# ASSOCIATION BETWEEN FORMALDEHYDE VAPOR EXPOSURE AND EYE IRRITATION AND UPPER RESPIRATORY TRACT IRRITATION DURING ANATOMY LABORATORY SESSIONS

**By**
**Silphia Novelyn[1], Morado Natanael Sidauruk[2], Reinne Natali Christine[3]**
**[1.2.3] Faculty of Medicine, Universitas Kristen Indonesia, Jakarta, Indonesia**
**E-mail: [1]silphia.novelyn@uki.ac.id, [2]2365050220@ms.uki.ac.id, [3]reine.christine@uki.ac.id**

***Article History:***
*Received: 15-11-2025*
*Revised: 23-11-2025*
*Accepted: 18-12-2025*

***Keywords:***
*Formaldehyde; Eye Irritation; Upper Respiratory Tract Irritation.*

***Abstract:*** *Formaldehyde is routinely used to preserve cadavers for anatomy practicums; however, volatilization releases airborne formaldehyde that can acutely irritate the eyes and upper respiratory tract. According to the WHO, irritation may be triggered at 0.08–2.52 ppm during 30 minutes of exposure. This comparative cross-sectional study involved 130 medical students (Faculty of Medicine, Universitas Kristen Indonesia/UKI; 2020 cohort) and examined the association between measured formaldehyde concentrations and acute irritative symptoms during anatomy practicum. Air measurements in the practicum room were 0.595 ppm (intact cadaver specimens) and 0.395 ppm (organ specimens), both reported to exceed the WHO limit and Indonesia's Ministry of Manpower (PERMENAKER) threshold. The most common eye symptoms were eye stinging/pain (n=119; 91.5%), watery eyes (n=102; 78.5%), red eyes (n=42; 32.2%), and itchy eyes (n=37; 28.5%), with additional complaints including a history of eye irritation (n=22; 29.2%), eye discomfort (n=19; 14.6%), and eye swelling (n=11; 8.5%). Upper respiratory symptoms included nasal stinging (n=75; 57.7%), runny nose (n=57; 43.8%), shortness of breath (n=32; 24.6%), sneezing (n=25; 19.2%), cough (n=24; 18.5%), difficulty swallowing (n=17; 13.1%), nausea/vomiting (n=16; 12.3%), hoarseness (n=14; 10.8%), and itchy throat (n=10; 7.7%).*

## INTRODUCTION

Anatomy practicums remain a key instructional method in medical education because they allow students to learn real human body structures through cadavers. However, the use of formalin (a formaldehyde solution) as a cadaver preservative may release formaldehyde vapor into the practicum room air. Formaldehyde is well recognized as a strong irritant to the eyes and respiratory tract and carries more serious health implications with long-term exposure. The International Agency for Research on Cancer (IARC) has concluded that there is sufficient evidence that formaldehyde causes nasopharyngeal cancer in humans, while the U.S. National Toxicology Program (NTP) classifies formaldehyde as "known to be a human carcinogen.

In the context of occupational and environmental safety, controlling formaldehyde exposure is important because irritative symptoms can occur after relatively short exposure periods and are influenced by both concentration and duration. The WHO indoor air quality guideline for formaldehyde is 0.1 mg/$m^3$ (≈0.08 ppm) for a 30-minute period. In Indonesia, technical occupational health and safety (K3) guidance referring to workplace threshold limit values (Nilai Ambang Batas/NAB) lists formaldehyde with a short-term/ceiling notation (T) of 0.3 ppm. This indicates that anatomy practicum activities may provoke complaints if ventilation is inadequate, practicum duration is prolonged, or the use of personal protective equipment (PPE)—such as eye protection—is not optimal.

Several studies in anatomy laboratories have shown that formaldehyde exposure during dissection is associated with acute complaints such as eye stinging/tearing, throat irritation, cough, burning sensation in the nose, headache, and shortness of breath in some individuals. Studies involving students and instructors in anatomy laboratories have reported eye and throat irritation as common symptoms during dissection activities. Other studies have also demonstrated differences in formaldehyde concentrations and personal exposure between dissection rooms and control areas, as well as their associations with clinical symptoms. Although the global evidence is fairly consistent, local data on airborne formaldehyde levels and their impact on students in anatomy laboratories—including comparisons by specimen type (intact cadaver vs organ specimens)—remain limited.

Based on these considerations, this study was designed to assess airborne formaldehyde levels in the anatomy laboratory of the Faculty of Medicine, Universitas Kristen Indonesia (UKI), and their relationship with the occurrence of eye irritation and upper respiratory tract irritation among the 2020 student cohort, while also taking into account operational factors such as practicum duration, air circulation, PPE availability, and variation in the type of cadaver specimens used.

## LITERATURE REVIEW

### Formaldehyde, Eye Irritation, Upper Respiratory Irritation.

Anatomy practicums using cadavers generally require preservatives, and formalin (a formaldehyde solution) can release formaldehyde vapor/gas into the practicum room air. This exposure is an occupational health and safety (OHS) concern because irritative complaints may occur even after relatively short exposures and are influenced by both concentration and exposure duration.

Formaldehyde (HCHO; CAS 50-00-0) is a pungent-smelling compound that readily


ISSN 2798-3471 (Cetak)
ISSN 2798-3641 (Online)

volatilizes and primarily enters the body through inhalation and mucosal contact (eyes, nose, and throat). In the dissection setting, the main sources are evaporation from preserved cadavers/specimens and from exposed formalin solutions or wet surfaces.

**Brief toxicology and mechanisms of formaldehyde irritation**

Due to its high reactivity and high solubility in mucosal layers, formaldehyde acts mainly as a site-of-contact irritant (eyes–nose–throat), causing symptoms to appear rapidly, predominantly as sensory irritation. This occurs through activation of sensory nerves (the trigeminal/chemesthesis pathway), which triggers protective reflexes such as tearing, increased nasal secretion, sneezing, coughing, and stinging or burning sensations. Because this mechanism is strongly influenced by peak exposure concentrations, symptoms are generally more closely related to formaldehyde levels than to duration alone, and may vary between individuals depending on mucosal sensitivity and respiratory tract conditions.

**Long-term health effects of formaldehyde (carcinogenicity)**

Beyond acute irritative effects, formaldehyde is also a concern due to evidence of carcinogenicity in humans. The International Agency for Research on Cancer (IARC) classifies formaldehyde as carcinogenic to humans (Group 1), supported by sufficient epidemiological evidence, including an association with nasopharyngeal cancer. The National Toxicology Program (NTP) also notes that formaldehyde is classified as "known to be a human carcinogen." For anatomy laboratories, the implication is that although this study focuses on acute irritation, exposure control remains important because repeated practicum sessions (over weeks or months) may increase cumulative exposure risk.

**Exposure–response and symptom thresholds**

Acute effects of formaldehyde are dominated by sensory irritation of the eyes and upper respiratory tract. The WHO indoor air quality guideline for formaldehyde is 0.1 mg/m$^3$ (≈0.08 ppm) for any 30-minute average period, established to prevent irritation. A summary of human effects data from NIOSH indicates that most subjects experience irritation of the eyes, nose, and throat at 1–3 ppm, and that some individuals have difficulty tolerating prolonged exposure at higher concentrations.

## METHODS

**Study Design**

This study was an analytical observational study using a cross-sectional approach to assess the association between formaldehyde gas exposure and upper respiratory tract irritation in the anatomy laboratory of the Faculty of Medicine, Universitas Kristen Indonesia (UKI), among the 2020 student cohort.

**Study Population**

The study population comprised all medical students from the Faculty of Medicine, Universitas Kristen Indonesia, class of 2020.

**Sample and Sampling Technique**

The study used **total sampling**, meaning all eligible students in the 2020 cohort who completed the questionnaire were included as the study sample.

**Research Instrument and Data Collection**

Data were collected using a questionnaire. Participants completed the questionnaire after providing informed consent. Total sampling was applied to the 2020 cohort.

**Study Variables**

The independent variable was the formaldehyde gas exposure level in the anatomy laboratory, evaluated in relation to the occupational threshold limit value (TLV)/Nilai Ambang Batas (NAB), while the dependent variables were irritative outcomes namely eye irritation and nasopharyngeal/upper respiratory tract irritation reported by UKI medical students from the 2020 cohort.

**Data Processing and Statistical Analysis**

All collected data were entered, edited, and cleaned using IBM SPSS version 25. Data were tabulated into frequency distribution tables for analysis. Descriptive statistics were generated using frequency analysis, and the association between variables was tested using the chi-square test.

**Study Flow**

The study procedures are summarized in Figure 1.

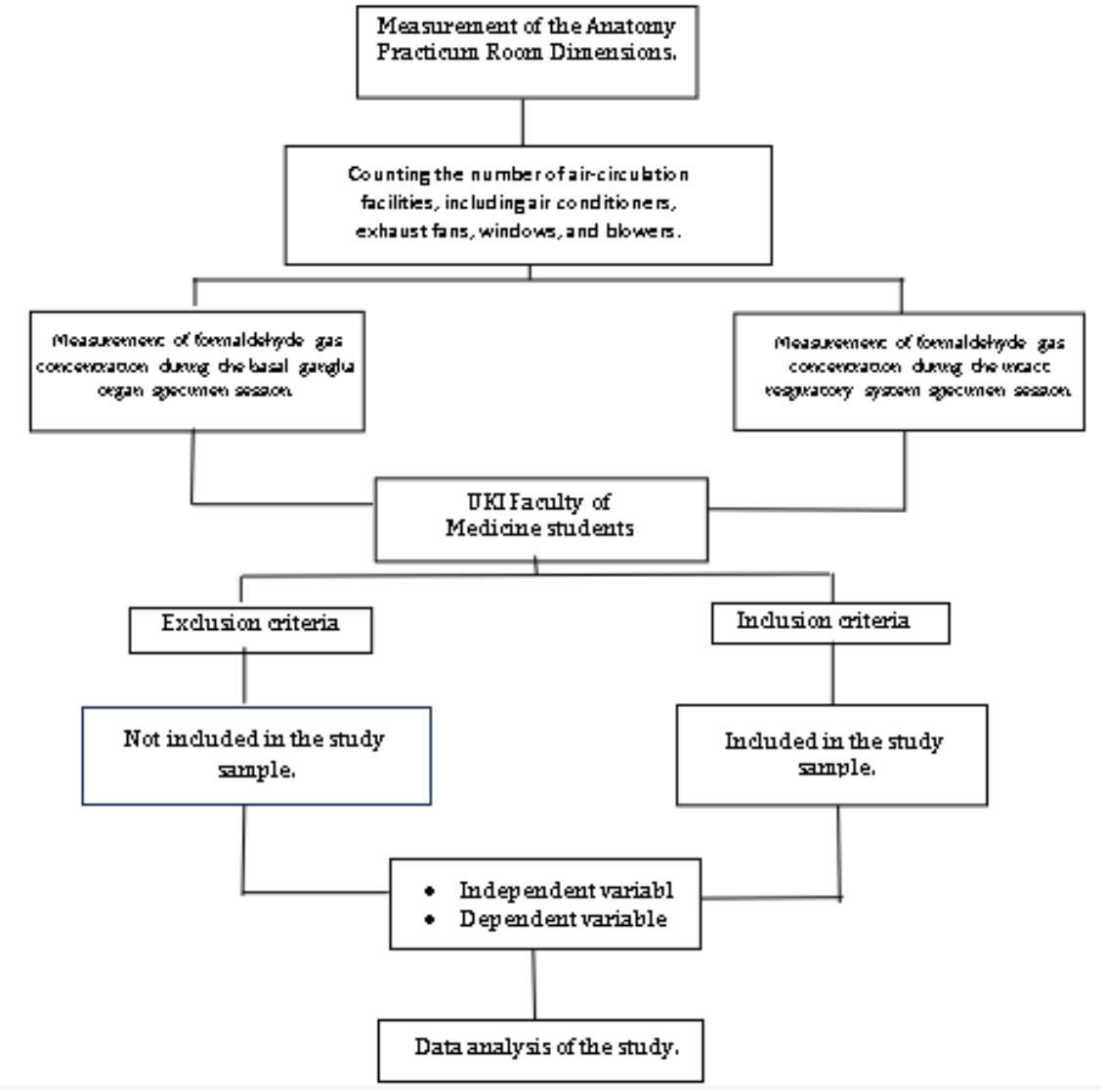



Figure 1. Study Flowchart


ISSN 2798-3471 (Cetak)
ISSN 2798-3641 (Online)

## RESULTS AND DISCUSSION

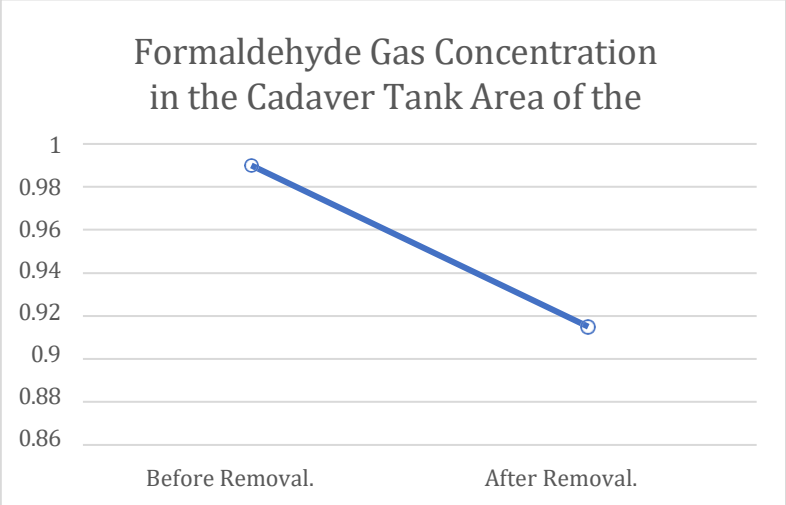
### Results

### Formaldehyde Gas Concentration Testing in the Laboratory Cadaver Tank

Before the anatomy practicum was conducted, cadavers were stored in a tank containing a formaldehyde solution. Three days prior to the practicum, the cadavers were removed from the tank and placed on preparation tables as either full-body specimens or organ specimens.

Formaldehyde measurements in the cadaver tank area were performed under two specimen conditions—an intact respiratory system specimen and a basal ganglia organ specimen—at two time points: before removal and after removal from the tank. The measured concentration before the intact respiratory system specimen and the basal ganglia organ specimen were removed was 0.990 ppm, while the concentration in the cadaver tank area after both specimens were removed was 0.915 ppm.

Figure 2. Graph of Formaldehyde Gas Concentration in the Cadaver Tank Area, Anatomy Laboratory.

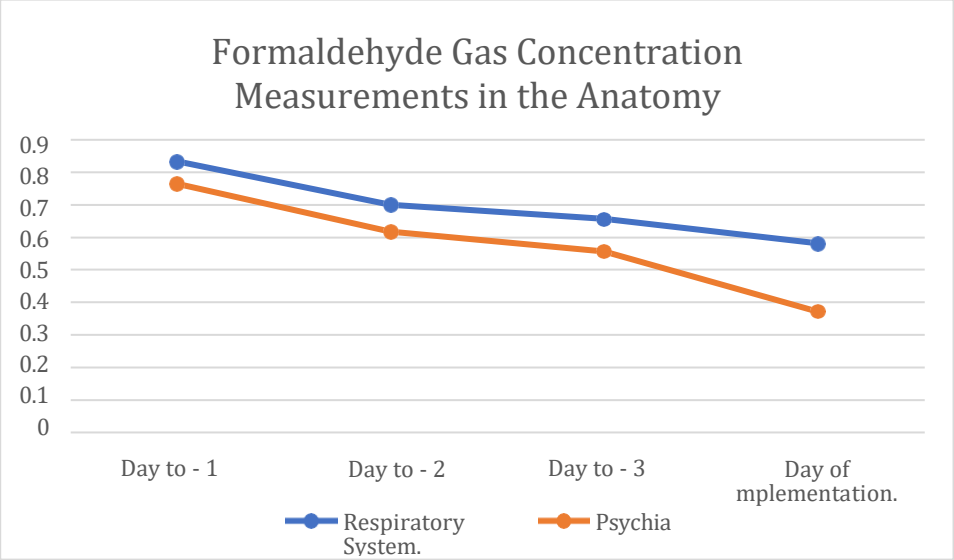



### Formaldehyde Gas Concentration Testing in the Anatomy Laboratory Room (Faculty of Medicine, UKI)

Formaldehyde gas concentration was measured in the anatomy laboratory during practicum sessions before and after cadavers were removed, and across two different blocks—Block 7 (Respiratory System) and Block 19 (Psychiatry)—to compare measurements taken three days before the practicum and during the practicum.

The concentration before cadavers were removed was 0.295 ppm. In Block 7, the concentrations after cadavers were removed were 0.847 ppm, 0.714 ppm, and 0.670 ppm, while the concentration during the practicum was 0.595 ppm. In Block 19, the concentrations after cadavers were removed were 0.778 ppm, 0.630 ppm, and 0.570 ppm, and the concentration during the practicum was 0.385 ppm.

Figure 3. Formaldehyde Gas Concentration Measurements in the Anatomy Practicum Room.




**Room Dimensions of the UKI Faculty of Medicine Anatomy Laboratory**

The cadaver tank room in the anatomy laboratory had a volume of 33.761 $m^3$, with a length of 7.58 m, a width of 2.227 m, and a height of 2.00 m. The anatomy practicum room had a volume of 170.616 $m^3$, with a length of 9.37 m, a width of 6.09 m, and a height of 2.99 m.

Figure 4. Anatomy Practicum Room

**Facilities in the UKI Faculty of Medicine Anatomy Laboratory**

The cadaver tank room had 2 windows, 4 air conditioners, 1 blower connected to the practicum room, and 3 air outlets venting to the outside. The anatomy practicum room had 4 exhaust fans, 8 air conditioners, 10 windows, and 1 blower. Before the practicum, only some facilities were operated (cadaver tank room: air conditioners and blower; practicum room: air conditioners and exhaust fans, while the blower was turned on only during the practicum), which likely contributed to differences in measured formaldehyde concentrations. Students were required to wear masks and laboratory coats, and certain PPE was provided; however, safety goggles were neither mandatory nor provided.


*ISSN 2798-3471 (Cetak)*
*ISSN 2798-3641 (Online)*

Table 1. Facilities in the Cadaver Tank Room and the Anatomy Practicum Room.

| Location | *Air conditioners* | Windows | *Blower* | *exhaust fan* |
|---|---|---|---|---|
| Cadaver tank room | 4 | 2 | 1 | 0 |
| Anatomy practicum room | 8 | 10 | | 4 |

**Respondents' Sex Characteristics**

The sex distribution of the 130 study respondents is presented below:

Table 2. Respondents by Sex

| Sex | Frequency | Percentage (%) |
|---|---|---|
| Male | 26 | 20% |
| Female | 104 | 80% |
| Total | 130 | 100% |

Based on the table, most respondents were female (n=104; 80%), while male respondents accounted for 26 (20%). All respondents had entered the anatomy laboratory more than twice.

**Personal Protective Equipment (PPE) Characteristics During Anatomy Practicum**

During the practicum, the required PPE included medical masks, laboratory coats, and gloves; however, safety goggles were not used as standard PPE. A total of 122 respondents (93.8%) wore medical masks, while 8 (6.2%) did not. Only 12 respondents (9.2%) had ever used safety goggles, whereas 118 (90.8%) had never used them, which may increase the likelihood of acute eye irritation among students.

Table 3. Respondents by Use of Face Mask

| Face mask use | Frequency | Percentage (%) |
|---|---|---|
| Yes | 122 | 93.8% |
| No | 8 | 6.2% |
| Total | 130 | 100% |

Table 4. Respondents by Use of Safety Goggles

| Safety goggles use | Frequency | Percentage (%) |
|---|---|---|
| Yes | 12 | 9.2% |
| No | 118 | 90.8% |
| Total | 130 | 100% |

**Characteristics of Anatomy Practicum Exposure Duration**

According to the WHO, exposure to formaldehyde gas at 0.08–2.52 ppm for 30 minutes or longer may cause acute eye and upper respiratory tract irritation.[3] Based on the questionnaire responses, 123 respondents (94.6%) reported an exposure duration of more than 30 minutes, while 7 respondents (5.4%) reported less than 30 minutes. All students had entered the anatomy laboratory more than twice (100%).

Table 5. Respondents by History of Entering the Anatomy Laboratory

| Entered the anatomy laboratory | Frequency | Percentage (%) |
|---|---|---|
| Yes | 130 | 100% |
| No | 0 | 0% |
| Total | 130 | 100% |

**Characteristics of Eye Irritation Symptoms**

According to the WHO, exposure to formaldehyde gas at 0.08–2.52 ppm may cause eye and upper respiratory tract irritation, while Indonesia's Ministry of Manpower Regulation (PERMENAKER) No. 5/2018 sets an occupational threshold limit value for formaldehyde at 0.3 ppm. Eye irritation was the most frequently reported complaint, which may be related to the lack of availability and use of safety goggles. Questionnaire results showed that the most common symptoms were eye stinging/pain in 119 respondents (91.5%) and watery eyes in 102 respondents (78.5%). The least frequently reported symptoms were a foreign-body sensation/grittiness in 19 respondents (14.6%) and eye swelling in 11 respondents (8.5%). These complaints are consistent with acute irritation following exposure for more than 30 minutes and may worsen with longer or repeated exposure.

Table 6. Respondents Reporting Eye Irritation Symptoms (n = 130)

| Eye irritation symptom | Frequency (n) | Percentage (%) |
|---|---|---|
| History of eye irritation | 22 | 29.2 |
| Red eyes | 42 | 32.3 |
| Watery eyes | 102 | 78.5 |
| Eye stinging/pain | 119 | 91.5 |
| Itchy eyes | 37 | 28.5 |
| Foreign-body sensation (grittiness) | 19 | 14.6 |
| Eye swelling | 11 | 8.5 |
| Recurrent eye irritation after the practicum | 10 | 7.7 |

**Characteristics of Upper Respiratory Tract Irritation Symptoms**

According to the WHO, exposure to formaldehyde gas at 0.08–2.52 ppm for more than 30 minutes may cause eye and upper respiratory tract irritation. Indonesia's Ministry of Manpower Regulation (PERMENAKER) No. 5/2018 also indicates that exposure around 0.3 ppm (short-term/ceiling) may trigger upper respiratory tract irritation, particularly involving the nose and throat, because formaldehyde readily enters the body via inhalation. Based on the questionnaire, the most frequently reported symptoms were nasal stinging/pain (n=75; 57.7%) and runny nose (n=57; 43.8%), followed by shortness of breath (n=32; 24.6%), sneezing (n=25; 19.2%), and cough (n=24; 18.5%). Other symptoms included difficulty swallowing (n=17; 13.1%), nausea/vomiting (n=16; 12.3%), hoarseness (n=14; 10.8%), and persistent symptoms after the practicum (n=12; 9.2%). A total of 21 respondents reported a prior history of nose–throat irritation.

Upper respiratory tract complaints were less frequent than eye irritation, which may be related to mask use, removal of cadavers from the tank three days before the practicum, room ventilation, and the rapid metabolism of formaldehyde to formic acid followed by excretion. Nevertheless, high and repeated exposure over long periods may increase the risk


ISSN 2798-3471 (Cetak)
ISSN 2798-3641 (Online)

of serious health outcomes, including nasopharyngeal cancer and leukemia.

Table 7. Respondents Reporting Upper Respiratory Tract Irritation Symptoms (n = 130)

| Upper respiratory tract irritation symptom | Frequency (n) | Percentage (%) |
|---|---|---|
| History of nose and throat irritation | 21 | 16.2 |
| Nasal stinging/pain | 75 | 57.7 |
| Shortness of breath | 32 | 24.6 |
| Sneezing | 25 | 19.2 |
| Cough | 24 | 18.5 |
| Runny nose | 57 | 43.8 |
| Difficulty swallowing | 17 | 13.1 |
| Itchy throat | 10 | 7.7 |
| Nausea and vomiting | 16 | 12.3 |
| Hoarseness | 14 | 10.8 |
| Recurrent nose and throat irritation after the practicum | 12 | 9.2 |

**Discussion**

This study was motivated by students' complaints during anatomy practicum, including eye irritation (stinging/pain, tearing, redness, itching) and upper respiratory tract irritation (burning/stinging in the nose/throat, cough, sneezing, and shortness of breath). According to the WHO, formaldehyde exposure of 0.08–2.52 ppm may cause eye and upper respiratory tract irritation, while PERMENAKER No. 5/2018 sets a threshold limit value of 0.3 ppm. The measurements in this study showed that formaldehyde levels exceeded the occupational limit, both in the cadaver tank area (0.990 ppm; symptom assessment was not possible because students were not allowed to enter) and in the practicum room across two learning blocks.

In Block 7 (Respiratory System), measured concentrations were 0.847, 0.714, and 0.670 ppm after cadavers were removed, and 0.595 ppm during the practicum. These higher values were presumed to be related to specimen characteristics, as the lungs are hollow and may retain more formalin, leading to greater volatilization. In Block 19 (Psychiatry) using the basal ganglia organ specimen, concentrations were 0.778, 0.630, and 0.570 ppm after removal and 0.385 ppm during the practicum. The lower concentration in this block was attributed to the more compact tissue structure and the practice of frequently spraying the specimen with water, which may reduce formaldehyde evaporation.

Differences in concentration were also influenced by ventilation and air-circulation facilities. Before the practicum, not all systems were operated (the blower was activated only during the practicum), which likely contributed to higher initial concentrations that decreased once the full circulation system was running.

Among 130 respondents (UKI Faculty of Medicine, class of 2020), commonly used PPE included medical masks, laboratory coats, and gloves, without eye protection. Consequently, eye complaints predominated, including eye stinging/pain (119; 91.5%), watery eyes (102; 78.5%), red eyes (42; 32.2%), itchy eyes (37; 28.5%), foreign-body sensation (19; 14.6%),

and eye swelling (11; 8.5%). Upper respiratory tract complaints were less frequent, including nasal stinging/pain (75; 57.7%), runny nose (57; 43.8%), shortness of breath (32; 24.6%), sneezing (25; 19.2%), and cough (24; 18.5%), along with other symptoms (e.g., difficulty swallowing, nausea/vomiting, and hoarseness). Notably, 12 students (9.2%) reported symptoms persisting after the practicum.

Association analysis indicated that an exposure duration of more than 30 minutes was more strongly related to the occurrence of complaints than exposure of less than 30 minutes. Overall, elevated formaldehyde concentrations and irritative symptoms in this study appeared to be influenced by specimen type, ventilation/air circulation, specimen handling (e.g., water spraying), exposure duration, and PPE use, particularly the absence of eye protection.

## CONCLUSION

Based on the findings of this study on the association between formaldehyde gas exposure and eye irritation as well as upper respiratory tract irritation during anatomy practicum among UKI Faculty of Medicine students (Class of 2020), it can be concluded that formaldehyde concentrations in the cadaver tank area (0.990 ppm) and in the anatomy practicum room (0.887 ppm) exceeded the allowable threshold limits according to WHO and PERMENAKER guidelines. The most frequently reported complaints were eye irritation, particularly eye stinging/pain (119 respondents; 91.5%) and watery eyes (102; 78.5%), followed by red eyes, itching, foreign-body sensation, and swelling.

For upper respiratory tract irritation, the most common symptoms were nasal stinging/pain (75; 57.7%), runny nose (57; 43.8%), and shortness of breath (32; 24.6%), along with other complaints such as sneezing, cough, difficulty swallowing, itchy throat, nausea/vomiting, and hoarseness; notably, 12 respondents still experienced symptoms after the practicum ended. Elevated formaldehyde concentrations and variation in complaints were influenced by the condition and operation of air-circulation facilities before the practicum began, as well as PPE use, which generally consisted only of medical masks, gloves, and laboratory coats without mandatory eye protection—likely contributing to the predominance of eye irritation. In addition, cadaver specimen type affected formaldehyde levels: the intact respiratory system specimen showed a higher concentration (0.887 ppm) than the basal ganglia organ specimen (0.778 ppm), indicating that intact specimens tended to produce greater formaldehyde exposure.

**Acknowledgements**

The authors express gratitude to Almighty God for His grace and guidance that enabled this study to be completed successfully. The authors also extend sincere appreciation to the Faculty of Medicine, Universitas Kristen Indonesia (UKI) for providing facilities and the opportunity to conduct this research. The authors thank the supervising lecturer(s) for their guidance, direction, and valuable input throughout the writing and completion of the study. Special thanks are also conveyed to the Head of the Anatomy Laboratory and all staff of the UKI Faculty of Medicine Anatomy Laboratory for their assistance in data collection and support during the research process. The authors are grateful to the UKI medical students (Class of 2020) who participated as respondents and completed the questionnaire, enabling the data to be collected properly. Finally, the authors thank all parties who cannot be

mentioned individually for their support, help, and prayers throughout this study. May all contributions and kindness receive the best reward.

**REFERENCES**

[1] Adamović, D., Čepić, Z., Adamović, S., Stošić, M., Obrovski, B., Morača, S., & Vojinović Miloradov, M. (2021). Occupational exposure to formaldehyde and cancer risk assessment in an anatomy laboratory. *International journal of environmental research and public health*, *18*(21), 11198.

[2] Ames, A., Weiler, M., Valigosky, M., Milz, S., & Akbar-Khanzadeh, F. (2021). Personal formaldehyde exposure during the transportation of embalmed cadavers. *Journal of Occupational and Environmental Hygiene*, *18*(7), 289-294.

[3] Arts, J. H., Muijser, H., Kuper, C. F., & Woutersen, R. A. (2008). Setting an indoor air exposure limit for formaldehyde: Factors of concern. *Regulatory Toxicology and Pharmacology*, *52*(2), 189-194.

[4] Arts, J. H., Rennen, M. A., & de Heer, C. (2006). Inhaled formaldehyde: evaluation of sensory irritation in relation to carcinogenicity. *Regulatory Toxicology and Pharmacology*, *44*(2), 144-160.

[5] Cammalleri, V., Pocino, R. N., Marotta, D., Protano, C., Sinibaldi, F., Simonazzi, S., ... & Vitali, M. (2022). Occupational scenarios and exposure assessment to formaldehyde: A systematic review. *Indoor Air*, *32*(1), e12949.

[6] Estai, M., & Bunt, S. (2016). Best teaching practices in anatomy education: A critical review. *Annals of Anatomy-Anatomischer Anzeiger*, *208*, 151-157.

[7] International Agency for Research on Cancer. (2012). Chemical agents and related occupations. *IARC Monogr Eval Carcinog Risks Hum*, *100*(F), 94.

[8] Kang, D. S., Kim, H. S., Jung, J. H., Lee, C. M., Ahn, Y. S., & Seo, Y. R. (2021). Formaldehyde exposure and leukemia risk: a comprehensive review and network-based toxicogenomic approach. *Genes and Environment*, *43*(1), 13.

[9] Leboulanger, N. (2011). First cadaver dissection: Stress, preparation, and emotional experience. *European Annals of Otorhinolaryngology, Head and Neck Diseases*, *128*(4), 175-183.

[10] Nadeak, B., Manik, J., & Destine, D. (2025). The Effectiveness of Managerial Approaches in Promoting Adolescent Healthy Lifestyles: A Qualitative Study at HKBP Gedong Church. *Asian Journal of Basic Science & Research*, *7*(2), 119-128.

[11] Nielsen, G. D., Larsen, S. T., & Wolkoff, P. (2017). Re-evaluation of the WHO (2010) formaldehyde indoor air quality guideline for cancer risk assessment. *Archives of toxicology*, *91*(1), 35-61.

[12] Noisel, N., Bouchard, M., & Carrier, G. (2007). Evaluation of the health impact of lowering the formaldehyde occupational exposure limit for Quebec workers. *Regulatory Toxicology and Pharmacology*, *48*(2), 118-127.

[13] Ozgok, Y. (2015). Planning and designing of an ideal animal laboratory set up for surgical training. *Current Opinion in Urology*, *25*(2), 175-181.

[14] Resdwivani, D. M. (2018). Kadar Benzene Di Udara, Kadar Asam Trans, Trans-Muconic Dalam Urine Dan Gangguan Kesehatan Pekerja SPBU X Di Jakarta Selatan. *Jurnal Kesehatan Lingkungan*, *10*(2), 159-164.

[15] Riederer, B. M. (2014). Plastination and its importance in teaching anatomy. Critical points for long-term preservation of human tissue. *Journal of anatomy*, *224*(3), 309-315.
[16] Ufaira, N. L. A. (2020). *HUBUNGAN KADAR DAN DERAJAT EFEK AKUT PAPARAN GAS FORMALDEHID TERHADAP MAHASISWA PADA SAAT PRAKTIKUM ANATOMI* (Doctoral dissertation, Universitas Andalas).
[17] von Horst, C., von Hagens, R., Sora, C. M., & Henry, R. W. (2019). History and development of plastination techniques. *Anatomia, Histologia, Embryologia*, *48*(6), 512-517.
[18] Yang, X., Zhang, Y. P., Chen, D., Chen, W. G., & Wang, R. (2001). Eye irritation caused by formaldehyde as an indoor air pollution--a controlled human exposure experiment. *Biomedical and Environmental Sciences: BES*, *14*(3), 229-236.


*ISSN 2798-3471 (Cetak)*
*ISSN 2798-3641 (Online)*