

Original Research Article

Medicolegal knowledge and observed personal protective equipment compliance among hospital laboratory staff in Boyolali, Indonesia: a cross-sectional study

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ABSTRACT

Background. Compliance with personal protective equipment (PPE) in hospital laboratories is often incomplete. Whether staff knowledge of the legal consequences of unsafe practice is associated with observed PPE use has not been examined in Indonesian laboratories.

Objective. To examine the association between medicolegal knowledge of occupational safety and health and observed PPE compliance among hospital laboratory staff.

Methods. This single-centre cross-sectional study was conducted at a private secondary hospital in Boyolali, Indonesia, over three months in 2024. A random sample of 120 of 150 laboratory staff completed the 25-item Medicolegal Implication Knowledge Scale (MIKS). Auditors covertly observed gloves, mask, coat and closed shoes in 10 shifts per participant. Full tier-1 bundle compliance was correct use of all four items in at least 80% of shifts. Associations were tested with chi-square or Fisher exact tests and logistic regression.

Results. Full tier-1 bundle compliance was 60.0% (72/120). It was 80.0% (48/60) among staff with high MIKS scores and 40.0% (24/60) among those with low scores (crude odds ratio 6.00, 95% CI 2.68–13.42). After adjustment, high MIKS score (adjusted odds ratio 3.36, 95% CI 1.48–7.64) and female sex (adjusted odds ratio 2.72, 95% CI 1.35–5.48) were associated with higher odds of compliance. Eye protection was the least-used audited item (35.0% compliant) and gloves the most used (85.0%).

Conclusion. In this hospital, higher medicolegal knowledge was associated with higher observed PPE compliance. The design cannot show that legal education improves compliance. Interventional studies and attention to eye protection are needed.

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1. Introduction

Hospital laboratory staff handle specimens that may contain hepatitis B and C viruses, human immunodeficiency virus, *Mycobacterium tuberculosis* and multidrug-resistant bacteria, and occupational exposure to blood and body fluids remains common among health care workers.^{1–3} Within the hierarchy of controls, personal protective equipment (PPE) complements elimination, engineering and administrative measures rather than replacing them.⁴ Even so, studies in many settings report incomplete adherence to standard precautions and PPE.^{5–9}

Non-compliance has been linked to physical discomfort, workload, limited PPE supply and fit, and weak safety climate.^{10–14} Knowledge alone does not guarantee safe practice,^{6,7} and education and training in isolation have shown limited effect on preventing sharps injuries and splash exposures.¹⁵ Many compliance studies also rely on self-report, which can differ from observed behavior.¹⁶ Health behavior models such as the theory of planned

behavior and the health belief model propose that knowledge, perceived consequences and perceived control jointly shape what workers do.^{17,18}

Indonesian law attaches duties and consequences to unsafe laboratory practice. Law No. 1/1970 on Occupational Safety requires the employer (*pengurus*) to post safety instructions and to provide PPE free of charge (Article 14), and refers to workers' duties and rights, including wearing the required PPE and objecting to work where safety conditions or PPE are in doubt (Article 12).¹⁹ Law No. 17/2023 on Health gives health workers the right to occupational safety and health protection and sets out their obligations (Article 273 paragraph 1(d) and Article 274), and makes employers responsible for work accidents and occupational disease (Article 99).²⁰ Ministry of Health Regulation (*Peraturan Menteri Kesehatan*, PMK) No. 52/2018 governs occupational safety and health in health care facilities, including standard precautions and PPE, although its Article 3 paragraph 2 excludes hospitals, and PMK No. 43/2013 on good clinical laboratory practice

(GCLP) lists PPE for laboratory work in its annex.^{21,22} Civil liability for unlawful acts arises under Article 1365 of the Civil Code (*Kitab Undang-Undang Hukum Perdata*, KUHPerdata), which is fault-based. Article 1367 makes an employer answerable for harm caused by employees in the work they were engaged to do; this is vicarious liability that depends on an unlawful act by the employee, not strict liability.^{23,24} Criminal liability for negligently causing death or injury was regulated by Articles 359 and 360 of the former Penal Code (*Kitab Undang-Undang Hukum Pidana*, KUHP), which concern negligence (*kealpaan*) rather than intentional conduct.²⁵ Law No. 1/2023, in force from 2 January 2026, now covers these offences in Articles 474 and 475.²⁶ In practice, omitting PPE mainly exposes the worker, so the most direct legal consequences concern employer duties, worker obligations and work-accident compensation;²⁷ liability toward patients or colleagues would require proof of fault, causation and damage.

We did not identify a study that paired a test of legal knowledge with repeated unannounced observation of PPE use in an Indonesian hospital laboratory. The objective of this study was to examine the association between medicolegal knowledge of occupational safety and health and observed PPE compliance among hospital laboratory staff in Boyolali, Indonesia, after adjustment for sociodemographic and professional characteristics. We hypothesized that higher scores on a medicolegal knowledge scale would be associated with higher odds of full PPE compliance.

2. Methods

2.1. Study design and setting

This single-centre cross-sectional study followed the STROBE reporting guideline for cross-sectional studies.²⁸ It was conducted in the central clinical laboratory of Indriati Boyolali Hospital, a private secondary referral hospital in Boyolali Regency, Central Java, Indonesia. The laboratory comprises clinical chemistry and hematology, microbiology and parasitology, blood bank and immunohematology, and histopathology and molecular diagnostics. Data were collected over a three-month period in 2024.

2.2. Participants

The source population comprised 150 medical laboratory personnel, including medical laboratory technologists (*Ahli Teknologi Laboratorium Medik*), bench supervisors and diagnostic support technicians. Eligible staff had been employed for at least six consecutive months, were regularly assigned to bench work involving biological specimens, and gave informed consent. Staff assigned exclusively to non-clinical administrative desks or on extended leave were excluded.

The minimum sample size was calculated with Cochran's formula with finite population correction, $n = N \cdot Z^2 \cdot p(1 - p) / [e^2(N - 1) + Z^2 \cdot p(1 - p)]$, using $N = 150$, $Z = 1.96$, $p = 0.50$ and $e = 0.05$, which gave 108.³⁰ The sample was increased to 120 (80% of the population) to allow for attrition. Participants were selected by simple random sampling, using computer-generated random numbers applied to the hospital employee registry.

2.3. Variables and measurements

Medicolegal knowledge was measured with the Medicolegal Implication Knowledge Scale (MIKS), a newly constructed 25-item multiple-choice test. Items were drawn from an analysis of Indonesian health and labor

legislation. Content validity was assessed by a panel of three forensic medicine consultants and two occupational health legal experts (content validity index 0.94). The scale was piloted among 30 laboratory workers at an affiliated regional hospital, giving Cronbach's alpha 0.884 and test-retest correlation $r = 0.892$ over 14 days. No assessment of structural validity was carried out.

The MIKS has four domains: Domain 1, statutory occupational safety and health mandates (6 items; Law No. 1/1970, Law No. 17/2023 and PMK No. 52/2018, the last applied by analogy); Domain 2, civil liability of the hospital and staff (6 items; KUHPerdata Articles 1365 and 1367); Domain 3, professional ethics and standard practice (7 items; the code of ethics of the Indonesian Association of Medical Laboratory Technologists, PATELKI, and GCLP standards); and Domain 4, criminal negligence (6 items; KUHP Articles 359 and 360). Each correct answer scored one point. Domain scores were scaled to a maximum of 25 and summed to a total of 0–100. Participants were classified as having high (score $\geq$ median) or low (score $<$ median) knowledge, giving two groups of 60; the median total score was 70.5. A domain score of at least 70% of its maximum was classed as adequate.

PPE use was assessed by unannounced direct observation by four trained biosafety auditors, who were present in the laboratory under the cover of routine workflow and accreditation quality monitoring. Inter-rater agreement was Cohen's kappa 0.915. Each participant was observed in 10 randomly selected shifts, giving 1,200 participant-shift observations. Six items were audited: gloves, surgical mask or N95 respirator, buttoned long-sleeved laboratory coat, eye protection (goggles or face shield during aerosol-generating or splash-risk procedures), closed fluid-resistant shoes, and a chemical splash apron during concentrated reagent handling.⁴ A shift was classified as compliant only if gloves, mask, coat and shoes (the tier-1 items) were all worn correctly throughout specimen handling. The primary outcome, full tier-1 bundle compliance, was defined as at least 80% compliant shifts out of 10. Eye protection and aprons were audited and are reported separately; they are not part of the outcome.

A structured questionnaire recorded age (continuous and in three categories), sex, highest education (senior high or vocational school, diploma [D3/D4], bachelor's degree), work experience (continuous and in three categories), laboratory unit, employment status (permanent versus contract or trainee) and occupational safety and health (OSH) training in the preceding two years. Laboratory units were grouped into three risk tiers: high (microbiology and parasitology), moderate (clinical chemistry, hematology and blood bank) and low/chemical (histopathology and molecular diagnostics).

2.4. Statistical analysis

Data were analyzed with IBM SPSS Statistics version 28.0 and Python (NumPy, Pandas, Statsmodels). Continuous variables were checked for normality with the Shapiro-Wilk test and are given as mean $\pm$ standard deviation (SD) or median and interquartile range (IQR). Categorical variables are given as counts and percentages. Associations between candidate predictors and compliance were tested with Pearson's chi-square test without continuity correction, or with the Fisher-Freeman-Halton exact test where expected counts were below 5 (education). Multivariable binary logistic regression included MIKS group, sex, work experience, age, education and OSH training, and gave adjusted odds ratios (aOR) with 95% confidence intervals (CI). Calibration was

checked with the Hosmer–Lemeshow test and explained variance with the Cox and Snell and Nagelkerke R^2 .³¹ With 48 non-compliant participants and six predictors, there were about 8 events per variable.³² Statistical significance was set at two-sided $p < 0.05$; exact p values are reported to three decimals.

2.5. Ethical approval

The study followed the Declaration of Helsinki and was approved by the Ethics Committee CMHC Research Center, Indonesia (approval number 2024-082). Participants gave written informed consent to a “Quality Assurance and Laboratory Workflow Evaluation Study”, and the specific focus on PPE was disclosed in a debriefing after data collection.

3. Results

3.1. Participants

All 120 sampled staff completed the MIKS and the observation period and were analyzed; there were no missing data. Table 1 shows the characteristics of the participants. Ages ranged from 22 to 54 years: 66 (55.0%) were aged 35 years or younger, 36 (30.0%) were 36–45 years and 18 (15.0%) were older than 45 years. Sixty-two participants (51.7%) were female. Education was a bachelor’s degree in 84 (70.0%), a diploma in 30 (25.0%) and senior high or vocational school in 6 (5.0%). Mean work experience was 7.32 ± 4.12 years (range 1–20). By unit, 52 (43.3%) worked in clinical chemistry and hematology, 34 (28.3%) in microbiology and parasitology, 18 (15.0%) in the blood bank and 16 (13.3%) in histopathology and molecular diagnostics. In total, 78 (65.0%) were permanent staff and 42 (35.0%) were on contract or in training, and 74 (61.7%) had attended OSH training in the previous two years.

Table 1. Characteristics of the 120 laboratory staff and bivariate association with full tier-1 bundle PPE compliance.

Characteristic	Total, n (%)	Compliant, n (%)	Non-compliant, n (%)	p
Medicolegal knowledge (MIKS)				<0.001
High ($\geq$ median)	60 (50.0)	48 (80.0)	12 (20.0)	
Low (< median)	60 (50.0)	24 (40.0)	36 (60.0)	
Age group, years				0.052
≤ 35	66 (55.0)	46 (69.7)	20 (30.3)	
36–45	36 (30.0)	18 (50.0)	18 (50.0)	
> 45	18 (15.0)	8 (44.4)	10 (55.6)	
Sex				0.011
Male	58 (48.3)	28 (48.3)	30 (51.7)	
Female	62 (51.7)	44 (71.0)	18 (29.0)	
Education				0.245†
Senior high or vocational	6 (5.0)	2 (33.3)	4 (66.7)	
Diploma (D3/D4)	30 (25.0)	16 (53.3)	14 (46.7)	
Bachelor’s degree	84 (70.0)	54 (64.3)	30 (35.7)	
Work experience, years				0.045
1–5	54 (45.0)	26 (48.1)	28 (51.9)	
6–10	42 (35.0)	28 (66.7)	14 (33.3)	
> 10	24 (20.0)	18 (75.0)	6 (25.0)	
OSH training in past 2 years				0.004
Yes	74 (61.7)	52 (70.3)	22 (29.7)	
No or expired	46 (38.3)	20 (43.5)	26 (56.5)	
Laboratory risk tier				0.288
High (microbiology and parasitology)	34 (28.3)	24 (70.6)	10 (29.4)	
Moderate (chemistry, hematology, blood bank)	70 (58.3)	40 (57.1)	30 (42.9)	
Low/chemical (histopathology, molecular)	16 (13.3)	8 (50.0)	8 (50.0)	
Employment status				Not tested
Permanent	78 (65.0)	–	–	

Characteristic	Total, n (%)	Compliant, n (%)	Non-compliant, n (%)	p
Contract or trainee	42 (35.0)	–	–	

Notes: Percentages in the compliant and non-compliant columns are row percentages. p values are from Pearson's chi-square test without continuity correction. †Fisher–Freeman–Halton exact test (two cells had expected counts below 5). MIKS, Medicolegal Implication Knowledge Scale; OSH, occupational safety and health; PPE, personal protective equipment.

3.2. Medicolegal knowledge and PPE compliance

Full tier-1 bundle compliance was reached by 72 of 120 participants (60.0%, 95% CI 51.1–68.3). Compliance was 80.0% (48/60) among participants with high MIKS scores and 40.0% (24/60) among those with low scores (crude odds ratio 6.00, 95% CI 2.68–13.42; $\chi^2 = 20.00$, df = 1, $p < 0.001$; Figure 1a). Table 2 gives the MIKS scores. The mean

total score was 68.83 ± 14.72 (median 70.5, IQR 57.0–81.0). Mean domain scores were highest for professional ethics and GCLP standards (78.6% of the maximum) and statutory mandates (71.4%), and lowest for civil liability (65.7%) and criminal negligence (59.7%). In Domain 4, 53.3% of participants scored at or above the 70% adequacy threshold, so 46.7% scored below it.

Table 2. Scores on the Medicolegal Implication Knowledge Scale by domain and knowledge group.

Domain	Legal basis	Maximum	Mean $\pm$ SD	Mean, % of max.	Median (IQR)	Adequate, %
Domain 1: statutory OSH mandates	Law No. 1/1970 Arts. 12, 14; Law No. 17/2023 Art. 273; PMK No. 52/2018	25	17.84 ± 4.12	71.4	18.0 (14.0–21.0)	68.3
Domain 2: civil liability	KUHPdata Arts. 1365, 1367	25	16.42 ± 4.56	65.7	17.0 (13.0–20.0)	61.7
Domain 3: professional ethics and standard practice	PATELKI code of ethics; PMK No. 43/2013 (GCLP)	25	19.65 ± 3.48	78.6	20.0 (17.0–22.0)	78.3
Domain 4: criminal negligence	KUHP Arts. 359, 360	25	14.92 ± 4.88	59.7	15.0 (11.0–19.0)	53.3
Total score	25-item scale ($\alpha = 0.884$ in pilot)	100	68.83 ± 14.72	68.8	70.5 (57.0–81.0)	–
Low knowledge group (n = 60)	Total score < median	100	56.40 ± 8.64	56.4	57.0 (50.0–63.0)	–
High knowledge group (n = 60)	Total score $\geq$ median	100	81.25 ± 7.92	81.3	81.0 (75.0–87.0)	–

Notes: Adequate: share of participants scoring at least 70% of the domain maximum. Mean as a percentage of the maximum is the mean score divided by the maximum. Arts., Articles; GCLP, Good Clinical Laboratory Practice; IQR, interquartile range; KUHP, Criminal Code; KUHPdata, Civil Code; OSH, occupational safety and health; PATELKI, Indonesian Association of Medical Laboratory Technologists; PMK, Ministry of Health Regulation; SD, standard deviation. Domain scores are scaled to a maximum of 25. The original “compliant threshold” rows (0.0% and 100.0%) and the “50.0% $\geq$ 72.5” entry were removed.

3.3. Bivariate associations with other characteristics

Compliance was higher among women than men (71.0% versus 48.3%; $\chi^2 = 6.43$, df = 1, $p = 0.011$), rose with work experience from 48.1% (1–5 years) to 75.0% (more than 10 years; $\chi^2 = 6.19$, df = 2, $p = 0.045$), and was higher among staff who had attended OSH training (70.3% versus 43.5%; $\chi^2 = 8.48$, df = 1, $p = 0.004$). Compliance fell across age groups (69.7%, 50.0% and 44.4%), but this was not statistically significant ($\chi^2 = 5.90$, df = 2, $p = 0.052$). Education (exact $p = 0.245$) and laboratory risk tier ($\chi^2 = 2.49$, df = 2, $p = 0.288$) were not associated with compliance (Table 1). Compliance was 70.6% in the high-risk tier, 57.1% in the moderate tier and 50.0% in the low/chemical tier.

3.4. Compliance with individual PPE items

Table 3 shows item-level status for the 120 participants. Compliance was highest for gloves (102, 85.0%) and closed shoes (94, 78.3%), followed by masks (88, 73.3%) and coats (78, 65.0%). Eye protection was fully compliant in 42 participants (35.0%); 22 (18.3%) were sub-optimal and 56 (46.7%) showed total neglect, so 65.0% were sub-optimal or absent. Aprons were compliant in 32 (26.7%). Breaches recorded by the auditors included not changing gloves between specimens and touching keyboards or telephones with soiled gloves, wearing masks below the nose (24 participants, 20.0%, sub-optimal), rolled-up coat sleeves and wearing coats into break rooms, and omitting eye protection because of lens fogging, discomfort and lack of individual fit.

Table 3. Observed compliance with individual PPE items among 120 laboratory staff (covert audit, 10 shifts per participant).

PPE item	Compliant, n (%) [95% CI]	Sub-optimal, n (%)	Total neglect, n (%)	Breaches recorded by auditors
Gloves	102 (85.0) [77.5–90.3]	14 (11.7)	4 (3.3)	Gloves not changed between patients; touching keyboards or telephones with soiled gloves
Surgical mask or N95 respirator	88 (73.3) [64.8–80.4]	24 (20.0)	8 (6.7)	Mask worn under the nose or chin; reuse of single-use masks beyond 4 hours
Laboratory coat	78 (65.0) [56.1–72.9]	32 (26.7)	10 (8.3)	Coat unbuttoned, sleeves rolled up, coat worn into cafeteria or break rooms

PPE item	Compliant, n (%) [95% CI]	Sub-optimal, n (%)	Total neglect, n (%)	Breaches recorded by auditors
Closed shoes	94 (78.3) [70.1–84.8]	18 (15.0)	8 (6.7)	Perforated clogs, mesh sneakers or exposed-dorsum footwear in analytical areas
Eye protection†	42 (35.0) [27.1–43.9]	22 (18.3)	56 (46.7)	Omission because of lens fogging, discomfort and lack of individual fit
Chemical splash apron†	32 (26.7) [19.6–35.2]	16 (13.3)	72 (60.0)	Seen as cumbersome; avoided during rapid batch staining
Full tier-1 bundle (gloves, mask, coat, shoes)	72 (60.0) [51.1–68.3]	34 (28.3)	14 (11.7)	Primary outcome: 72 compliant versus 48 non-compliant

Notes: Counts are participants (N = 120), not shifts. †Audited but not part of the primary outcome. Confidence intervals are Wilson 95% intervals. Standard applied: WHO Laboratory Biosafety Manual, 4th edition (PMK No. 52/2018 used by analogy, see Section 1). CI, confidence interval; PPE, personal protective equipment.

3.5. Multivariable analysis

The multivariable model was statistically significant (omnibus $\chi^2 = 34.825$, df = 6, $p < 0.001$; Nagelkerke $R^2 = 0.341$, Cox and Snell $R^2 = 0.252$) and correctly classified 75.8% of participants. The Hosmer–Lemeshow test gave no evidence of poor calibration ($\chi^2 = 6.418$, df = 8, $p = 0.601$). High MIKS score was associated with higher odds of full compliance (aOR 3.36, 95% CI 1.48–7.64, $p = 0.004$),

as was female sex (aOR 2.72, 95% CI 1.35–5.48, $p = 0.005$) (Table 4, Figure 1b). Each additional year of work experience was associated with 20% higher odds (aOR 1.20, 95% CI 1.03–1.40, $p = 0.023$), whereas each additional year of age was associated with 35% lower odds (aOR 0.65, 95% CI 0.50–0.84, $p = 0.001$). Education (aOR 1.42, 95% CI 0.58–3.48, $p = 0.442$) and OSH training (aOR 1.85, 95% CI 0.74–4.62, $p = 0.188$) were not independently associated with compliance.

Table 4. Crude and adjusted odds ratios for full tier-1 bundle PPE compliance (N = 120; 72 compliant, 48 non-compliant).

Predictor	Crude OR (95% CI)	Adjusted OR (95% CI)	Wald χ^2 (adjusted)	p (adjusted)
High versus low MIKS score	6.00 (2.68–13.42)	3.36 (1.48–7.64)	8.38	0.004
Female versus male sex	2.62 (1.23–5.58)	2.72 (1.35–5.48)	7.84	0.005
Work experience, per year	1.15 (1.02–1.30)	1.20 (1.03–1.40)	5.42	0.023
Age, per year	0.72 (0.58–0.90)	0.65 (0.50–0.84)	10.60	0.001
Bachelor's degree versus diploma or lower	1.80 (0.82–3.97)	1.42 (0.58–3.48)	0.59	0.442
OSH training in past 2 years versus none	3.07 (1.41–6.70)	1.85 (0.74–4.62)	1.73	0.188

Notes: Logistic regression with all six predictors entered. Model fit: omnibus $\chi^2 = 34.825$, df = 6, $p < 0.001$; Cox and Snell $R^2 = 0.252$; Nagelkerke $R^2 = 0.341$; Hosmer–Lemeshow $\chi^2 = 6.418$, df = 8, $p = 0.601$; classification accuracy 75.8%. Wald χ^2 (1 df) was recomputed from the reported 95% CI. The crude odds ratio for education was recalculated from the counts in Table 1 (the original value was 1.58, 0.72–3.48). CI, confidence interval; MIKS, Medicolegal Implication Knowledge Scale; OR, odds ratio; OSH, occupational safety and health; PPE, personal protective equipment.

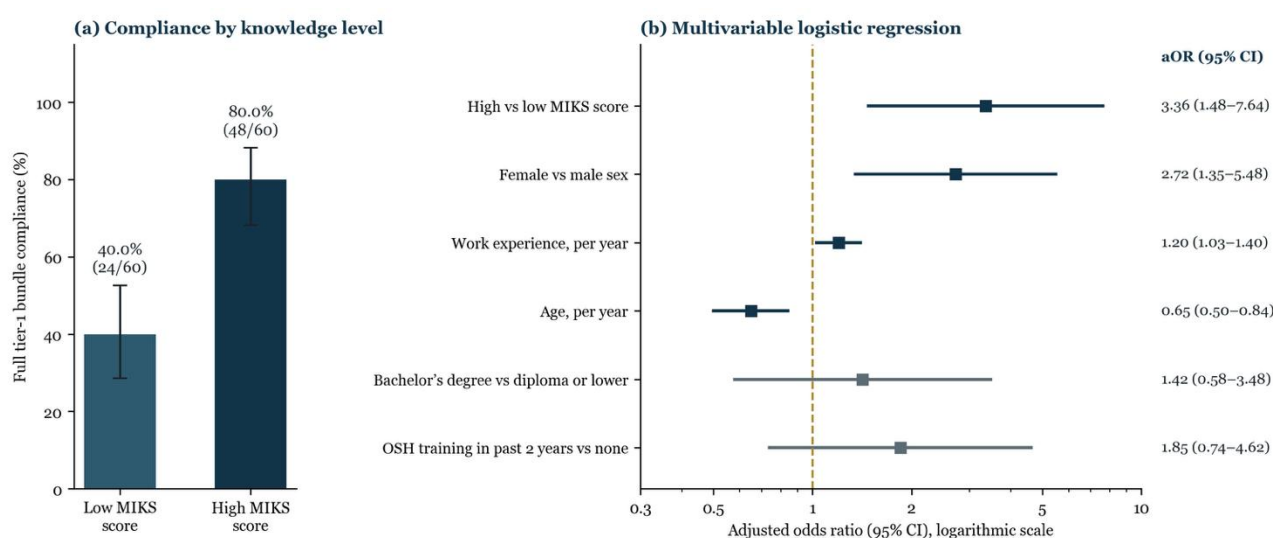


Figure 1. (a) Full tier-1 bundle compliance by knowledge group, with Wilson 95% confidence intervals. (b) Adjusted odds ratios and 95% confidence intervals from the multivariable model (logarithmic scale). MIKS, Medicolegal Implication Knowledge Scale; OSH, occupational safety and health.

4. Discussion

4.1. Principal finding

In this hospital laboratory, staff with higher scores on a medicolegal knowledge scale were more likely to be fully compliant with four core PPE items when observed without notice. The association remained after adjustment for sex, work experience, age, education and training. Because knowledge and behavior were measured in the same cross-sectional sample, the data show an association and do not show that legal knowledge changed behavior.

4.2. Comparison with the literature

Reported PPE compliance among health workers varies widely between settings and depends on how compliance is defined.^{8,9,13} Our overall figure of 60.0% reflects a strict definition (four items, at least 80% of shifts), and a direct numerical comparison with other studies is not appropriate. Most earlier work relies on self-reported practice, which can differ from audited behavior;¹⁶ direct observation across repeated shifts is a strength of this study. Studies of standard precautions in other settings have likewise found that knowledge does not translate reliably into practice,^{6,7,33,34} and a Cochrane review found that education alone has limited effect on sharps injuries and splash exposures.¹⁵ Our result adds a specific kind of knowledge, legal knowledge, to that literature.

Eye protection was the weakest audited practice: 35.0% of participants were compliant and 46.7% showed total neglect. The reasons recorded (lens fogging, discomfort and poor fit) match the barriers reported for face shields and PPE in other studies.^{10,12} These are problems of equipment and supply that legal education is unlikely to solve, and PPE availability and fit are known determinants of use.¹¹ Practical measures that follow from the audit are anti-fog and individually fitted eyewear, prompts to change gloves between specimens, coat-free zones, a mask replacement schedule and feedback to staff. Eye and splash protection may also not be required in every shift; applying a blanket requirement could understate appropriate use, and task-based definitions are needed.⁴

The sex and age findings should be treated as exploratory. Female staff and older staff may be unevenly distributed across units and job roles, age and work experience are likely to be collinear, and the age estimate is not consistent with the age-group data. We do not interpret the age result.

4.3. Interpretation and medicolegal implication

Several explanations are compatible with the association. Legal knowledge may influence behavior through perceived consequences and perceived control, as the theory of planned behavior would suggest,¹⁷ but attitudes, norms and perceived control were not measured here. Staff who are more conscientious or better trained may both score higher on a knowledge test and use PPE more consistently, and safety climate may affect both.¹⁴ The correlation between MIKS score and OSH training, which is likely, was not reported. Reverse causation is also possible if PPE-compliant staff pay more attention to safety rules.

The legal implications are narrower than is often assumed. Because omitting PPE mainly exposes the worker, the most direct consequences are the employer's duty to provide PPE and safety instruction and the worker's duty to use it,¹⁹ together with work-accident compensation.²⁷ Liability to a patient or colleague under Articles 1365 and 1367 of the Civil Code, or criminal liability for negligence, would require proof of fault, a causal chain from the omission to

the injury and damage, which is difficult to establish for a PPE omission. In a dispute, the hospital's own written procedures, training records and incident reports would also be examined. The finding that 46.7% of participants scored below the adequacy threshold on criminal negligence points to a knowledge gap, but whether informing staff about penalties would improve practice is untested. A punitive framing could also encourage concealment of exposures; teaching the content as worker rights and employer duties within a just-culture approach may be preferable, and this too needs testing. Hospital procurement of suitable equipment and engineering controls should accompany any training.⁴

4.4. Limitations

This was a single-centre study in a private secondary hospital with a young and highly qualified workforce, so the findings may not apply to public hospitals, primary care laboratories or other regions. The cross-sectional design precludes causal inference. Unmeasured confounders include PPE availability and fit, workload, supervisor presence, safety climate, hepatitis B vaccination and previous exposure incidents, and the association with OSH training and seniority was not examined. The MIKS is new, was assessed only for content validity and pilot reliability, and has no evidence of structural validity;³⁵ dichotomizing it at the median discards information. Observation by auditors presented as quality monitors cannot exclude an observer effect, and auditor blinding is not reported; the 80% threshold is arbitrary and eye protection and aprons were outside the outcome. The model had about 8 events per variable, age and experience are collinear, clustering by unit and auditor was not modeled, and several tests were run without correction for multiplicity. Some strata were small (6 staff with secondary education). No exposure incidents or infections were recorded, so the clinical effect of non-compliance is unknown.

5. Conclusion

In this single hospital, full tier-1 PPE bundle compliance was 60.0%, and eye protection was the least-used audited item (35.0% compliant). Higher medicolegal knowledge was associated with higher observed compliance after adjustment for a limited set of covariates (aOR 3.36, 95% CI 1.48–7.64). These findings do not show that legal education improves compliance; interventional studies that compare it with equipment and engineering measures are needed.

Declarations

Use of generative artificial intelligence. None. The authors declare that no generative artificial intelligence tool was used in the conception, research, analysis, drafting, revision or preparation of this manuscript.

Author contributions. A.K.P.: conceptualization, methodology, investigation, formal analysis, data curation, writing – original draft, visualization. I.S.D.R.: methodology, validation, writing – review & editing, supervision. E.I.: investigation, resources, data curation. Y.M.: investigation, resources, project administration. B.A.W.: conceptualization, validation, writing – review & editing, supervision. All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Data availability. The de-identified participant-level dataset (MIKS domain scores, covariates and per-item compliance) is available from the corresponding author on reasonable request.

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