

# Formaldehyde Exposure of Medical Students and Instructors and Clinical Symptoms during Gross Anatomy Laboratory in Thammasat University

Kajorn Lakchayapakorn MD\*,  
Pensri Watchalayarn PhD\*\*

\* Department of Preclinical Science, Faculty of Medicine, Thammasat University, Bangkok, Thailand

\*\* Faculty of Public Health, Thammasat University, Bangkok, Thailand

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To study formaldehyde concentrations in the breathing zone and symptoms induced by gaseous formaldehyde exposure of medical students and instructors during gross anatomy laboratory at faculty of Medicine, Thammasat university. Formaldehyde concentrations in the indoor air and breathing zone of medical students were measured during the cadaver dissection. Formaldehyde concentrations in the indoor air and in the breathing zone were ranged from 0.401 to 0.581 ppm (mean  $0.491 \pm 0.090$ ) and from 0.472 to 0.848 ppm (mean  $0.660 \pm 0.188$ ) respectively. The mean of formaldehyde concentrations in the breathing zone of medical students and instructors was significantly higher than the mean of formaldehyde concentration in indoor air ( $p < 0.05$ ). The most symptoms were general fatigue (82.7-87.8%), burning eyes (66.2-85.0%) and burning nose (62.5-81.1%). There was no statistically significant difference in burning eye symptom between contact lenses users and no contact lenses users ( $p > 0.05$ ). Even though formaldehyde concentrations were relatively low, medical students, instructors and cadaver related workers should wear personal protective devices to reduce the effect of gaseous formaldehyde exposure during gross anatomy laboratory or contact cadaver.

**Keywords:** Formaldehyde, Breathing zone, Gross anatomy laboratory

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During an anatomy class, the evaporation of formaldehyde from the cadavers, embalming fluid, could negatively affect medical students and instructors' health. The Ministry of interior of Thailand declared in 1977 about the safety of working environment that formaldehyde concentration for eight hours working could not be over 3 ppm<sup>(1)</sup> while the threshold limit value by the American Conference of Governmental Industrial Hygienists is 0.3 ppm<sup>(2)</sup>. In Japan, the maximum concentration level for working environment is 0.25 ppm<sup>(3)</sup>. Ohmichi K et al<sup>(4)</sup> stated that the indoor formaldehyde concentrations in anatomy laboratory were 0.45, 0.38 and 0.68 ppm for the 4th, 10th and 18th session respectively whereas personal exposure concentrations in the 4th, 10th and 18th session for medical students were 1.02, 1.08 and 0.89 ppm and for

instructors 0.80, 0.45 and 0.51 ppm, respectively. Kurose T et al<sup>(5)</sup> found that formaldehyde concentrations in anatomy laboratory were about 0.25-0.55 ppm as well as formaldehyde concentrations studied by Takayanagi M et al<sup>(6)</sup> ranged from 0.48 to 1.11 ppm during systematic anatomy. Furthermore the indoor formaldehyde concentrations of anatomy class studied in Australia<sup>(7)</sup> were ranged from 0.059 to 0.219 ppm (mean  $0.124 \pm 0.05$  ppm).

Chronic symptoms from formaldehyde exposure are nasal cancer and nasopharyngeal cancer<sup>(8)</sup>. Exposure to formaldehyde concentrations ranging from 0.1 to 5 ppm can cause skin irritation, burning eyes, tearing, rhinorrhea and upper respiratory irritation while exposure 5 to 20 ppm can cause coughing, chest tightening or pain, difficulty in breathing, headache and palpitation as well as exposure 50 to 100 ppm and more can cause pneumonia, pulmonary edema and death<sup>(9-12)</sup>.

The objective of this research is to study formaldehyde concentrations in indoor air and the breathing zone of medical students and instructors and

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**Correspondence to:**

Lakchayapakorn K, Division of anatomy, Department of Preclinical Science, Faculty of Medicine, Thammasat University, Bangkok 12120, Thailand.  
Phone & Fax: 0-2926-9710  
E-mail: [kajorn98@hotmail.com](mailto:kajorn98@hotmail.com)

clinical symptoms during gross anatomy laboratory at Faculty of Medicine, Thammasat University.

## **Material and Method**

### ***Formaldehyde measurement***

The area used for collecting samplings was the gross anatomy laboratory at division of anatomy, Faculty of Medicine, Thammasat University. The two methods used for collecting formaldehyde samplings were;

#### ***Indoor air sampling***

Collect samplings in six spots in laboratory to measure the concentration of formaldehyde in indoor air during three anatomy classes; two samplings per classes, six times in total. Including measuring the formaldehyde concentration in indoor air during the period with no practical activity. The indoor sampling site was placed beside the cadavers with 2 meter far from the cadavers bed as shown in Fig. 1.

#### ***Personal air sampling***

Collect samplings in breathing zone of fifteen medical students. The measuring instruments were attached to the students, which was a foot away from their noses, in order to measure the concentration of formaldehyde that the students inhaled. The personal air samplings were measured six times (Fig. 2).

Formaldehyde was collected by using XAD-2 (2-hydroxymethyl piperidine) sorbent tube connecting to air sampler pump. The sampling flow rate was 100 ml/min for three hours. After samplings, the sampling tubes were sent to analyze in laboratory by gas chromatography with flame ionization detector (GC-FID). The temperature of the laboratory during collecting samplings process were ranged from 25.6 to 30°C

### ***Collecting clinical symptoms induced during formaldehyde exposure by questionnaire***

In questionnaire, there was a statement explained to medical students and instructors about this research and asking them to be volunteers. The questionnaires were handed to voluntary medical students and instructors before they went into gross anatomy laboratory and were collected after they finished the class. This process occurred three times in 2008 semester.

### ***Data Analysis***

Formaldehyde concentrations data were



**Fig. 1** Indoor air sampling



**Fig. 2** Personal air sampling

analyzed with descriptive statistics. The difference of mean of formaldehyde concentrations between indoor air and breathing zone were tested by using Wilcoxon Mann-Whitney method. Furthermore the data from questionnaires were analyzed as percentage of each symptom and were tested to find any relationship of burning eyes or eyes irritations between contact lenses users and no contact lenses users by using Pearson Chi-Square test.

## **Results**

### ***Formaldehyde concentrations in indoor air and in the breathing zone of medical students during the gross anatomy laboratory***

#### ***The mean of formaldehyde concentrations in indoor air***

The formaldehyde concentrations in indoor air during the three classes were ranged from 0.401 to 0.581 ppm (mean  $0.491 \pm 0.090$ ) which can be divided

into followings; the class of thoracic organs system was  $0.440 \pm 0.091$  ppm; the class of abdominal organs system was  $0.559 \pm 0.083$  ppm; the class of brain, nervous and behavior systems was  $0.462 \pm 0.022$  ppm (see Table 1). Formaldehyde concentrations during the period with no practical activity was ranged  $0.381 \pm 0.039$  ppm.

***The mean of formaldehyde concentrations in breathing Zone***

The formaldehyde concentrations in the breathing zone during the three class were ranged from 0.472 to 0.848 ppm (mean  $0.660 \pm 0.188$ ) which can be divided into the followings; the class of thoracic organs system was  $0.595 \pm 0.193$  ppm; the class of abdominal organs system was  $0.693 \pm 0.182$  ppm; the class of brain, nervous and behavior system was  $0.713 \pm 0.170$  ppm (see Table 1).

The different means of formaldehyde concentrations between indoor air and breathing zone were statistically significant (p-value = 0.001).

***Clinical symptoms induced by gaseous formaldehyde General Information***

Allergic history are allergic rhinitis, dermatitis, urticaria, asthma, allergic contact dermatitis and allergic conjunctivitis.

The analyzed data from every class discovered that most of the volunteers were women. 11-20% of the group was contact lenses user, 87-91% of the group was medical student and 30-33% of the group had allergic history as the details show in Table 2.

***Clinical symptoms in each class***

The clinical symptoms discovered among the volunteers were skin irritation, throat irritation,

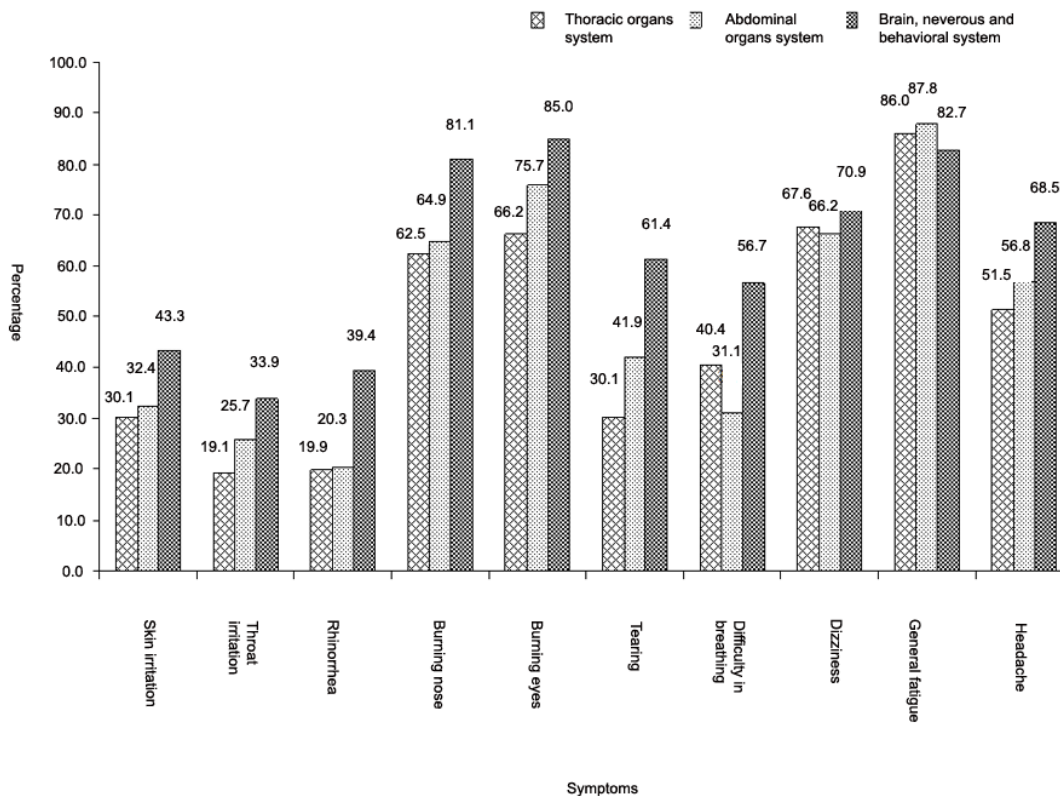
**Table 1.** The mean and standard deviation of formaldehyde concentrations in indoor air and breathing zone of each class

Class	Formaldehyde Concentration, Mean $\pm$ SD (ppm)		p-value*
	Indoor Air (n = 12)	Breathing Zone (n = 30)	
Thoracic organs system	$0.440 \pm 0.091$	$0.595 \pm 0.193$	
Abdominal organs system	$0.559 \pm 0.083$	$0.693 \pm 0.182$	
Brain, nervous and behavioral system	$0.462 \pm 0.022$	$0.713 \pm 0.170$	
Mean	$0.491 \pm 0.090$	$0.660 \pm 0.188$	0.001

\* Statistically analyzed by Wilcoxon Mann-Whitney test

**Table 2.** General information

General Information		Class, n (%)		
		Thoracic Organs System (n = 136)	Abdominal Organs System (n = 74)	Brain, Nervous and Behavioral System (n = 127)
Sex	Male	40 (29.4)	26 (35.1)	44 (34.6)
	Female	96 (70.6)	48 (64.9)	83 (65.4)
Contact lens user	No	115 (84.6)	66 (89.2)	102 (80.3)
	Yes	21 (15.4)	8 (10.8)	25 (19.7)
Status	Medical student	123 (90.4)	64 (86.5)	115 (90.6)
	Instructor	13 (9.6)	10 (13.5)	12 (9.4)
Allergic history	No	91 (66.9)	52 (70.3)	85 (66.9)
	Yes	45 (33.1)	22 (29.7)	42 (33.1)



**Fig. 3** Percentage of clinical symptoms each class

**Table 3.** The relationship of contact lenses usage and burning eyes

Factor	Burning Eyes, n (%)		p-value
	No (n = 83)	Yes (n = 254)	
Contact Lens User	No 71 (85.5)	Yes 212 (83.5)	0.654
	Yes 12 (14.5)	42 (16.5)	

\* Statistically analyzed by Pearson Chi-Square

rhinorrhea, burning nose, burning eyes, tearing, difficulty in breathing, dizziness, general fatigue, and headache. The most common clinical symptom that was discovered was general fatigue, which is 82.7-87.8% of the volunteers. The second one was burning eyes, which is 66.2-85.0% of the volunteers. The third one was burning nose, which is 62.5-81.1% of the volunteers. When considering each class individually, we discovered that the class of abdominal organs system caused 87.8% of volunteers a general fatigue

and the class of thoracic organs system caused 86% of volunteers a general fatigue. The most common symptom for the class of brain, nervous and behavior system was burning eyes, which is 85% of the volunteers. See Fig. 3.

#### ***The relationship between contact lenses usage and burning eyes***

16.5% of medical students and instructors who wore contact lenses had burning eyes. 14.5% of contact lenses users did not have burning eyes. 83.5% of medical students and instructors who was not a contact lenses user had burning eyes. 85.5% of no contact lenses users did not have burning eyes. Please see more details in Table 3.

#### **Discussion**

Formaldehyde concentrations in indoor air during three classes of the gross anatomy laboratory at Thammasat University were ranged from 0.401 to 0.581 ppm (mean  $0.491 \pm 0.090$ ), which is similar to the results of the studies in Japan<sup>(4-6)</sup>. However, formaldehyde concentrations in indoor air during the



period with no practical activity (mean  $0.381 \pm 0.039$ ) were lower than during the period with practical activities (mean  $0.491 \pm 0.090$ ). Comparing with the declaration of the Ministry of Interior<sup>(1)</sup> and the regulation of Australia, the maximum concentrations level set to be 1 ppm<sup>(13)</sup>, formaldehyde concentrations in anatomy laboratory were relatively low but they were slightly high comparing with the American Conference of Governmental Industrial Hygienists (ACGIH) and Japan which the set maximum formaldehyde concentrations level to be 0.3 ppm and 0.25 ppm respectively<sup>(2,3)</sup>. Tepwitoon Thongsri and Surat Petkasem<sup>(9)</sup>, who studied in Thailand, discovered that the gross anatomy laboratory with practical activities with formaldehyde trapping system had the concentrations level ranged from 0.01 to 0.18 ppm (mean 0.07).

Formaldehyde concentrations in breathing zone of medical students and instructors at Thammasat University were ranged from 0.472 to 0.848 ppm (mean  $0.660 \pm 0.188$ ), which is similar to the result in breathing zone of the students from Ohmichi et al, who studied in Japan, which were 1.02, 1.08, and 0.89 ppm and in breathing zone of the instructors were 0.80, 0.45, and 0.51 ppm<sup>(4)</sup>. Formaldehyde concentrations in breathing zone of medical students was statistically significant higher than indoor air ( $p < 0.05$ ) which conform to the study of Ohmichi et al who discovered that the formaldehyde concentrations in breathing zone was 2 to 3 times higher than indoor air of gross anatomy laboratory<sup>(4)</sup>.

The clinical symptoms induced by gaseous formaldehyde exposure of medical students and instructors during working in gross anatomy laboratory at Faculty of Medicine, Thammasat University were skin irritation, throat irritation, rhinorrhea, burning nose, burning eyes, tearing, difficulty in breathing, dizziness, general fatigue and headache. The most common clinical symptom was general fatigue, which is 82.7-87.8% of the volunteers. The second one was burning eyes, which is 66.2-85.0% of the volunteers. The third one was burning nose, which is 62.5-81.1% of the volunteers. These results conformed to many studies<sup>(7,14,15,17)</sup> which reported that the students and instructors had burning eyes, rhinorrhea, general fatigue and skin irritation. Ikaharu et al<sup>(18)</sup> discovered that using deodorant and wearing activated carbon mask could decrease the formaldehyde concentrations in indoor air and breathing zone, including decreasing the clinical symptoms induced by gaseous formaldehyde exposure in medical students.

This research indicated that there were no statistically significant difference in burning eye symptoms between contact lenses users and no contact lenses users ( $p > 0.05$ ), which is different from the study of Tanaka et al<sup>(16)</sup> who discovered that ocular discomfort was found significantly higher in the contact lenses users compared to the spectacle users or normal eye sight group.

### Conclusion

Formaldehyde concentrations in the indoor air and breathing zone were  $0.491 \pm 0.090$  ppm and  $0.660 \pm 0.188$  ppm, which are relatively low. The clinical symptoms such as skin irritation, throat irritation, rhinorrhea, burning nose, burning eyes, tearing, difficulty in breathing, dizziness, general fatigue and headache could be found under the concentrations ranged from 5 to 20 ppm. This information could be used as a fundamental data for planning to protect medical students, instructors and cadaver related workers from the toxicity of formaldehyde, improving ventilation system and improving an effective formaldehyde treatment system. Medical students, instructors and cadavers related workers should wear personal protective devices such as activated carbon mask, goggle and rubber glove during working in gross anatomy laboratory.

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การสัมผัสฟอร์มาลดีไฮด์ของนักศึกษาแพทย์และอาจารย์ผู้สอน และอาการที่เกิดขึ้นระหว่างการเรียน  
ปฏิบัติการมหากายวิภาคที่มหาวิทยาลัยธรรมศาสตร์

ขจร ลักษณะชยปรกรณ์, เพ็ญศรี วัจฉลนะญาณ

เพื่อศึกษาความเข้มข้นของฟอร์มาลดีไฮด์ในบรรยากาศแบบพื้นที่การหายใจ และอาการที่เกิดขึ้นจากการสัมผัสไอระเหยของฟอร์มาลดีไฮด์ของนักศึกษาแพทย์และอาจารย์ผู้สอนระหว่างการเรียนปฏิบัติการมหากายวิภาค ที่สาขากายวิภาคศาสตร์ คณะแพทยศาสตร์ มหาวิทยาลัยธรรมศาสตร์ ตรวจวัดความเข้มข้นของฟอร์มาลดีไฮด์ในบรรยากาศแบบพื้นที่ทั่วไปในห้องปฏิบัติการและแบบพื้นที่การหายใจของนักศึกษาแพทย์ระหว่างการผ่าร่างอาจารย์ใหญ่ ความเข้มข้นของฟอร์มาลดีไฮด์ในบรรยากาศแบบพื้นที่ทั่วไปและแบบพื้นที่การหายใจมีค่าระหว่าง 0.401-0.581 ppm ( $0.491 \pm 0.090$ ) และ 0.472-0.848 ppm ( $0.660 \pm 0.188$ ) ตามลำดับ ค่าเฉลี่ยของความเข้มข้นของฟอร์มาลดีไฮด์ในบรรยากาศแบบพื้นที่การหายใจของนักศึกษาแพทย์และอาจารย์ผู้สอนมีค่าสูงกว่าค่าเฉลี่ยของความเข้มข้นของฟอร์มาลดีไฮด์ในบรรยากาศแบบพื้นที่ทั่วไปอย่างมีนัยสำคัญทางสถิติ ( $p < 0.05$ ) อาการที่พบมากที่สุดคือเหนื่อยล้าคิดเป็นร้อยละ 82.7-87.8 รองลงมาคือแสบตาหรือระคายเคืองตาคิดเป็นร้อยละ 66.2-85.0 และแสบจมูกคิดเป็นร้อยละ 62.5-81.1 อาการแสบตาหรือระคายเคืองตาระหว่างกลุ่มที่ใส่เลนส์สัมผัสและกลุ่มที่ไม่ใส่เลนส์สัมผัสไม่แตกต่างกันอย่างมีนัยสำคัญทางสถิติ ( $p > 0.05$ ) ถึงแม้ว่าความเข้มข้นของฟอร์มาลดีไฮด์มีค่าค่อนข้างต่ำ นักศึกษา อาจารย์ผู้สอนและเจ้าหน้าที่ที่ปฏิบัติงานกับร่างอาจารย์ใหญ่ควรใช้อุปกรณ์ป้องกันเพื่อลดผลกระทบจากการสัมผัสไอระเหยของฟอร์มาลดีไฮด์ระหว่างที่เรียนปฏิบัติการมหากายวิภาคหรือสัมผัสกับร่างอาจารย์ใหญ่

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