The Evaluation of Formaldehyde Exposure in the Anatomy Laboratories and the Preventive Measures

Anatomi Laboratuvarlarında Formaldehit Maruziyeti ve Koruyucu Önlemlerin Değerlendirilmesi

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ABSTRACT

Objective: Our aim is to evaluate the studies about formaldehyde exposure in anatomy laboratories at faculties of medicine all over the world reported from 2000 to 2013.
Materials and Methods: In this research, formaldehyde exposure of medical students and researchers in the anatomy laboratories of faculties of medicine studies, which were reported in Pubmed database from 2000 to 2013, were reviewed and classified clinical symptoms, environmental monitoring and preventive measures.
Results: There are 27 studies on formaldehyde exposure from anatomy laboratories of various faculties of medicine 15 (55.6%) of which are clinical symptom studies whereas 12 (44.4%) are environmental monitoring of formaldehyde exposure.
Conclusion: Considering the fact that lower levels of exposure to formaldehyde is associated with cytogenetic changes in epithelial cells of the nasal region, long-term exposure to formaldehyde in the anatomy laboratories poses risks of nasopharynx and nasal cavity cancers. Medical students and instructors working in anatomy laboratories should take concrete measures to reduce exposure to formaldehyde.

Key Words: Formaldehyde exposure, anatomy laboratory, clinic symptoms, environmental monitoring, preventive measures

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ÖZET

Amaç: Bu çalışmanın amacı 2000-2013 yılları arasında dünyada tıp fakültesi öğrencileri üzerinde yapılmış formaldehit maruziyetiyle ilgili çalışmaların incelenmesidir.
Yöntem: Bu çalışmada, tıp fakültlerinin anatomi laborauvarlarında öğrenciler ve araştırmacıların formaldehit maruziyetiyle ilgli Pubmed veritabanında 2000-2013 yılları arasında yayımlanmış çalışmalar incelenmiş ve çalışmalar klinik semptomlar, formaldehit maruziyetinin çevresel izlenmesi ve koruyucu önlemler olarak sınıfandırılmıştır.
Bulgular: Çeşitli üniversitelerin tıp fakültelerinde yapılan 27 formaldehit maruziyeti çalışmasının 15'i (%55.6) klinik semptom çalışması olup, 12'si (%44.4) çevresel etki ve önleyici eylemlerle ilgilidir.
Sonuç: Düşük formaldehit maruziyeti, nasal bölgedeki epitel hücrelerinde sitogenetik değişikliklere neden olurken, anatomi laboratuvarlarındaki yüksek formaldehit maruziyeti, nazofarenks ve nazal kavite kanserlerine neden olabilemektedir. Bu nedenle anaotmi laboratuvarlarında çalışan tıp fakültesi öğrencileri ve eğitmenlerinin formaldehite karşı önlem almaları gerekmektedir.

Anahtar Sözcükler: Formaldehit maruziyeti, anatomi laboratuvarı, klinik semptomlar, çevresel izleme, koruyucu önlemler

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INTRODUCTION

Formaldehyde (FA), which is said to be a carcinogenic agent, is commonly used in anatomy laboratories (1) as formalin an aqueous solution of formaldehyde (FA). It is known that at room temperature, formaldehyde is a colorless gas; its odor can be detected at concentrations of 0.5-1.0 parts formaldehyde per million parts of air (ppm) (2)**.** FA constitutes an occupational risk for anatomy instructors, whose jobs entail classroom and laboratory instruction, advising students, administrative activities and research. Moreover, students working with formaldehyde-preserved tissues and instructors demonstrating or observing students as they perform specific dissection or prosection activities are under the risk of exposure to formaldehyde during anatomy laboratory sessions (3).

In laboratories where tissues are preserved in formaldehyde-based solutions, routes by which formaldehyde exposure may occur include (a) absorption by the respiratory tract via inhalation through the nose or mouth, (b) absorption through the skin following dermal contact, (c) absorption through the digestive tract via ingestion, including splashes into the mouth or by eating or smoking using the hands or (d) injection. The risk of inhalation exposure is particularly high due to the close proximity of embalmed tissue to the breathing zones of the students and instructors (3).

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Acute exposures of FA are associated with irritation of the eyes, nose, throat and respiratory tract. Prolonged exposure has been associated with mild neurological symptoms, including headaches and dizziness, and genetic damage. The carcinogenicity classification of formaldehyde is based largely on carcinogenicity in the human nasal tract and genotoxicity in human lung and nasal epithelial cells and rodent lung epithelial cells (4,5).

Our aim is to evaluate the studies about formaldahyde exposure in anatomy laboratories at faculties of medicine all over the world reported from 2000 to 2013.

MATERIALS AND METHODS

The online digital archives PubMed, database year from 2000 to 2013, were searched for the keywords "formaldehyde exposure" and "anatomy laboratories". The formaldehyde exposure of medical students and researcher in the anatomy laboratories at faculty of medicine were selected and classified in 2 categories: clinical symptom studies, environmental monitoring and preventive measures studies.

Clinical symptom studies focus on formaldehyde concentrations in the air of the anatomy laboratories, skin exposures and effects on pulmonary functions during cadaver dissection exercises.

Environmental monitoring and preventive measures studies focus on, reducing the level of formaldehyde exposure in the air anatomy laboratories during the cadaver dissection exercises.

RESULTS

There are a total of 27 studies on formaldehyde exposure from anatomy laboratories of various faculties of medicine of which 15 (55.6%) are clinical symptom studies whereas 12 (44.4%) are environmental monitoring of formaldehyde exposure. 7 (46.6%) of the clinical symptom studies focus on formaldehyde concentrations in the air and clinical symptoms, 4 (26.6%) studies concentrate on skin exposures and 4 (26.6 %) refer to pulmonary functions in the anatomy laboratories during cadaver dissection exercises.

Clinical Symptoms

Formaldehyde concentrations in the air and clinic symptoms

It must be considered that formaldehyde solution is a hazardous compound and its vapor is toxic (6). In the anatomical context of the dissection laboratory, the adverse effects of formaldehyde have been studied (7). Formaldehyde may function as an irritant and cause mild eye and mucous membrane complaints at air levels of 0.5–2 ppm (8). Different studies related to formaldehyde concentrations in the air and clinical symptoms are presented in Table 1.

Table1. Clinical symptoms studies to formaldehyde exposure of medical students and instructors during anatomy laboratory

Authors and publication years	Type of exposure	Duration of exposure	Exposure Formaldehyde concentration (ppm)	Clinic symptoms
Mirabelli et al. (2011) (3)	Inhalation exposure	Autopsy was being performed Samples collected in the breathing zones of anatomy students	1.70-2.44 ppm 1.79-3.78 ppm	Acute exposures; eyes, nose, throat and respiratory tract Long term exposures carcinogenicity in the human nasal mucosa Genotoxicity in human lung and nasal epithelial
Lakchayapakorn and Watchalayarn (2010) (9)	Inhalation exposure	During gross anatomy laboratory or contact cadaver	Indoor air: 0.401-0.581 ppm breathing zone: 0.472-0.848 ppm	General fatigue, burning eyes, burning nose
Vimercati et. al. (2010) (10)	Inhalation exposure	Autopsy room	All the personal exposure data obtained exceeded the NIOSH TLV-TWA: 0.02 mg/m(3)	Irritative effects in more than 50% of the workers enrolled, increasing the risk of injuries.
Kunugita et al. (2004) (11)	Inhalation exposure	Before starting the anatomy dissecting course After beginning the dissecting course	20-93 ppb 1012-1380 ppb	- "Unusual thirst", "burning eyes", "itchy eyes", "bad feeling", "fatigue", etc. in comparison with the non-exposed period.
Tanaka et al. (2003) (12)	Inhalation exposure	3 months during the anatomy dissection exercise	0.62 ppm- 0.11 ppm	Irritation of eyes, nose, throat, airways, skin, and headache during the course.
Onyije and Avwioro (2012) (13)	Inhalation exposure	Gross anatomy dissection laboratory 6 hr/wk	-	of 75 students, 58 (77%) were strongly affected by unpleasant smell of formaldehyde. Runny or congested nose and "redness of the eyes. Skin-related diseases" was identified.
Mori M et al. (2013) (14)	Inhalation exposure	Gross anatomy dissection course	-	During the course were eye fatigue, runny nose, and dry eyes. Most symptom after the course was eye fatigue.

Formaldehyde levels in anatomy laboratories have been reported from air samples collected in the ambient airspace and breathing zones of individuals performing dissections. Air sample concentrations ranging from 0.2 to 2.4 ppm were reported at times when an autopsy was being performed, and from 1.70 to 2.44 ppm when samples were collected from an anatomy laboratory classroom with opened windows but no mechanical ventilation system. Samples collected in the breathing zones of anatomy students have been reported as high as 1.79 to3.78 ppm. Acute exposures cause irritation of the eyes, skin and respiratory tract and sensitisation of the respiratory tract, and swallowing (3).

Formaldehyde concentrations in indoor anatomy laboratories in the indoor air and breathing zone of medical students during the cadaver dissection were measured. Formaldehyde concentrations in indoor air and breathing zone ranged from 0.401 to 0.581 ppm and from 0.472 to 0.848 ppm respectively. Symptoms were general fatigue (82.7-87.8%), burning eyes (66.2-85.0%) and burning nose (62.5-81.1%) (9).

When the personnel, which worked in an autopsy room are studied, irritative effects of formaldehyde in more than 50% of the workers enrolled, increasing the risk of injuries (10).In the anatomy laboratory before starting the anatomy dissecting course 20-93 ppb, highest geometric mean formaldehyde concentrations were 1012-1380 ppb after beginning the dissecting. Significant differences were observed during the exposed period. These symptoms "unusual thirst", "burning eyes", "itchy eyes", "bad feeling", "fatigue", etc. in comparison with the non-exposed period (11).

In the dissection room of anatomy laboratories, formaldehyde concentrations were found to be 0.62 ppm 10 minutes after starting of the

class. Formaldehyde-related symptoms were observed in 59% of students. They had experienced symptoms of irritation of eyes, nose, throat, airways, skin, and headache during the dissection exercise (12).

Of the students who are exposured to formaldehyde in gross anatomy dissection laboratory, the average duration of exposure for each student in the dissection hall was 6 hr/wk. Of 75 students, 58 (77%) were strongly affected by unpleasant smell of formaldehyde. It was followed by "runny or congested nose" and "redness of the eyes." "Skin-related diseases" was identified as the least ranked effect of formaldehyde (13).

The prevalence of most subjective symptoms was lower 6 months after the course than during the course. The major symptoms experienced during the course were eye fatigue, runny nose, and dry eyes. The most common symptom 6 months after the course was eye fatigue (14).

Skin exposure to formaldehyde in the anatomy laboratory during the cadaver dissection exercise

Acute and chronic skin exposure to formaldehyde may produce irritation and peeling, as well as an allergic contact dermatitis (8**).** Different studies related to skin exposure to formaldehyde are presented in Table 2.

Table 2. Skin exposure to formaldehyde in the anatomy laboratory during the cadaver dissection exercise

Authors and publication years	Type of exposure	Duration of exposure	Exposure Formaldehyde concentration (ppm)	Clinic symptoms
Suruda (2003) (8)	Skin exposure	-	At air levels of 0.5–2 ppm	Formaldehyde may function as an irritant and peeling, as well as an allergic contact dermatitis
Takahashi et al. (2007) (15)	Skin exposure	Begining and end of the human anatomy laboratory course Finished the course 2- 4 years patch test	-	Skin irritation,
Mizuki and Tsuda (2001) (16)	Skin exposure	During the anatomy dissection course	-	Skin irritation, Chemical sensitivity
Wantke et al. (2000) (17)	Skin exposure	Before and during dissecting	Indoor formaldehyd was 0.265 +/- 0.07 mg/m3	Four students developed specific IgE against formaldehyde-albumin all four also had spesific

Formaldehyde may function as an irritant and peeling, as well as an allergic contact dermatitis at air levels of 0.5–2 ppm (8).Clinical symptoms and skin test reactions were examined in medical students exposed to formaldehyde in the anatomy laboratory. The frequencies of skin irritation, eye soreness, lacrimation, eye fatigue, rhinorrhea, throat irritation, general fatigue and mood swings increased after repeated exposure (15). In the anatomy laboratory during dissection exercise, the relationship between atopic factors and physical symptoms induced by formaldehyde exposure were investigated. FA exposure may exacerbate basic allergic symptoms, and moreover that people with chemical sensitivity demonstrated worse symptoms following FA exposure (16).

The exposure to formaldehyde and phenol were studied during a dissecting exercise in the anatomy laboratory: sensitizing potency of formaldehyde in medical students. Formaldehydeexposure during dissecting exercise may induce specific IgE, but not IgG, against formaldehyde-albumin. Sensitization did not correlate with symptoms (17).

Pulmonary functions exposure to formaldehyde in the anatomy laboratory during the cadaver dissection exercise

Acute exposure to formaldehyde is also associated with irritation respiratory tract in the anatomy laboratory during the cadaver dissection exercise. Different studies related to pulmonary functions to formaldehyde exposure are presented in Table 3.

Table 3. Pulmonary functions exposure to formaldehyde in the anatomy laboratory during the cadaver dissection exercise

Authors and publication years	Type of exposure	Duration of exposure	Exposure Formaldehyde concentration (ppm)	Clinic symptoms
Khaliq and Tripathi (2009) (18)	Inhalation exposure	After first dissection class (2 hrs.), within 24 hrs	-	Acut exposure of formalin FVC decreased in students FVC reverted back to normal lung function parameters remained unchanged some mild transient bronchoconstriction
Ostojić et al. (2006) (19)	Inhalation exposure	Pathoanatomic laboratory for at least 4 years daily exposure 8 +/- 1 hours	-	Blood volume of pulmonary capillaries (Vc') which was significantly larger in a group exposed to formaldehyde fumes
Kriebel et al. (2001) (20)	Inhalation exposure	A gros anatomy laboratory 2.5 hr/wk for 14 wk	1.1 ppm	Exposure during the previous 2.5 hr reduced peak expiratory flow by -1.0% per ppm
Sakamoto and Miyake M. (2010) (21)	Inhalation exposure	-	-	Asthma and 'sick house syndrome' The ability of low concentrations of **f**ormaldehyde to trigger mechanisms contributing

Acute effects of formalin on pulmonary functions were investigated in the anatomy laboratory. Forced vital capacity (FVC) decreased in subjects after their first exposure While other lung function parameters remained unchanged, indicating some mild transient bronchoconstriction on acute exposure to formalin (18).

Pulmonary function was shown in persons who are professionally exposed to formaldehyde and examined long-term effects of occupational exposure to formaldehyde fumes on lung function. The only parameter differing in two groups was blood volume of pulmonary capillaries (Vc') which was significantly larger in a group exposed to formaldehyde fumes (19).

When the short-term effects and irritant symptoms of formaldehyde on peak expiratory flow values were examined, the short-term exposure effect was diminished during the first 14 wk, suggesting at least partial acclimatization. Symptom reporting was also associated with exposure during the previous 2.5 hr, and similar evidence of acclimatization was observed (20).

In the other study, researchers have shown that associated with asthma and 'sick house syndrome' (health disturbances induced by chemical contaminants in domestic environments). The ability of low concentrations of formaldehyde to trigger mechanisms contributing to them is still debated (21).

Environmental Monitoring and Preventive Measures

Reducing the level of formaldehyde exposure in the anatomy laboratory during the cadaver dissection exercise

Formaldehyde is a highly reactive aldehyde gas formed by oxidation. Formaldehyde gas is also created from the combustion of organic material and can be produced secondarily in air from photochemical reactions involving virtually all classes of hydrocarbon pollutants(6). Different studies related to environmental monitoring and preventive measures to formaldehyde exposure are presented in Table 4.

Table 4. Environmental monitoring and preventive measures studies to formaldehyde exposure of medical students and instructors during anatomy laboratory.

Authors and publication years	Type of exposure	Duration of exposure (min or h)	Exposure Formaldehyde concentration (ppm)	Preventive measures
Uchiyama (2010) (22)	Inhalation	During anatomy practice	0.05 ppm	0.1 ppm or less formaldehyde concentration
Vohra (2011) (23)	Inhalation	Gross anatomy dissecting room	-	The personal exposure level of FA was higher than the indoor concentration The personal exposure levels of instructors were higher than that of the students.
Kikuta (2010) (24)	Inhalation	During a gross anatomy dissection course	0.066 ppm	They were developed a local ventilation apparatus that can be attached to an ordinary dissection table
Ohmichi (2007) (25)	Inhalation	During a gross anatomy laboratory	0.026, 0.015 and 0.020 ppm 0.458, 0.271 and 0.336 ppm 0.084, 0.057 and 0.101ppm	The cadaver was not dissected or opened the room at location A, B, C. When the cadavers bag totally open and FA had spread into the room at location A, B, C. When they used the highly efficient photocatalyctic device at location A, B, C.
Whitehead and Savoia (2008) (26)	Inhalation	During a gross anatomy laboratory	-	InfuTrace and Perfect Solution using as cadaver fixation. Their effectiveness in reducing ambient formaldehyde levels
Yamato (2005) (27)	Inhalation	Gross anatomy laboratory dissection course	50 ppb 405 ppb 480 ppb	Outside of the hood (breating zone of students sitting closed to the dissection table) Inside of the hood while the local ventilation was disconnect while the local ventilation was disconnect
Proietti (2002) (28)	Inhalation	In pathological anatomy laboratory	1.81 ppm, 3.78 ppm, 8.3.05 ppm	by an infrared gas analyser
Keil CB (2001) (29)	Inhalation	A gros anatomy laboratory	0.635 to 1.82 mg/m3 95.2-274 mg/min	Average daily area concentrations in the laboratory The daily average formaldehyde emission rate from all sources in the laboratory.
Kurose (2004) (30)	Inhalation	During a gross anatomy course	0.25-0.55 ppm	Formaldehyde concentrations 0.12 +/- 0.09% (n=29) the lung, FA concentration 0.12 +/- 0.09% (n=29) the liver, FA concntration 0.11 +/- 0.09% (n=30) the brachioradialis muscle
Ohmichi (2005) (31)	Inhalation	Gross anatomy laboratory total over a period of 10 weeks	2 to 3-fold higher than the mean indoor FA concentration	Risk assessment of FA in gros anatomy laboratory
Ahmed (2011) (32)	Inhalation	Anatomy laboratory, during covered cadaver	FA concentration was 0.100 ppm with a range of 0.095-0.105 ppm	Standard established by USA-NIOSH which is 0.1 ppm, American Conference of Governmental Industrial Hygienists which is 0.3 ppm.
Takayanagi (2007) (33)	Inhalation	During systematic anatomy During neuroanatomy	Breathing zone: from 0.24 to 3.04 ppm Indoor air: from 048 to 1.11 ppm Breathing zone from 0.72 to 1.60 Indoor air: from 0.21 to 0.23 ppm	-

It is preferable that the exposure concentration of formaldehyde to the medical students is 0.1 ppm or less during anatomy practice because formaldehyde is an irritant gas and a sensitizing potential, and is also a human carcinogen (22).

The gross anatomy laboratory at college of medicine was observed for indoor FA concentration and the personal exposure levels of instructors and the medical students during the 4th, 10th and 14th weeks of the dissection sessions. The personal exposure level of FA was higher than the indoor concentration, and the personal exposure levels of instructors were higher than that of the students. The concentration of FA was also higher in the center of the room than the corners and near the doors.The instructors and students are exposed to the higher concentration of FA than the general population (23).

Researchers were developed a local ventilation apparatus that can be attached to an ordinary dissection table. Adopting the local ventilation system reduced the students' and researchers' exposure to formaldehyde (24).

They used the highly efficient photocatalyctic device the FA concentrations were decreased to 0.084, 0.057 and 0.101 locations (A) 30 cm above the cadaver on the special dissection table, (B) 30 cm above the flor under the table by the exhaust outlet, and (C) at the corner of the room respectively (25).

Researchers evaluated two chemicals, InfuTrace and Perfect Solution, for their effectiveness in reducing ambient formaldehyde levels (26).

They have examined that novel ventilation system to reduce the levels of formaldehyde exposure in the anatomy laboratory during the cadaver dissection exercise. The average formaldehyde concentration outside of the breathing zone of students sitting closet to the dissection table was 50 ppb (1) and inside of the breathing zone of students sitting closet to the dissection table was 405 ppb (2) (27). Instrumental approach based on environmental evaluation of 10% formaldehyde used in pathological anatomy, by an infrared gas analyser was investigated. Different settings of 1.81 ppm, 3.78 ppm, 8.3.05 ppm were found (28).

Evaporation of formaldehyde from cadavers in anatomy laboratories can produce high exposures among students and instructors. Average daily area concentrations in the laboratory were 0.635 to 1.82 mg/m3 in gross anatomy laboratory. The daily average formaldehyde emission rate from all sources in the laboratory ranged from 95.2-274 mg/min over the course of the study (29).

The formaldehyde concentrations varied in different tissues: 0.12 +/- 0.09%; the liver, 0.12 +/- 0.09%; and the brachioradialis muscle, 0.11 +/- 0.09%. It is conceivable that relatively low formaldehyde levels in the air result from low formaldehyde concentrations in cadavers (30). Formaldehyde exposures in 4th, 10th and 18th sessions of 20 laboratory sessions were examined. The study revealed that, if a person is close to the cadavers during the anatomy laboratory, personal exposure level is possibly 2 to 3-fold higher than the mean indoor FA concentration. This should be considered in the risk assessment of FA in anatomy laboratories (31).

Air samples were collected and analyzed for formaldehyde using National Institute for Occupational Safety and Health (NIOSH) method 3500. For the anatomy laboratory and in the presence of the covered cadaver, the mean concentration of formaldehyde was found to be 0.100 ppm with a range of 0.095-0.105ppm (32)**.**

During the anatomy laboratories, formadehyde concentrations in the breathing zone ranged from 0.24 to 3.04 ppm and during the neuroanatomy labs, from 0.72 to 1.60 ppm and FA concentration ranged from 048 to 1.11 ppm and from 0.21 to 0.23 ppm (33)**.**

DISCUSSION

Cadavers for anatomy laboratories are usually prepared by using embalming fluid which contains formaldehyde (FA) as a principal component. During the process of dissection, FA vapors are emitted from the cadavers, resulting in the exposure of medical students and their instructors to potentially dangerous levels of FA in the laboratory. The American Conference of Governmental Industrial Hygienists (ACGIH) has set a ceiling limit for FA at 0.3 ppm (34)**.** In Japan, the Ministry of Health, Labour and Welfare (MHLW) has set an air quality guideline defining two limit values for environmental exposure to FA: 0.08 ppm as an average for general workplaces and 0.25 ppm for specific workplaces such as an FA factory (MHLW 2002) (35).

European Commission reported that setting air exposure limit for formaldehyde: factors of concern. Not more than 1 microg/m^3 (0.8 ppb) formaldehyde level is advised (36).

Selected studies have shown that the levels of airbone FA in anatomy laboratories exceed recommended exposure criteria 0.05 ppm limit **(**3, 9, 10, 11, 12, 19, 23, 25, 26, 27, 28, 29, 31, 32, 33). These are primarily caused by evaporation of formaldehyde used for the preservation of tissues and specimens.

Previously published data have shown clinical symptoms formaldehyde exposure of medical students and instructors in the anatomy laboratory (3, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 30, 31).

Acute exposures are associated with irritation of the eyes, nose, throat, respiratory tract and skin irritation following dermal contact. These symptoms may occur following exposures at concentrations lower than those detectable by the odour of formaldehyde (2, 4)**.** The most common complaints were nasal irritation, breathing difficulties, and skin irritation (James and Bedino 2004) on the other hand (Onyije and Avwioro 2012) study's skin-related diseases were weakly affected to formaldehyde exposure (37,13).

Prolonged exposure has also been associated with mild neurological symptoms, including headaches and dizziness, and genetic damage (4,5)**.** Inhaled formaldehyde is classified as a known human and animal carcinogen, causing nasopharyngeal cancer. Lu K et al (2010) have shown that in their study provides strong evidence supporting a genotoxic and cytotoxic mode of action for the carcinogenesis of inhaled formaldehyde in respiratory nasal epithelium(38). Formaldehyde may cause cytogenetic damage in buccal cells and that use of exfoliated buccal cells seems to be appropriate to measure exposure to organic solvents such as formaldehyde (39).

James and Bedino (2004) have shown that students were exposed to 5PPM- 1PPM formaldehyde 3 hours, 1 day per week for 10 weeks fundamental and observable mutative effects noted in the nasal/buccal tissues and significant changes in blood lymphocytes, both indicative of significant formaldehyde-induced changes. A possible causal role for formaldehyde may be considered likely for cancer of the nasopharynx and the nasal cavities in humans. Low level exposure to formaldehyde is associated with cytogenetic changes in epithelial cells of the nasal region and that nasal mucosa cells exposed through respiration is an important target of formaldehyde-induced genotoxic effects (40). Souza and Devi (2013) have shown that thirty male anatomy laboratory workers from various medical colleges involved with storing specimens and embalming were included in the study highlights significant DNA damage used the cytokinesis blocked micronucleus assay (CBMN) in humans exposed to FA. Mori et al. (2012) investigated to examine the effect of large-scale repair work on indoor formaldehyde (FA) levels and subjective symptoms in medical students during a gross anatomy dissection course. The mean indoor FA levels before and after repair work were 1.22 ppm and 0.14 ppm, respectively. The mean indoor FA level significantly decreased after repair work. The mean indoor FA levels and prevalences of subjective symptoms decreased after the repair work. They have to continuously monitor indoor FA levels, carry out private countermeasures to minimize exposure to FA, and maintain equipment for ventilation to be able to conduct practice in a comfortable environment (41)**.**

CONCLUSION

Acute exposures to formaldehyde are associated with irritation of the eyes, nose, throat and respiratory tract whereas prolonged exposure has been associated with mild neurological symptoms, including headaches and dizziness, and genetic damage.

Considering the fact that low levels of exposure to formaldehyde is associated with cytogenetic changes in epithelial cells of the nasal region, long-term exposure in anatomy laboratories poses risks of nasopharynx and nasal cavity cancers.

Anatomy instructors can be affected by both acute and long-term exposures and the extent to which they are protected by workplace regulations is unknown (3)**.** During anatomy laboratory sessions, students working with formaldehyde-preserved tissues and instructors demonstrating or observing students as they perform specific dissection or prosection activities are under risk of exposure to formaldehyde (1).

As a preventative measure, educational programs should inform instructors and students about the potential health effects of formaldehyde exposure and other laboratory hazards. Moreoever, anatomy laboratories may increase the use of personal protective equipment (PPE) and improve laboratory ventilation and exhaust systems are needed (42). The appropriate use of effective PPE and ventilation equipment reduces the movement of formaldehyde into the body. To minimize the amount of formaldehyde released into the ambient air reduce exposures not only for students and instructors, but also for custodial staff, maintenance technicians, laboratory aides and others who enter the laboratory for any duration of time**.** Such measures include the replacement of some preserved cadaver dissection lectures with technology-based lectures and substitution of the formaldehyde solution used to preserve cadavers an alternative (3). There is likely to be little support for eliminating cadaver dissection from the curriculum, but students and medical professionals largely agree that both computer-aided instruction and cadaver dissection are important components of the education of healthcare trainees**.**

Conflict of interest

No conflict of interest was declared by the authors

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