84% of respondents demonstrated a high level of understanding of PPE and laboratory safety, indicating that most students cognitively comprehend the importance of PPE and the potential risks associated with non-use.

Attitudes toward PPE usage were generally positive, with 98% of respondents showing support for safety practices. In terms of facilities, the majority of respondents (88%) assessed the availability of PPE in the laboratory as adequate. Observational data confirmed that the chemistry laboratory possesses sufficient facilities and infrastructure that comply with the safety standards for Diploma III Environmental Health laboratories as stipulated by the Ministry of Health of Indonesia (2015)[13]. However, compliance with PPE usage was not yet optimal, as 38% of respondents were non-compliant. This finding highlights a gap between knowledge, attitude, and facility availability and actual behavior. From a work behavior perspective, this may be influenced by reinforcing factors such as supervision and an underdeveloped safety culture[11,12] .

To examine the relationship between the independent variables (knowledge, attitude, and PPE availability) and compliance with PPE usage, a bivariate analysis was conducted using the Chi-square test at a significance level of 0.05.

Table 2. Relationship between Knowledge, Attitude, and PPE Availability with PPE Compliance

| Independent Variables | PPE Compliance | | Total n (%) | p-value |
|---|---|---|---|---|
| | Compliant n (%) | Non-compliant n (%) | | |
| **Knowledge** | | | | |
| • High | 43 (64,2) | 24 (35,8) | 67 (100) | 0,539 |
| • Low | 7 (53,8) | 6 (46,2) | 13 (100) | |
| **Attitude** | | | | |
| • Positive | 49 (62,8) | 29 (37,2) | 78 (100) | 1,000 |
| • Negative | 1 (50,0) | 1 (50,0) | 2 (100) | |
| **PPE Availability** | | | | |
| • Sufficient | 46 (65,7) | 24 (34,3) | 70 (100) | 0,164 |
| • Insufficient | 4 (40,0) | 6 (60,0) | 10 (100) | |

Based on Table 2, respondents with high knowledge demonstrated a compliance level of 64.2%, whereas respondents with low knowledge only showed 53.8%. The Chi-square test yielded $p = 0.539$ ($p > 0.05$), indicating no significant relationship between knowledge and compliance in the use of personal protective equipment (PPE). According to the PRECEDE–PROCEED model developed by Green, knowledge is categorized as a predisposing factor that can promote safe behavior[11,12]. Adequate knowledge should serve as a foundation for compliant behavior. Iskandar et al. (2025) reported that knowledge and peer influence are significant factors affecting compliance with PPE usage among chemical laboratory students [14]. Similarly, a study conducted at Poltekkes Kemenkes Kupang by Novianti Baunsele et al. (2024) also demonstrated that knowledge level was associated with PPE compliance ($p = 0.027 < 0.05$)[15].

However, in this study, knowledge did not fully support compliant behavior in PPE usage. This finding aligns with Zamzami et al. (2019), who stated that occupational health and safety (OHS) knowledge levels did not correlate with attitudes toward OHS in the laboratory[16]. According to Yana (2019), the contribution of OHS knowledge to awareness of OHS behavior was 23.21%, while the remaining 76.79% was determined by other variables[17]. This indicates that enabling and reinforcing factors remain necessary to ensure the implementation of safe behaviors[18,19].

Attitude variables showed a similar pattern. Almost all respondents (98%) exhibited a positive attitude toward PPE usage, with a compliance level of 62.8%, whereas respondents with a negative attitude showed a compliance level of 50.0%. Noviarmi and Prananya (2023) reported that attitude was associated with compliance with PPE usage ($p = 0.000 < 0.05$)[20].

This finding is consistent with Liswanti (2017), who observed a significant relationship between attitude and PPE usage behavior among D3 Health Analyst students at STIKes BTH Tasikmalaya ($p = 0.04$; $\alpha = 0.05$)[21].

In this study, however, statistical testing yielded $p = 1.000$ ($p > 0.05$), indicating no significant relationship. According to Green's theory, attitude is a predisposing factor influencing behavioral intention[11]. A positive attitude reflects awareness of the importance of safety; however, without adequate facilities and supervision, the intention may not always translate into behavior[9]. Similar findings were reported by Dewi and Widowati (2022), who found no significant relationship between attitude and compliance ($p = 0.662$)[9], and by Nurdiani and Krianto (2019), who stated that PPE compliance showed no significant relationship ($p = 0.627$)[22].

The availability of PPE, as an enabling factor, showed a clearer trend: respondents who assessed PPE availability as sufficient demonstrated a compliance level of 65.7%, whereas those who considered it insufficient showed 40.0%. Although statistical testing yielded $p = 0.164$ ($p > 0.05$), this pattern aligns with Rahmawati et al., who found that completeness of PPE could enhance compliance[19] . Conversely, a study at PT. Liku Telaga Gresik reported that PPE availability alone did not guarantee compliance ($p = 0.652$)[23]. On the other hand, Humayra (2024) found a significant relationship ($p = 0.018$) between PPE availability and compliance[18], while Munawaroh and Mindiharto (2023) reported a very strong relationship ($p = 0.000$)[19].

The lack of significance in this study may be influenced by the homogeneity of respondent characteristics—most already possessed good knowledge and attitudes and had relatively adequate access to facilities—resulting in minimal measurable behavioral variation. Nevertheless, practically, these findings still support the view that improving compliance requires an integrative approach combining predisposing, enabling, and reinforcing factors. According to Wijaya (2023), factors influencing compliance include behavior and attitude as predisposing factors (p-value = 0.001; PR = 0.181; 95% CI = 0.089–0.367), PPE availability and information as enabling factors (p-value = 0.001; PR = 0.146; 95% CI = 0.071–0.300), and sanctions and supervision as reinforcing factors (p-value = 0.001; PR = 0.144; 95% CI = 0.046–0.453)[24]. Education alone is insufficient; adequate PPE provision, consistent supervision, and the establishment of a strong safety culture in the educational environment are required. Indragiri and Shaihah (2020) found a relationship between supervision and PPE compliance ($p = 0.049$), as well as between PPE completeness and compliance ($p = 0.001$)[25].

## CONCLUSIONS AND RECOMMENDATIONS

This study confirms that the addition of bioactivators in the form of cattle rumen and leachate can accelerate the maturation of compost derived from fruit waste. Treatment D2, which combined 0.5 kg of cattle rumen and 1.5 L of leachate, was proven to be the most effective, as indicated by stable temperature, neutral pH, and moisture content approaching the SNI 19-7030-2004 standard. These results demonstrate that this bioactivator combination successfully optimizes composting conditions, allowing the compost to mature faster and achieve quality characteristics close to national standard criteria.

Nevertheless, this study has limitations regarding replication, the use of statistical tests, and the scope of analytical parameters. Therefore, further research is recommended with a more robust experimental design, including heavy metal analysis, microbiological testing, and application at field scale with more efficient composter designs. Such efforts could establish this method as a practical solution for communities and government agencies in managing organic waste and mitigating environmental pollution.

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