

Article

Biological Risk Knowledge and Occupational Safety Training: Testing the Threat Appraisal Pathway of Protection Motivation Theory in Healthcare

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Abstract

Sharps injuries and biological exposures remain a leading occupational safety risk in healthcare training environments. Preventing such injuries requires not only trainees' declarative knowledge of biological hazards, but their threat appraisal—the cognitive process through which individuals evaluate personal risk and that motivates consistent adherence to standard precautions in practice. This cross-sectional study (N = 581) examined whether biological risk knowledge predicts cognitive threat appraisal in Italian health professions students surveyed prior to their first supervised clinical internship, and whether this relationship varies by gender. Drawing on Protection Motivation Theory (PMT), a multiple linear regression showed that biological risk knowledge significantly predicted personalized threat appraisal ($\beta = 0.214$, $p < 0.001$). Gender was also associated with threat appraisal, with female students reporting higher levels than male peers at equivalent knowledge levels ($\beta = 0.184$, $p = 0.035$). The overall model explained 16% of variance in threat appraisal (adjusted $R^2 = 0.150$), indicating that mandatory pre-placement occupational safety training is associated with risk appraisal activation, but only partially, and that a causal interpretation requires longitudinal confirmation. These findings suggest that knowledge transmission alone is insufficient to reduce biological risk exposure in clinical settings: appraisal-activating components—including scenario-based learning and near-miss incident review—should be integrated into occupational safety curricula for health professions students, with attention to gender differences in risk perception.

Keywords: occupational safety training; biological risk; threat appraisal; risk perception; injury prevention; gender differences; occupational health

Academic Editor: Raphael Grzebieta

Received: 5 May 2026

Revised: 12 June 2026

Accepted: 26 June 2026

Published: 2 July 2026

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1. Introduction

Biological hazards in clinical settings represent one of the most extensively documented occupational risks in healthcare. Healthcare workers face routine exposure to potentially infectious biological material through sharps injuries, mucosal splashes, and procedural contamination. Globally, percutaneous injuries are estimated at approximately 385,000 annually among US healthcare workers alone [1], with student-specific prevalence figures ranging from 25% to 34% [2,3]. The pathogens of greatest concern—HBV,

HCV, and HIV—are transmissible via the hematogenous route and preventable through consistent adherence to standard precautions [4]. Italian occupational health legislation (D.Lgs. 81/2008) mandates risk assessment and prevention training for all healthcare workers, including students on supervised placements.

Yet knowing the risk and feeling personally at risk are not the same thing. A persistent gap exists between declarative knowledge of infection-control procedures and actual compliance behavior in clinical practice [5–7]. This gap is explicable through unrealistic optimism [8]: individuals tend to rate their personal susceptibility to occupational hazards as lower than that of comparable others. Medical and nursing students exhibit this bias specifically in the context of occupational infection [9,10].

Rogers' Protection Motivation Theory [11,12] provides the theoretical framework: formal training in biological risk is expected to activate threat appraisal, but whether this activation occurs is an empirical question. The present cross-sectional study (N = 581) examines this in Italian health professions students prior to their first clinical internship. H1 proposes that biological risk knowledge positively predicts cognitive threat appraisal; H2 proposes that female students report higher threat appraisal than male students at equivalent knowledge levels [13,14]. From an occupational safety science perspective, the study addresses a structural gap in workplace injury prevention: if mandatory pre-placement training does not reliably activate the appraisal processes that motivate protective behavior, then a reduction in sharps injuries cannot be achieved through instruction alone.

2. Literature Review

2.1. Biological Risk in Healthcare Training: An Occupational Medicine Perspective

The occupational medicine literature has extensively characterized the biological risk profile of healthcare training environments [2]. Sharps injuries constitute the primary mechanism of occupational biological exposure in both qualified healthcare workers and students on clinical placement. A systematic review and meta-analysis of needle-stick injuries in nursing students estimated a pooled prevalence of 35%, with the highest rates recorded during the internship period and in Asian countries [15]. More recent evidence confirms substantial variability across professional programs and national contexts: a 2024 UK university survey found an annual incidence rate of 13% across healthcare students, with podiatry (31%) and midwifery (21%) showing the highest program-specific prevalence, and injuries occurring more frequently in the first three academic years than in later stages of training [16]. A critical epidemiological concern compounding these figures is systematic underreporting. A 2023 national US survey found that medical students and residents reported the highest incidence of sharps injuries but were the least likely to report them, with only 54% of injured healthcare providers submitting a formal report [17]. A large-scale Chinese survey similarly documented a 32.86% NSI incidence among healthcare workers, with 28.53% of injuries going unreported, confirming that underreporting constitutes a global surveillance problem with implications for accurate resource allocation and post-exposure management [18].

Regarding pathogen-specific transmission risk, the estimates established in the foundational–occupational medicine literature remain clinically valid. Prospective studies of healthcare workers have estimated that the average risk of HIV transmission after percutaneous exposure is approximately 0.3%, while HBV carries the highest risk (6–30% in unvaccinated individuals) and HCV an intermediate risk of approximately 1.8% [4]. Among these pathogens, only HBV is preventable through vaccination, reinforcing the primacy of standard precautions as the universal protective mechanism across all three exposures [19].

The regulatory framework governing these risks in Italy—D. Lgs. 81/2008—mandates formal risk assessment, preventive training, and health surveillance for all workers, including students on supervised placement, exposed to biological agents in the workplace. Compliance with this mandate, however, is not equivalent to adequate risk internalization. A 2024 cross-sectional study of nursing students found a statistically significant correlation between occupational health and safety knowledge and risk control evaluation in clinical environments, yet blood and bodily fluid exposure, needle-stick injuries, and sharps-related incidents remained the most prevalent self-identified occupational risks—indicating that knowledge acquisition does not automatically translate into effective risk management behavior [20]. Aksoy et al. [21] confirmed that occupational risk perception in nursing students was significantly associated with the quality of the clinical learning environment, age, gender, and self-rated knowledge, and recommended that clinic-oriented training programs be organized at regular intervals to sustain risk perception across the placement period.

2.2. *The Knowledge–Appraisal Gap: A Psychological Perspective*

The occupational psychology literature consistently documents that factual knowledge does not automatically produce a personalized sense of vulnerability [8,22,23]. This knowledge-appraisal gap is well established: a cross-sectional study of medical and nursing students found that despite formal instruction, a substantial proportion could not correctly identify standard precautions or post-exposure prophylaxis procedures, and the authors identified a persistent know–do gap in which even students who possessed theoretical knowledge failed to translate it into consistent protective practice [24]. The gap appears to be at least partly mediated by the nature of the learning experience: Romero-Nieto et al. [5] found that students with prior clinical experience reported significantly stronger personal vulnerability perceptions, suggesting that experiential contact activates threat appraisal in a way that classroom instruction does not. Ayub et al. [25] confirmed that targeted educational interventions can activate threat appraisal when they incorporate specific appraisal-targeting components. This distinction between declarative knowledge transmission and appraisal activation is the central applied problem the present study addresses.

Protection Motivation Theory, developed by Rogers [11,12], provides the theoretical framework for this analysis. PMT distinguishes two cognitive pathways: threat appraisal—comprising perceived severity and personal vulnerability—and coping appraisal—comprising response efficacy, self-efficacy, and response costs. The present study focuses exclusively on the threat appraisal pathway of PMT—comprising perceived severity and personal vulnerability—and does not assess coping appraisal components (response efficacy, self-efficacy, response costs). This delimitation is theoretically motivated: the pre-clinical context, in which students have received instruction but lack clinical experience, represents the optimal window for isolating the knowledge–threat appraisal link prior to the activation of coping-relevant experiential cues. Threat appraisals represent beliefs about risks or threats to health—in this context, beliefs about the likelihood and seriousness of biological harm during clinical placement—and encompass both perceived severity and perceived susceptibility. For the present study, the key theoretical proposition is that the factual basis from which students can estimate personal severity and vulnerability; whether this activation actually occurs is an empirical question. PMT has been widely applied across multiple behaviors, populations, and contexts, and recent conceptual review work has identified both its predictive strengths and the boundary conditions that moderate its effects [26,27]. Importantly, the theory does not assume that knowledge transmission and appraisal activation are equivalent processes. Meta-analytic evidence supports the predictive validity of PMT components [28,29].

Gender represents a theoretically significant moderator of the knowledge–appraisal relationship. Women consistently report higher perceived risk across occupational and health hazards [13,14], a pattern documented in healthcare-specific contexts [21,30] and attributed to greater health consciousness, higher empathic sensitivity, and differential socialization towards caution [31]. Within PMT, gender may moderate the knowledge–appraisal link through differential susceptibility to the unrealistic optimism bias [32]. A systematic review of nursing students' risk perception confirmed that gender is among the principal factors shaping how students appraise occupational risk during clinical training, alongside age, level of anxiety, and perceived quality of the clinical learning environment [33]. More recent evidence found that female gender was significantly associated with higher occupational health risk, even after controlling for clinical safety behaviors and occupational health literacy—a finding that complicates simple interpretations of gender differences in risk perception and underscores the need for gender-stratified analysis in training evaluation research [34].

Relatively few studies have examined the cognitive pathway between pre-clinical knowledge acquisition and personalized threat appraisal using a PMT framework in an Italian academic context. Many existing studies assess knowledge and compliance separately [5,6] or focus on qualified healthcare workers [2]. This period is theoretically critical: students possess formal knowledge but lack experiential cues that clinical contact provides, making it the optimal window for detecting whether instruction alone bridges the knowledge–appraisal divide. From an occupational safety standpoint, if pre-placement training does not reliably activate the personalized appraisal processes that motivate adherence to standard precautions, then the regulatory objectives of D. Lgs. 81/2008 cannot be fully achieved through instruction alone.

3. Research Hypotheses

Drawing on the evidence reviewed above, the present study tests:

H1. *Knowledge predicts threat appraisal: biological risk knowledge is positively associated with cognitive threat appraisal, after controlling for age, gender, and educational level.*

H2. *Female students report higher cognitive threat appraisal than male students at equivalent levels of biological risk knowledge, reflecting a gender difference in personalized occupational risk perception.*

Both hypotheses are tested simultaneously within a multiple regression framework.

4. Materials and Methods

4.1. Study Design and Participants

This study employed a cross-sectional survey design. Data were collected between March 2024 and March 2025 through an online questionnaire administered via the Qualtrics platform at a university in Central Italy. Participation was voluntary and anonymous. Pre-clinical status was ensured procedurally: the survey was administered during the mandatory occupational health medical examination required by D. Lgs. 81/2008 prior to first clinical placement authorization. This institutional gate structurally excluded students with prior clinical exposure from the sample, without reliance on self-report screening. Informed consent was obtained electronically in accordance with D. Lgs. 196/2003 and EU 2016/679. The study was conducted under the joint supervision of the Chairs of Occupational Medicine and Occupational Psychology.

The analytical sample comprised $N = 581$ participants (190 male, 32.7%; 387 female, 66.6%; 4 other, 0.7%). Mean age was 21.6 years ($SD = 4.30$; range 18–55). The large majority

held a secondary school diploma ($n = 527$, 90.7%). Of 851 students who initiated the survey, 270 cases were excluded via listwise deletion applied to all regression model variables, yielding a final analytic sample of $N = 581$. Missing data were due to section-level non-response rather than progressive survey dropout, a pattern consistent with missing at random (MAR). Listwise deletion under MAR produces unbiased regression estimates [34] (Schafer & Graham, 2002).

4.2. Measures

4.2.1. Biological Risk Knowledge

Biological risk knowledge was assessed through seven dichotomously scored items (correct = 1, incorrect = 0) covering: (1) self-rated knowledge level; (2) classification of healthcare environment as high biological risk; (3) hematogenous transmission route of HCV; (4) HIV seropositivity not detectable from appearance; (5) airborne transmission route of *Mycobacterium tuberculosis*; (6) correct post-exposure procedure after sharps injury; (7) standard precautions apply to all patients. Composite score ranged from 0 to 7. Item 1 differs from Items 2–7 in that it captures self-rated rather than objectively scored knowledge; it was retained to reflect the metacognitive dimension of knowledge self-assessment, consistent with its theoretical role in PMT-based training evaluation. Readers should note this distinction when interpreting the score. Reliability of the knowledge composite was assessed using the Kuder-Richardson Formula 20 (KR-20), the appropriate coefficient for dichotomously scored items [36]. $KR-20 = 0.50$ ($N = 581$). This value reflects the content heterogeneity inherent in a multi-domain knowledge test spanning transmission routes, risk classification, post-exposure procedures, and standard precautions—domains that are conceptually independent and not expected to co-vary strongly. All corrected item-total correlations were positive and statistically significant ($r_{pb} = 0.10$ to 0.37), confirming unidirectional item functioning. The instrument is best characterized as a content-valid screening measure anchored in D. Lgs. 81/2008 training requirements, rather than a psychometrically optimized scale. This limitation is acknowledged in Section 6.2.

4.2.2. Cognitive Threat Appraisal

Operationalized following PMT [12] as the personal appraisal of probability and severity of biological harm during internship. Five items were included (1–5 scales): perceived probability of harm, perceived severity of harm, and three Likert statements on personal risk during internship. Affective items were excluded to preserve cognitive specificity. Exploratory factor analysis yielded a single-factor solution (44.5% variance; $KMO = 0.733$; Bartlett's $\chi^2(10) = 1034$, $p < 0.001$). Cronbach's $\alpha = 0.754$ [24].

4.2.3. Control Variables

Age (continuous), gender (male, female, other), and educational level (diploma, bachelor's, master's, postgraduate) were included as covariates.

4.3. Statistical Analysis

A multiple linear regression was conducted with Cognitive Threat Appraisal as the dependent variable and Biological Risk Knowledge as the focal predictor. Gender and educational level were dummy-coded (reference categories: male; secondary school diploma). Multicollinearity was assessed through VIF statistics. All analyses used Jamovi (version 2.7.23) [37]. Statistical significance was set at $\alpha = 0.05$.

5. Results

5.1. Descriptive Statistics

Table 1 presents descriptive statistics. Biological Risk Knowledge ranged from 0 to 6 ($M = 4.09$, $SD = 1.41$). Cognitive Threat Appraisal ranged from 1.00 to 5.00 ($M = 3.56$, $SD = 0.65$). Both showed mild negative skewness consistent with approximately normal distributions. Sample characteristics are presented in Table 2.

Table 1. Descriptive Statistics for Continuous Study Variables ($N = 581$).

Variable	N	M	SD	Min	Max	Skewness
Biological Risk Knowledge	581	4.09	1.41	0	6	−0.54
Cognitive Threat Appraisal	581	3.56	0.65	1.00	5.00	−0.44
Age	581	21.6	4.30	18	55	3.65

M = mean; SD = standard deviation; Min = minimum; Max = maximum.

Table 2. Sample Characteristics: Gender and Educational Level ($N = 581$).

Variable	n	%
Gender		
Male	190	32.7
Female	387	66.6
Other	4	0.7
Educational Level		
Secondary school diploma	527	90.7
Bachelor's degree	34	5.9
Master's degree or equivalent	17	2.9
Postgraduate qualification	3	0.5

5.2. Multiple Linear Regression: Predictors of Cognitive Threat Appraisal

VIF values ranged from 1.01 to 1.15, indicating no multicollinearity concerns. The overall regression model was statistically significant ($F(8,572) = 4.78$, $p < 0.001$), accounting for 16.3% of the variance in cognitive threat appraisal ($R^2 = 0.163$, adjusted $R^2 = 0.150$). Full model coefficients are presented in Table 3.

Table 3. Multiple Linear Regression Predicting Cognitive Threat Appraisal ($N = 581$). Asterisks (*) indicate statistically significant predictors ($p < 0.05$).

Predictor	b	SE	β	95% CI Lower	95% CI Upper	p
BIOLOGICAL RISK KNOWLEDGE *	0.098	0.019	0.214	0.060	0.136	<0.001
Age	0.005	0.007	0.033	−0.009	0.019	0.483
Gender (Female vs. Male) *	0.119	0.056	0.184	0.008	0.229	0.035
Gender (Other vs. Male)	0.340	0.320	0.527	−0.288	0.969	0.288
Education: Bachelor's vs. Diploma	−0.185	0.114	−0.286	−0.409	0.040	0.106
Education: Master's vs. Diploma	−0.106	0.158	−0.164	−0.416	0.205	0.505
Education: Postgraduate vs. Diploma	0.076	0.476	−	−	−	0.873

b = unstandardized coefficient; SE = standard error; β = standardized coefficient; CI = confidence interval. Reference categories: Male (gender); Secondary school diploma (education). Model fit: $F(8, 572) = 4.78$, $p < 0.001$, $R^2 = 0.163$, adjusted $R^2 = 0.150$.

5.3. Tests of Hypotheses

Hypothesis 1 was supported. Biological Risk Knowledge was a significant positive predictor of Cognitive Threat Appraisal ($b = 0.098$, $\beta = 0.214$, 95% CI [0.060, 0.136], $p < 0.001$). For each one-unit increase in the knowledge composite, threat appraisal increased by 0.098 points on the 1–5 scale.

Hypothesis 2 was supported. Female students reported significantly higher Cognitive Threat Appraisal than male students ($b = 0.119$, $\beta = 0.184$, 95% CI [0.008, 0.229], $p = 0.035$), after controlling for Biological Risk Knowledge, age, and educational level. Female students scored on average 0.12 points higher than male students with equivalent knowledge. Age and educational level were not significant predictors (all $p > 0.10$).

6. Discussion

The present study tested two hypotheses derived from Protection Motivation Theory in a pre-clinical population of Italian health professions students. Both were supported. Biological risk knowledge significantly predicted cognitive threat appraisal ($\beta = 0.214$, $p < 0.001$), and female students reported significantly higher threat appraisal than male students at equivalent knowledge levels ($\beta = 0.184$, $p = 0.035$). The overall model explained 16.3% of variance ($R^2 = 0.163$, adjusted $R^2 = 0.150$).

The magnitude of the knowledge–appraisal effect is theoretically meaningful despite the modest explained variance. Within PMT, threat appraisal is determined by multiple informational inputs—both environmental (instruction, observational learning) and intrapersonal (prior experience, personality) [11,12]. A pre-clinical sample, by definition, lacks the experiential pathway; the explained variance, therefore, reflects the isolated contribution of declarative instruction, abstracted from clinical contact. Recent meta-analysis on PMT has noted that threat appraisal effects in single-pathway tests are inherently bounded by the absence of complementary coping appraisal activation and by individual difference moderators—conditions that apply directly here [29]. The present R^2 is consistent with the interpretive framework proposed by Romero-Nieto et al. [5], who found that students with prior clinical experience showed substantially stronger personal vulnerability perceptions. The implication is not that knowledge is irrelevant to appraisal—the effect is real and significant—but that instruction constitutes a necessary rather than sufficient condition for risk internalization.

From an occupational safety standpoint, this finding has direct regulatory relevance. D.Lgs. 81/2008 mandates pre-placement biological risk training but does not specify appraisal-targeting content components. The present data provide empirical grounds for recommending that mandatory training be supplemented with elements designed to activate personalized appraisal rather than transmit declarative knowledge alone. The appraisal-activating components most consistently supported in the occupational health literature are scenario-based learning that places students in first-person risk situations, structured near-miss incident review, and facilitated reflection on personal vulnerability and optimism bias. These components operationalize the shift from third-person knowledge (“sharp injuries are dangerous”) to first-person appraisal (“I am personally at risk during my internship”) [38,39].

6.1. Theoretical and Practical Implications

The gender finding warrants specific theoretical attention. Female students scored on average 0.12 points higher on the threat appraisal composite than male students with equivalent biological risk knowledge, a difference that persisted after controlling for age and educational level. This is consistent with the well-documented pattern of higher perceived risk among women across occupational and health hazard domains [13,21], and

with the specific prediction that gender moderates the knowledge-appraisal relationships through differential susceptibility to the unrealistic optimism bias [40]. Recent evidence found that female gender was independently associated with higher occupational health risk exposure even after controlling for safety behaviors and occupational health literacy, a finding that complicates the interpretation of higher female threat appraisal as simply “more accurate.” [41,42].

The practical implication for curriculum design is twofold. First, occupational health training evaluations in health professions programs should routinely include a brief pre/post threat appraisal measure alongside the standard knowledge test. The five-item composite used here ($\alpha = 0.754$) demonstrated adequate reliability and convergent validity and is feasible for routine program evaluation. Second, gender-stratified or gender-targeted components—specifically, scenarios and reflective exercises designed to address optimism bias and personalize vulnerability—should be incorporated into pre-placement training, with particular attention to male students as the group at greater risk of entering clinical training with insufficient appraisal activation. A 2024 PMT-based educational intervention for emergency ward nurses [27] demonstrated that structured training targeting both threat appraisal and coping appraisal components produced significant improvements in occupational protective behaviors, suggesting that the same framework is transferable to pre-clinical student populations.

6.2. Limitations and Directions for Future Research

Several limitations qualify the interpretation of the present findings. The cross-sectional design precludes causal inference [29,43]: the observed association between knowledge and threat appraisal is consistent with the OMT prediction but does not establish that knowledge acquisition produces appraisal activation. Longitudinal designs, ideally with pre- and post-training measurement, are required to test this directional claim. Reliance on self-report introduces common method bias, which may inflate observed correlations between knowledge and appraisal when both are measured in the same session. The single-institution sample limits generalizability across Italian academic health professions programs that differ in disciplinary composition, training culture, and placement structure. Most critically, the present study does not establish a link between threat appraisal and behavioral outcomes. A student who enters clinical training with a high personalized risk appraisal may nonetheless fail to adhere consistently to standard precautions if coping appraisal is insufficient, if situational demands override deliberative processing, or if organizational factors in the clinical environment do not support safe behavior. Longitudinal research with behavioral outcome measures—specifically, observed adherence to standard precautions and incident reporting rates—is necessary before appraisal-targeted training can be recommended as an evidence-based injury prevention strategy. Finally, the present study assessed only the threat appraisal pathway of PMT; coping appraisal components—response efficacy, self-efficacy, and response costs—were not measured, leaving the full motivational model unexamined. This is a substantive theoretical limitation: without coping appraisal data, it is not possible to determine whether students who correctly appraise the threat also believe they can execute protective behaviors (self-efficacy) or that those behaviors will be effective (response efficacy). A student may perceive high personal risk yet fail to adopt standard precautions if coping appraisal is low—a pattern that the present design cannot detect. Future research should incorporate both PMT pathways within a single study to test the full motivational model, ideally using validated coping appraisal measures such as those developed by Milne et al. [32] or Mullan et al. [42]. The biological risk knowledge scale demonstrated moderate internal consistency ($KR-20 = 0.50$), consistent with the content heterogeneity of a multi-domain declarative knowledge test. Future studies should employ validated biosafety knowledge

instruments with established psychometric properties across the full range of D. Lgs. 81/2008-mandated competency domains. Moreover, the use of listwise deletion to handle missing data (270 cases excluded from an initiated sample of 851) may limit the generalizability of findings if non-completers differed systematically from the analytic sample on key study variables.

Longitudinal follow-up post-internship could test whether the pre-internship knowledge–appraisal relationship predicts actual compliance behavior and incident occurrence in the clinical environment—the distal outcomes that justify the theoretical and practical investment in appraisal-targeted training. A multi-institution replication would also clarify whether the present pattern of findings generalizes across Italian health professions programs and whether program-level variables (discipline, placement structure, instructor approach) moderate the knowledge–appraisal relationship observed here.

7. Conclusions

Pre-clinical occupational safety training in biological risk activates personalized cognitive threat appraisal, but this effect is modest ($R^2 = 0.163$), indicating that mandatory instruction alone is insufficient to achieve the level of risk internalization needed for consistent protective behavior. Male students enter clinical training with systematically lower personalized risk appraisal than female students at equivalent knowledge levels, representing a specific vulnerability group. These findings provide empirical grounds for recommending that risk assessment training for healthcare students—as required by D. Lgs. 81/2008—be supplemented with appraisal-activating components, and that gender-stratified approaches be incorporated to reduce the incidence of biological exposure incidents during clinical training. It must be emphasized, however, that elevated threat appraisal is a proximal cognitive precursor to safe work behavior, not a guarantee of it. Whether heightened pre-clinical risk appraisal translates into actual adherence to standard precautions, safe sharps management, and reduced biological exposure incidents during clinical placement remains an open empirical question that the present cross-sectional design cannot answer.

Key Takeaways for Health Professions Education and Occupational Safety

- Pre-clinical instruction in biological risk activates personalized cognitive threat appraisal—knowledge is not inert with respect to the PMT appraisal pathway.
- Occupational safety implication: Sharps injury prevention depends on internalized risk awareness, not only on declarative knowledge. Training that does not activate personalized appraisal leaves a critical gap in the injury prevention chain.
- The effect is real but modest ($R^2 = 0.163$): Experiential and reflective training components are needed to amplify the effect.
- Male students show lower threat appraisal than female students at equivalent knowledge levels. Gender-targeted appraisal-activating components should be considered.
- Training evaluation should include threat appraisal measures alongside knowledge tests. The five-item composite ($\alpha = 0.754$) is a feasible candidate for routine assessment.
- Regulatory implication (D. Lgs. 81/2008): Mandatory pre-placement safety training should incorporate scenario-based learning, near-miss case reviews, and structured reflection on personal vulnerability to reduce biological exposure incidents.

Author Contributions: Conceptualization, T.G., L.D.G. and M.C.; Methodology, T.G. and L.D.G.; Formal analysis, T.G. and M.S.; Writing—original draft preparation, T.G. and M.S.; Writing—review

and editing, T.G., M.S., L.D.G. and M.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the IRB-CRRM of the University “G. d’Annunzio” of Chieti-Pescara (protocol number: CRRM_2023_12_07_04; date of approval: 12 December 2023).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data supporting reported results are available upon reasonable request from the corresponding authors.

Acknowledgments: The authors wish to thank the students who participated in the study.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

Abbreviation	Full Form
PMT	Protection Motivation Theory
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HIV	Human Immunodeficiency Virus
OHS	Occupational Health and Safety
VIF	Variance Inflation Factor
EFA	Exploratory Factor Analysis
D.Lgs.	Decreto Legislativo (Italian Legislative Decree)

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