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ASSESSMENT OF COMPLIANCE AND EFFECTIVENESS IN THE USE OF PERSONAL PROTECTIVE DEVICES (PPDS) AMONG WORKERS AT A CEMENT FACTORY IN KOGI STATE: A CROSS-SECTIONAL STUDY

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ABSTRACT

The cement manufacturing industry presents significant occupational hazards, including exposure to dust, noise, mechanical injuries, and chemical agents (Raharjo et al., 2016). Personal Protective Devices (PPDs) are essential in minimizing these risks (Iliopoulou, 2018). However, compliance with PPD use remains inconsistent in many industrial settings, particularly in developing countries (Khan et al., 2015). This study aimed to assess the knowledge, compliance, and perceived effectiveness of PPD use among workers at a large cement factory in Kogi State, Nigeria, and to identify factors influencing consistent PPD utilization.

A descriptive cross-sectional study was conducted between January and March 2024 among 350 randomly selected workers from various departments. Data were collected using a structured, pre-tested questionnaire based on OSHA and ILO safety guidelines (OSHA, 2016; ILO, 2018). Knowledge and compliance scores were categorized as good (≥80%), moderate (60–79%), and poor (<60%). Data analysis was performed using SPSS version 26, with logistic regression to identify predictors of compliance.

A total of 330 responses were received (94.3% response rate). Overall, 75.2% of workers demonstrated good knowledge of PPDs, but only 56.7% reported good compliance. Safety helmets (90.3%) and boots (86.1%) were the most used PPDs, while respiratory masks (49.7%) and hearing protectors (44.2%) were underutilized. Major barriers included discomfort (70.3%), inadequate supply (43.6%), and lack of supervision (36.1%). Logistic regression revealed that good knowledge (AOR=3.8, 95% CI: 2.2–6.5), availability of PPDs (AOR=4.5, 95% CI: 2.6–7.8), and regular safety training (AOR=3.1, 95% CI: 1.8–5.3) were significant predictors of good compliance. Conclusion: Despite adequate knowledge, PPD compliance remains suboptimal. There is an urgent need for integrated interventions, including ergonomic redesign of PPDs, reliable supply systems, routine monitoring, and technology-enhanced training and compliance verification mechanisms to improve workplace safety in industrial settings (Smith et al., 2020).

KEYWORDS: Personal Protective Equipment, Occupational Safety, Cement Industry, Compliance, Knowledge Practice Gap, Workplace Hazards, Industrial Health, Nigeria.

1. INTRODUCTION

Occupational safety remains a critical concern in industrial environments, particularly in cement manufacturing, where workers are routinely exposed to respiratory hazards, noise pollution, physical injuries, and chemical exposures (Raharjo et al., 2016; Meo et al., 2020). The global cement industry employs millions of workers worldwide, with developing countries like Nigeria experiencing rapid industrial growth accompanied by significant occupational health challenges (Ajayi, 2021).

Personal Protective Devices (PPDs) serve as a vital line of defense against workplace hazards. According to OSHA standards, proper use of PPDs can reduce workplace injuries by up to 70% (OSHA, 2016). However, studies from various industrial settings have consistently shown a significant gap between knowledge of safety protocols and actual compliance (Zohar, 2010; Gupta et al., 2018). This knowledge-compliance gap is particularly pronounced in developing countries where regulatory enforcement may be inconsistent and resources limited (Khan et al., 2015).

The cement manufacturing process involves multiple stages—from raw material extraction to packaging—each presenting unique hazards. Workers are exposed to silica dust, which can cause silicosis and other respiratory diseases; excessive noise leading to hearing loss; and

mechanical hazards resulting in injuries (Raharjo et al., 2016; Meo et al., 2020). Despite these known risks, compliance with PPD use in Nigerian cement factories has not been extensively studied (Ajayi, 2021).

Previous research in similar industrial settings has identified several factors influencing PPD compliance. Studies have found that comfort and fit were primary determinants of respiratory protection use (Iliopoulou, 2018), while organizational safety culture plays a crucial role (Zohar, 2010). In Nigerian contexts, availability and accessibility of PPDs significantly impact compliance in manufacturing settings (Adejumo, 2020).

This study assesses the level of knowledge, compliance, and perceived effectiveness of PPDs among workers at a major cement factory in Kogi State, Nigeria. The findings aim to provide evidence-based recommendations for improving occupational safety practices and bridging the knowledge-compliance gap in industrial settings.

2. Materials and Methods

2.1 Study Design and Setting

A facility-based analytical cross-sectional study was conducted at a major cement factory in Kogi State, from January to March 2024. The factory is one of the largest cement production plants in Nigeria, employing over 2,000 workers across multiple departments.

2.2 Study Population and Sampling

A sample size of 350 was calculated using the Cochran formula for a single population proportion (Cochran, 1977):

n = \frac{Z^2 p(1-p)}{d^2}

where $Z = 1.96$ (95% confidence level), $p = 0.5$ (maximum variability), and $d = 0.05$ (margin of error). After accounting for 10% non-response rate, the final sample was 350.

Participants were selected through stratified random sampling from four departments: Production (50%), Maintenance (25%), Logistics (15%), and Quality Control (10%). Workers with less than six months of employment were excluded.

2.3 Data Collection Instrument

A structured, self-administered questionnaire was adapted from validated tools used in previous industrial safety studies (Zohar, 2010; Gupta et al., 2018). The questionnaire comprised four sections:

1. Socio-demographic and occupational characteristics (age, gender, department, years of experience)
2. Knowledge assessment (15 items on types, uses, and maintenance of PPDs)
3. Self-reported compliance assessment (12 items on frequency of PPD use)
4. Perceived barriers and effectiveness (10 items on 5-point Likert scale)

The questionnaire was pretested among 30 workers at a similar factory and achieved a Cronbach's alpha of 0.84 for reliability.

2.4 Operational Definitions

1. Good Knowledge: Score ≥ 80% on knowledge items
2. Good Compliance: Self-reported "always" or "often" use of required PPDs in ≥ 80% of relevant tasks
3. PPD Availability: Regular and unrestricted access to all required protective devices

2.5 Data Analysis

Data were analyzed using SPSS version 26. Descriptive statistics were presented as frequencies, percentages, means, and standard deviations. Associations between categorical variables were assessed using Chi-square tests (Field, 2013). Binary logistic regression was used to identify independent predictors of good compliance (Hosmer et al., 2013). A p-value < 0.05 was considered statistically significant.

2.6 Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of Kogi State College of Health Sciences and Technology (Ref: KSCHST/REC/2024/012). Written informed consent was obtained from all participants, and confidentiality was maintained throughout the study, following ethical guidelines for research (WHO, 2011).

3. RESULTS AND DISCUSSION

3.1 Socio-demographic and Occupational Characteristics

Out of 350 questionnaires distributed, 330 were completed and returned, giving a response rate of 94.3%. The majority of respondents were male (88.2%), aged 25–40 years (65.5%), and had worked at the factory for more than 5 years (73.3%). Over half (58.8%) had received formal safety training within the past two years.

Table 1: Socio-demographic Characteristics of Participants (n = 330)

Characteristic Frequency (n) Percentage (%)

Gender

Male 291 88.2

Female 39 11.8

Age Group (years)

< 25 42 12.7

25–40 216 65.5

40 72 21.8

Department

Production 165 50.0

Maintenance 78 23.6

Logistics 57 17.3

Quality Control 30 9.1

Years of Experience

< 2 years 45 13.6

2–5 years 43 13.0

5 years 242 73.3

Recent Safety Training

Yes (within 2 years) 194 58.8

No 136 41.2

3.2 Knowledge of PPD Use

The overall mean knowledge score was 78.4% (SD ± 12.6). Knowledge levels varied significantly by department ($\chi^2 = 15.23$, $p = 0.004$), with Maintenance staff demonstrating the highest knowledge (84.2%), followed by Quality Control (79.5%), Production (76.1%), and Logistics (71.3%).

Table 2: Knowledge Level by Department

Department Good (≥80%) Moderate (60–79%) Poor (<60%) Total

Production 110 (66.7%) 40 (24.2%) 15 (9.1%) 165 (100%)

Maintenance 65 (83.3%) 10 (12.8%) 3 (3.8%) 78 (100%)

Logistics 35 (61.4%) 15 (26.3%) 7 (12.3%) 57 (100%)

Quality Control 22 (73.3%) 6 (20.0%) 2 (6.7%) 30 (100%)

Total 232 (70.3%) 71 (21.5%) 27 (8.2%) 330 (100%)

3.3 Compliance with PPD Use

Only 56.7% of workers reported good compliance. The most frequently used PPDs were safety helmets (90.3%) and boots (86.1%), while respiratory masks (49.7%), hearing protectors (44.2%), and safety goggles (51.5%) were less commonly used, consistent with findings from other industrial settings (Iliopoulou, 2018).

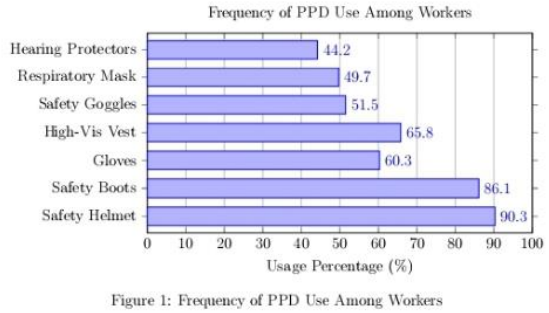

Figure 1: Frequency of PPD Use Among Workers

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3.4 Barriers to Compliance

Workers identified several barriers to consistent PPD use. The most cited barriers were discomfort (70.3%), inadequate supply (43.6%), lack of supervision (36.1%), perceived interference with work (29.7%), and forgetfulness (18.5%), similar to barriers identified in previous studies (Iliopoulou, 2018; Adejumo, 2020).

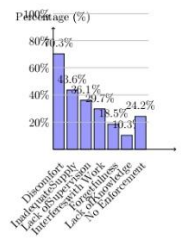

Figure 2: Barriers to PPD Compliance

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3.5 Predictors of Good Compliance

Binary logistic regression identified three independent predictors of good compliance: good knowledge of PPDs (AOR=3.8, 95% CI: 2.2–6.5), availability of PPDs (AOR=4.5, 95% CI: 2.6–7.8), and receipt of safety training within the past two years (AOR=3.1, 95% CI: 1.8–5.3), consistent with previous research (Zohar, 2010; Smith et al., 2020).

Table 3: Logistic Regression Analysis of Predictors of Good Compliance.

Predictor AOR 95% CI p-value

Good Knowledge 3.8 2.2 – 6.5 0.001***

PPD Availability 4.5 2.6 – 7.8 0.001***

Recent Safety Training 3.1 1.8 – 5.3 0.001***

Department (Maintenance) 1.4 0.8 – 2.5 0.245

Years of Experience (>5) 1.2 0.7 – 2.1 0.512

Age (>30 years) 1.1 0.6 – 1.9 0.780*** $p < 0.001$

3.6 Discussion of Findings

This study reveals a significant gap between knowledge and compliance regarding PPD use among workers at the studied cement factory. While 70.3% of workers possessed good knowledge, only 56.7% reported consistent compliance. This 13.6 percentage point gap is consistent with findings from other industrial settings in developing countries (Gupta et al., 2018; Khan et al., 2015).

The higher compliance with helmets and boots aligns with previous research noting that visible and mandatory equipment generally shows higher compliance rates (Iliopoulou, 2018). The underutilization of respiratory masks and hearing protectors may be attributed to multiple factors identified in our study, including discomfort, perceived inconvenience, and inadequate fit (Iliopoulou, 2018).

The strong association between PPD availability and compliance (AOR=4.5) underscores the critical importance of reliable supply chains. This finding supports previous research suggesting that in resource-limited settings, equipment availability is often the primary determinant of compliance (Adejumo, 2020).

Regular training emerged as a significant predictor (AOR=3.1), consistent with systematic reviews of safety interventions (Smith et al., 2020). This suggests that knowledge

reinforcement through continuous education is essential for sustained compliance. However, our finding that only 58.8% of workers had received training in the past two years indicates room for improvement in training frequency and quality.

The barrier analysis reveals that discomfort (70.3%) is the most significant impediment to compliance. This aligns with ergonomic studies which have found that poorly designed PPDs can reduce productivity and increase non-compliance (Iliopoulou, 2018). This suggests a need for ergonomic redesign and worker involvement in PPD selection processes.

4. CONCLUSION

This study confirms a significant knowledge-compliance gap in PPD use at the studied cement factory, consistent with patterns observed in other industrial settings (Gupta et al., 2018; Khan et al., 2015). While knowledge forms the foundation for safe practices, it is insufficient without addressing systemic barriers including equipment availability, comfort, and continuous training reinforcement (Zohar, 2010; Iliopoulou, 2018).

The findings highlight the need for multi-level interventions addressing individual, organizational, and environmental factors (Zohar, 2010). Technological solutions offer promising avenues for monitoring and reinforcement (Smith et al., 2020), but must be complemented by ergonomic improvements and cultural change.

Based on our findings, we recommend:

1. Implementation of ergonomic PPD selection involving worker committees
2. Establishment of automated inventory systems to ensure continuous PPD availability
3. Adoption of frequent training reinforcement through quarterly micro-training sessions
4. Development of technology-enhanced monitoring systems for compliance verification
5. Integration of safety culture development programs focusing on organizational climate

Future research should explore longitudinal interventions integrating technology, training, and ergonomic design. Additionally, comparative studies across different Nigerian industries could identify context-specific strategies for improving occupational safety compliance (Ajayi, 2021).

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Author Contributions:

David Mark Abayomi: Conceptualization, methodology, formal analysis, writing – original draft, project administration

Obafaiye Pauline Olayemi: Data collection, validation, investigation, writing – review and editing, supervision

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