

# Irritating Effects of Exposure to Formaldehyde in User Students of the Human Anatomy Laboratory

**ORIGINAL**

Jalles Dantas de Lucena<sup>1</sup>, Helson Freitas da Silveira<sup>1</sup>,  
Livia Santiago de Paula<sup>2</sup>, Howard Lopes Ribeiro Junior<sup>2</sup>,  
Osvaldo Pereira da Costa Sobrinho<sup>2</sup>,  
Katarina Maria Brasileiro Leal<sup>2</sup>, Nathan Andrade Verissimo<sup>2</sup>,  
Roberta Silva Pessoa<sup>2</sup>, Ariel Gustavo Scafuri<sup>1,2</sup>,  
João Erivan Façanha Barreto<sup>2</sup>,  
Antônio Jorge Santos Cerqueira<sup>4</sup>, Delane Viana Gondim<sup>1,2</sup>,  
Roberta Oliveira da Costa<sup>1</sup>, Deiziane Viana da Silva Costa<sup>1</sup>,  
Gilberto Santos Cerqueira<sup>1,3</sup>

- 1 Post-Graduate Program in Morphofunctional Sciences, Federal University of Ceara, Fortaleza, Ceara, Brazil.
- 2 Department of Morphology, Federal University of Ceara, Fortaleza, Ceara, Brazil.
- 3 Biotechnology and Biodiversity Center Research, BIOTEC, Postgraduate Program in Biotechnology, Federal University of Piaui, Parnaiba, Piaui, Brazil.
- 4 College Integrates da Bahia, Salvador, Bahia, Brazil.

## Abstract

Formaldehyde (FA) is commonly used in cadaver fixation for years. FA vapors are released during the dissection process and macroscopic study of preserved anatomical pieces, raising their concentration in the Anatomy laboratory, causing greater exposure for students and teachers. Therefore, the objective of this study was to investigate toxic reactions in 37 students, through a questionnaire, produced by exposure to FA used for preservation of cadaveric material used in Anatomy, Morphofunctional Department, Faculdades Integradas de Patos (FIP), Brazil. Of the 37 interviewees, 26 (70.3%) were affected by the unpleasant and irritating smell of FA, 10 (27%) had no problems, and 1 (2.7%) did not tolerate an irritation produced by FA, not participating in the laboratory practical classes. Exposure to FA was followed by several symptoms: excessive lacrimation (54%), itchy eyes (48.5%), redness of the eyes (40.6%), coryza or congested nose (35.2%) and respiratory distress (29.7%), with persistent symptoms during the permanence in the laboratory for 32.5% of the students. All students wear a lab coat for individual protection. However, only 8% used mascara and did not wear glasses, increasing the risk of contamination. Medical schools should encourage the use of Personal Protective Equipment (PPE) for the manipulation of FA, ensuring the protection of students and teachers in the Anatomy laboratory. Besides finding alternatives for the replacement of FA in the conservation of corpses.

## Contact information:

**Gilberto Santos Cerqueira.**

**Address:** Rua Delmiro de Farias, s/n.  
Campus Porangabussu/CE, Brazil.

CEP: 60.6442-056

**Tel:** +55 (85) 3366-8497

 [giufarmacia@hotmail.com](mailto:giufarmacia@hotmail.com)

## Keywords

Anatomy; Cancer;  
Formaldehyde; Students;  
Anatomy Laboratory.

## Introduction

Formaldehyde (FA) is a harmful chemical compound used in a large number of industrial activities and found in many consumer products brackets [1, 2, 3]. It is also widely used in the embalming and preserving fluid of corpses, ensuring the preservation and disinfection of anatomical pieces used in Anatomy classes [4-7]. The International Agency for Research on Cancer (IARC) has classified FA as a carcinogenic agent for humans (Group 1), based on epidemiological and toxicological evidence that its exposure causes nasopharyngeal cancer in humans [8]. Therefore, requiring safe practices in the handling of FA, seeking to minimize the harmful effects of their exposure.

Formaldehyde is a human leukemic agent. Since there is a latency period between initial FA and the development of leukemia, the subsequent impact of FA on hematopoietic stem or progenitor cells in post-exposure stage is crucial for a deep understanding of FA-induced hematotoxicity [9]. This occurs many among anatomists who develop laryngeal cancer and leukemia only after the after-care and a long time of exposure to formaldehyde during the working life.

Due to its great solubility in water, FA enters the body through inhalation or by ingestion and is rapidly absorbed into the respiratory and digestive tracts, or through dermal absorption [7, 8, 10, 1]. FA vapors are released during sessions of dissection and macroscopic study of conserved anatomical pieces, raising their concentration in the Anatomy labs, causing greater exposure for students and teachers [5, 12, 13].

In Brazil, students and teachers of health science courses are exposed to high levels of FA during Anatomy classes [14]. Acute exposure is characterized by irritation of the mucosa of the ocular and upper respiratory tract [8, 10, 15]. On the other hand, prolonged and repeated exposure to FA vapors can cause damage to the Central Nervous System, Immune System disorders, blindness, respiratory diseases, contact dermatitis, headache, nausea, vertigo,

vomiting, abortion and cancer [8, 11]. The present study investigated the presence of toxic reactions in students produced by exposure to FA used for the preservation of cadaveric material used in Human Anatomy, Faculdades Integradas de Patos (FIP) classes in Brazil.

## Methods

The study was carried out in the Anatomy laboratory, Faculdades Integradas de Patos (FIP), in Brazil. The Faculty has about 300 students enrolled in the Nursing Course, a questionnaires were distributed to 45 healthy students of the first year of Nursing. Of the 45 questionnaires, only 37 were completed correctly and returned. All participants signed the Consent form. The mean exposure time for each student in the Anatomy Laboratory was 4 hours / week. There were no students with a history of smoking, respiratory or skin diseases in this study.

The instrument used for the data collection was a semi-structured questionnaire, containing easy-to-understand questions, and previously tested and based on the studies of Freitas et al. [16] and modified by Cerqueira et al. [17]. The basic team for data collection was composed of a researcher, previously trained for the application of the questionnaire. The analysis of the data was of the descriptive type, in order to determine the exposure to the formaldehyde of the studied sample. The dataset was coded in Microsoft Excel and analyzed using Graph Pad Prisma 6,0.

This study was approved by the Research Ethics Committee of the Federal University of Paraíba, UFPB (18191213.7.3001.5183). Free and informed consent forms were signed by the interviewed, with a guarantee of anonymity for students and university. Participants were instructed about the voluntary nature of this study and their freedom to stop participating or to leave answers blank.

## Results

It was verified that the sample had the average age of 23 years, with the majority being 78.38%, of sex female. Of these, most had only one symptom. It was found that 56.04% of the interviewees had a history of allergy and Allergic rhinitis was the most incident (13.5%). (Table 1)

**Table 1.** Demographic characteristics of students.

Demographic data	Total		Male		Female	
	n	%	n	%	n	%
Age (years)	23.2		23.4		76.19	
Sex	37	100.0	8	21.62	29	78.38
Symptom of number	26	70.3	6	75.0	20	68.97
One symptom	11	29.72	3	37.5	8	27.58
Two symptoms	8	21.62	2	25.0	6	20.69
Three symptoms	5	13.51	1	12.5	4	13.80
More than three symptoms	2	5.40	0		2	6.90
Allergy history	11	29.72	2	25.0	9	31.04
Allergic rhinitis	5	13.51	1	12.5	4	13.80
Alimentary allergy	2	5.40	0		2	6.90
Bronchial asthma	2	5.40	0		2	6.90
Dermatitis	2	5.40	1	12.5	1	3.45
Other	1	2.70	0		1	3.45

Of the 45 questionnaires distributed, 37 were answered and returned for analysis, a response rate of 82%. Of the 37 interviewees, 26 (70.3%) were affected by the unpleasant and irritating smell of FA; 10 (27%) had no problems with the smell of FA; and 1 (2.7%) did not bear the irritation and unpleasant smell, failing to participate in the practical classes in the Laboratory. Exposure to FA was followed by several symptoms: excessive lacrimation (54%), itching eyes (48.5%), redness of the eyes (40.6%), coryza or congested nose (35.2%), and respiratory Distress (29.7%), and for 12 (32.5%) students the symptoms were persistent during the stay in the Laboratory. The results are presented in Table 2. Of the students, 5 (13.5%) reported learning impairments during class, of which, 1 (20%) were not able

to participate in practical classes with anatomical pieces, having the study in anatomical models. All students used some Personal Protective Equipment (PPE), such as the lab coat. However, only 17 (46%) students wore gloves, 3 (8%) wore a mask and no students wore glasses, which were associated with a higher risk of contamination.

**Table 2.** Frequencies and extent of complaints reported.

Symptoms	Extent of Symptom							
	Not at All		Barely Recognizable		Strong and Irritating		Intolerable	
	n	%	n	%	n	%	n	%
Unpleasant and irritant smell	4	10.8	6	16.2	26	70.3	1	2.7
Coryza or congested nose	15	40.4	9	24.4	11	29.8	2	5.4
Dry or sore nose	32	86.5	3	8	2	5.4	0	0
Respiratory distress	14	37.8	12	32.5	9	24.3	2	5.4
Redness of the eyes	9	24.4	13	35	12	32.6	3	8
Excessive lacrimation	10	27	7	19	17	46	3	8
Itching eyes	5	13.5	14	38	15	40.5	3	8
Itching skin	34	92	3	8	0	0	0	0
Dizziness	30	81	5	13.6	2	5.4	0	0
Nausea	25	67.6	6	16.2	4	10.8	2	5.4
Headache	17	46	11	29.8	6	16.2	3	8
Disturbed nocturnal sleep	31	83.8	4	10.8	2	5.4	0	0
Syncope (fainting episode)	37	100	0	0	0	0	0	0
Low assimilation	27	73	5	13.5	4	10.8	1	2.7

## Discussion

In Brazil, occupational exposure among students and health workers is a public health problem, due to the lack of policy to minimize exposure during anatomy classes. Many students exhibit various respiratory, ocular and dermal reactions due to exposure to this chemical agent.

Our results reinforce the findings of Daisey, Angell and Apte [18], Erich [19], Neslihan et al. [20], the acute exposure to formaldehyde can cause eye, nose, throat, and skin irritation, whereas long-term exposure has been associated with certain cancers nasal as well as asthma.

During dissections and macroscopic study of anatomical parts used in Anatomy classes, the inhalation of FA vapors and their contact with the skin may cause adverse effects. The main complaint reported by students was the unpleasant and irritating odor of FA, followed by excessive lacrimation, itching eyes, redness of the eyes, coryza or congested nose, and respiratory distress. In a recent study in Thailand, about FA exposure in Anatomy labs, most students also had these symptoms [7]. Similar results were found in the studies of [4, 13, 15, 21], which reported, in addition to these clinical symptoms, general fatigue and skin irritation.

In addition to ocular and upper respiratory irritation symptoms, students reported neurobehavioral changes such as headache, nausea, sleep disturbances, and decreased learning, associated with FA exposure. The neurobehavioral changes reported by the students are in agreement with the results of other studies [8, 10, 22], which relate exposure to FA to sleep disorders and learning deficits.

Previous studies have shown that concentrations of FA varying between 0.1-5 ppm inside Anatomy laboratories during dissections and study of anatomical parts are responsible for upper airway irritation, coughing, eye burning and tearing in students, teachers and technicians [5, 14, 23, 24]. Although not analyzing FA concentrations in the

Anatomy laboratory frequented by students and teachers in this study, but considering the clinical symptoms reported by participants, it is suggested that the level of FA in the laboratory was high, causing symptoms similar to those presented in these studies.

Most students did not use the PPE needed for protection during Anatomy classes, exposing the respiratory system, eyes and skin to FA and its vapors. For manipulation of FA it is indicated the use of rubber gloves, latex or Nitrile, apron, goggles and mask to protect the face [5, 13, 25].

Lakchayapakorn and Watchalayarn [4] reported that students and teachers of Anatomy who used more activated charcoal had fewer clinical symptoms resulting from exposure to FA compared to those who did not. They have also proven that wearing eyeglasses protects the eyes from direct contact with FA vapors. Safety devices are used to protect students and teachers from inhalation and for skin contact with FA during dissections and Anatomy classes [7].

In brief, there is a need to conduct safety campaigns at work, in order to clarify the workers and students who are exposed to FA about its cytotoxic action (26). Emphasizing the use of personal protective equipment and considering the health risk posed by are of paramount importance, since it the Formaldehyde exposure contributes to the development of future research in Brazil.

## Conclusion

It can be seen that FA cannot be considered an appropriate product for the preservation of cadavers used for dissection and Anatomy classes, given the numerous health problems that can cause in those who manipulate it. In addition, medical schools should continue to encourage the use of PPE as a lab coat, mask, goggles and gloves, to manipulate the FA, as well as provide guidance on the correct use of these equipment, ensuring the protection of

technicians, students and teachers in the laboratory of Anatomy.

## Acknowledgements

The author thanked to the University of Integradas of Patos for research support and/or financial support.

## Conflict of interest

No conflict of interest was declared.

## References

1. Tang X, Bai Y, Duong A, Smith M, Li L, Zhang L. Formaldehyde in China: Production, consumption, exposure levels, and health effects. *Environ Int.* 2009; 35:1210-24. <http://www.sciencedirect.com/science/article/pii/S0160412009001378>.
2. Moeller BC, Lu K, Doyle-Eisele M, McDonald J, Gigliotti A, James AS. Determination of N2-hydroxymethyl-dG adducts in the nasal epithelium and bone marrow of nonhuman primates following 13CD2-formaldehyde inhalation exposure. *Chem Res Toxicol.* 2011; 24:162-4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3273041/>
3. Wu Y, You H, Ma P, Li L, Yuan Y, et al. Role of Transient Receptor Potential Ion Channels and Evoked Levels of Neuropeptides in a Formaldehyde-Induced Model of Asthma in Balb/c Mice. *PLoS ONE.* 2013; 8: e62827. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0062827>.
4. Lakchayapakorn K, Watchalayarn P. Formaldehyde exposure of medical students and instructors and clinical symptoms during gross anatomy laboratory in Thammasat University. *J Med Assoc Thai.* 2010; 93(Suppl. 7):S92-S98. <https://www.ncbi.nlm.nih.gov/pubmed/21294402>.
5. Vohra MS. Personal formaldehyde exposure level in the gross anatomy dissecting room at College of Medicine King Saud University Riyadh. *Int J Occup Med Environ Health.* 2011; 24(1):108-13. <https://www.ncbi.nlm.nih.gov/pubmed/21468908>.
6. Azari MR, Asadi P, Jafari MJ, SOORI H, Hosseini V. Occupational exposure of a medical school staff to formaldehyde in Tehran. *Tanaffos.* 2012; 11(3):36-41. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4153202/>
7. Saowakon N, Ngermsoungnern P, Watcharavitoon P, Ngermsoungnern A, Kosanlavit R. Formaldehyde exposure in gross anatomy laboratory of Suranaree University of Technology: a comparison of area and personal sampling. *Environ Sci Pollut Res.* 2015; 22(23):19002-12. <https://link.springer.com/article/10.1007%2Fs11356-015-5078-2>.
8. IARC (International Agency for Research on Cancer). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Vol. 88: Formaldehyde, 2-Butoxyethanol, and 1-tert-Butoxypropan-2-ol. Lyon, France, 2006.
9. Wei C, Chen M, You H, Qiu F, Wen H, et al. Formaldehyde and co-exposure with benzene induce compensation of bone marrow and hematopoietic stem/progenitor cells in BALB/c mice during post-exposure period. *Toxicol Appl Pharmacol.* 2017; 324, 36-44. <http://www.sciencedirect.com/science/article/pii/S0041008X17301382>.
10. NIOSH (The National Institute for Occupational Safety and Health). NIOSH Pocket Guide to Chemical Hazards: Formaldehyde. Atlanta, United States of America: Center for Disease Control and Prevention, 2011. Retrieved April 9, 2016, from: <http://www.cdc.gov/niosh/npg/npgd0293.html>
11. Shrivastava A, Saxena Y. Effect of formalin vapours on pulmonary functions of medical students in anatomy dissection hall over a period of one year. *Indian J Physiol Pharmacol.* 2013; 57(3): 255-60. [http://www.ijpp.com/IJPP%20archives/2013\\_57\\_3\\_July%20-%20Sep/255-260.pdf](http://www.ijpp.com/IJPP%20archives/2013_57_3_July%20-%20Sep/255-260.pdf).
12. Kimihide O, Masatoshi K, Yoshiharu M, Yoshimitsu T, Hiroshi M, et al. Formaldehyde Exposure in a Gross Anatomy Laboratory. Personal Exposure Level Is Higher Than Indoor Concentration. *Environ Sci & Pollut Res.* 2006; 13(2): 120-4. <https://www.ncbi.nlm.nih.gov/labs/articles/16612901/>
13. Onyije FM, Awuioro OG. Excruciating effect of formaldehyde exposure to students in gross anatomy dissection laboratory. *Int J Occup Environ Med.* 2012; 3(2):92-5. <http://www.theijoem.com/ijoem/index.php/ijoem/article/view/125/262>.
14. Ochs SM, Grotz LO, Factorine LS, Rodrigues MR, Pereira Netto AD. Occupational exposure to formaldehyde in an institute of morphology in Brazil: a comparison of area and personal sampling. *Environ Sci Pollut Res Int.* 2011; 19(7): 2813-19. <https://www.ncbi.nlm.nih.gov/pubmed/22322292>.
15. Khaliq F, Tripathi P. Acute effects of formalin on pulmonary functions in gross anatomy laboratory. *Indian J Physiol Pharmacol.* 2009; 53(1): 93-6. <https://www.ncbi.nlm.nih.gov/pubmed/19810583>.
16. Freitas APF, Pinto RH, Lima TAJ, Vasconcelos TC, Cerqueira GS, et al. Exposição ocupacional de trabalhadores de postos de combustíveis do sertão Paraibano. In: XV Congresso Brasileiro de Toxicologia. Rev. Bras. de Toxicologia. 2007; 20(1): 310-31, 2007.
17. Cerqueira GS, Arruda VR, Freitas APF, Oliveira TL, Vasconcelos TC, Mariz SR. Dados da exposição ocupacional aos agrotóxicos em um grupo assistido por uma unidade básica de saúde na cidade de Cajazeiras, PB. *Rev. Intertox de Toxicologia, Risco Ambiental e Sociedade.* 2010; 3(1): 16-28. <http://revistarevinter.com.br/index.php/toxicologia/article/view/45/256>.

18. Daisey JM, Angell WJ, Apte MG. Indoor air quality, ventilation and health symptoms in schools: an analysis of existing information. *Indoor Air*. 2003;13(1):53-64. <http://onlinelibrary.wiley.com/doi/10.1034/j.1600-0668.2003.00153.x/epdf>.
19. Erich B. Human body preservation – old and new techniques. *J Anat*. 2014; 224(3): 316-44. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3931544/pdf/joa0224-0316.pdf>.
20. Neslihan G, Zafer KC, Feza AL, Afitap A, Hasan BT. The Evaluation of Formaldehyde Exposure in the Anatomy Laboratories and the Preventive Measures. *Gazi Med J*. 2016; 27(2): 98-103. <http://medicaljournal.gazi.edu.tr/index.php/GMJ/article/view/1233/1102>.
21. Mori M, Hoshiko M, Hara K, Saga T, Yamaki K, Ishitake T. Changes in subjective symptoms and allergy state among medical students exposed to low-level formaldehyde 6 months after completion of a gross anatomy dissection course. *Environ Health Prev Med*. 2013; 18(5): 386-93. <https://www.ncbi.nlm.nih.gov/pubmed/23588414>.
22. Golden R. Identifying an indoor air exposure limit for formaldehyde considering both irritation and cancer hazards. *Crit Rev Toxicol*. 2011; 41(8): 672–721. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3175005/>
23. Vimercati L, Carrus A, Martino T, Galise I, Minunni V, Caputo F, et al. Formaldehyde exposure and irritative effects on medical examiners, pathologic anatomy postgraduate students and technicians. *Iran J Publ Health*. 2010; 39(4): 26–34. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3481685/>
24. WHO (World Health Organization). WHO guidelines for indoor air quality: selected pollutants. WHO, Switzerland, 2010. Retrieved April 9, 2016, from: [http://www.euro.who.int/\\_data/assets/pdf\\_file/0009/128169/e94535.pdf](http://www.euro.who.int/_data/assets/pdf_file/0009/128169/e94535.pdf).
25. Raja D, Sultana B. Potential Health Hazards for Students Exposed to Formaldehyde in the Gross Anatomy Laboratory. *J Environ Health*. 2012; 74(6): 36-40. <https://www.ncbi.nlm.nih.gov/pubmed/22329207>.
26. Lacerda, Lourran Paula; Dantas, Ellifran Bezerra de Siqueira; Cerqueira, Gilberto Santos Cerqueira, Peron, Ana Paula, Sousa, João Marcelo de Castro. Occupational toxicology study emphasizing the cytotoxic and mutagenic activity among workers exposed to gasoline Biotemas,2015. 28 (3): 135-141. <https://periodicos.ufsc.br/index.php/biotemas/article/view/2175-7925.2015v28n3p135/29984>

#### Publish in International Archives of Medicine

International Archives of Medicine is an open access journal publishing articles encompassing all aspects of medical science and clinical practice. IAM is considered a megajournal with independent sections on all areas of medicine. IAM is a really international journal with authors and board members from all around the world. The journal is widely indexed and classified Q2 in category Medicine.