



Respiratory Symptoms of Exposure to Substances in the Workplace among Bulgarian Dental Students: a Self-report Questionnaire Survey

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Received: 15 Apr 2019 ♦ **Accepted:** 31 July 2019 ♦ **Published:** 31 March 2020

Citation: Stoeva I, Dencheva M, Mircheva K, Chonin A. Respiratory symptoms of exposure to substances in the workplace among Bulgarian dental students: a self-report questionnaire survey. *Folia Med (Plovdiv)* 2020;62(1):141-6. doi: 10.3897/folmed.62.e48268.

Abstract

Background: Dental students are at high risk of developing adverse respiratory reactions as a result of their practical work during their dentistry degree program when they come into contact with multiple airborne irritants and allergens.

Aim: To estimate the prevalence of respiratory symptoms of exposure to substances in the workplace and associated risk factors in Bulgarian dental students.

Materials and methods: A cross-sectional study of dental students at the Plovdiv Medical University and Sofia Medical University was performed by using a self-report questionnaire. A total of 467 dental students completed the questionnaire (response rate 51.8%).

Results: The prevalence of self-reported respiratory symptoms related to the pre-clinical and clinical training courses of the dentistry program was 12.4%. According to logistic regression analysis, the most important risk factors for work-related respiratory symptoms were a personal history of allergic rhinoconjunctivitis (odds ratio (OR) 6.34, 95% confidence interval (CI): 3.14-12.78), atopic dermatitis (OR 2.81, 95%CI: 1.26-6.26), and exposure to chemicals from dental environment for more than 6 hours a day (OR 3.60, 95%CI: 1.21-10.70).

Conclusion: The results of this study suggest that work-related respiratory symptoms are frequent among dental students and indicate the need for efforts to establish effective primary preventive programs for occupational respiratory disorders at national level.

Keywords

respiratory symptoms, dental students, dental materials, latex gloves

INTRODUCTION

Dental students are exposed to multiple irritants and allergens during the pre-clinical and clinical training courses of the dentistry program. The contact with dental materials, disinfectants and protective gloves causes mainly hand skin

diseases¹⁻⁴ but exposure to airborne dental environment substances may also lead to respiratory hypersensitivity^{5,6} and even asthma⁷. The methacrylic monomers and natural rubber latex (NRL) proteins are the major causes of respiratory disorders. Respiratory hypersensitivity caused by methacrylates amongst the dental personnel is a re-

sult of volatile unpolymerized acrylic monomers such as 2-hydroxyethyl methacrylate (2-HEMA), ethylene glycol dimethylacrylate (EGDMA), triethylene glycol dimethacrylate (TEGDMA) and methyl methacrylate (MMA).^{5,8,9} Reactions to latex gloves can vary from irritation to allergy. NRL allergy is an immediate hypersensitivity reaction. NRL protein-powder particles from powdered NRL gloves can become airborne when gloves are donned and removed, resulting in additional respiratory and conjunctival exposure. Thus the allergen could induce respiratory symptoms such as rhinorrhea, sneezing, itching of the eyes and nose, hoarseness, and asthma. Natural rubber latex is an important occupational allergen for dentists and dental nurses not only due to the use of latex gloves, but also to the contact with other frequently ignored sources of allergen in dental offices such as rubber dams, bite blocks, and prophylaxis cups.² The use of rotary grinding and polishing instruments should be considered as an additional factor increasing the concentration of inhaled irritants and allergens.

To the best of our knowledge, no study exists concerning work-related respiratory symptoms among dental students. The present research was conducted to determine the prevalence of self-reported respiratory symptoms related to the laboratory and clinical work included in the dentistry education program and possible risk factors in Bulgarian dental students based on a self-administered questionnaire.

MATERIALS AND METHODS

A cross-sectional survey was conducted among dental students at the Plovdiv Medical University and Sofia Medical University, Bulgaria. The survey used a self-administered online questionnaire which was created using Google Drive. Spam and bots were prevented using JavaScript generated checkbox. The questionnaire was shared as a link via Facebook by the moderator of the closed dental students' Facebook group. Only second-, third-, fourth-, fifth- and sixth-year dental students were invited to participate. The first-year students were excluded, because their contact with occupational chemical hazards as per the study programs in the Faculties of Dental Medicine was minimal. A total of 467 dental students participated in the study (response rate 51.8%).

Participants were asked whether they had observed any work-related respiratory reactions. Respiratory symptoms included nasal symptoms, cough, hoarseness, dyspnea, and pharyngitis. The questionnaire also inquired about suspected etiologic dental environment factors, use and type of protective gloves, atopic diseases or other allergic disorders. The history of atopic dermatitis (infant eczema or eczema on knee and elbow flexures), hay fever, or asthma was accepted as signs of atopy.

Ethical approval for this study was granted by the Ethics Committee of the Medical University, Plovdiv, Bulgaria.

The information from the digital questionnaire was exported to a database file. Statistical analysis was carried out with SPSS, version 18.0. Descriptive statistics were used to evaluate the prevalence of various exposures, symptoms. Differences between students with or without work-related respiratory symptoms were examined by chi-square analysis. The level of significance was set at $p=0.05$.

Multiple logistic regression analysis was conducted in order to investigate the relationship between sex, latex gloves use, daily exposure to chemicals from dental environment, history of allergic rhinconjunctivitis, asthma, and atopic dermatitis (included as independent variables in the model) with work-related respiratory symptoms (included as a dependent variable).

RESULTS

The examined group had more females ($n=337$, 72.2%) than males ($n=130$, 27.8%). Their ages ranged from 20 to 35 years with a mean \pm SD of 22.8 ± 2.1 . The sample included 62 (13.3%) second-year students, 106 (22.7%) third-year students, 151 (32.3%) fourth-year students, 108 (23.1%) fifth-year students and 40 (8.6%) sixth-year students.

A total of 58 (12.4%) respondents reported respiratory reactions related to the laboratory or clinical work with an improvement at weekends, during holidays and examination sessions when there was no contact with chemicals from the dental environment. The prevalence of respiratory reactions was higher among females compared to males. There was no significant difference in the prevalence of respiratory symptoms between the students from different classes (**Table 1**).

Table 1. Characteristics of participants with work-related respiratory symptoms

Characteristic	Work-related respiratory symptoms N (%)	p-value
All ($n=467$)	58 (12.4)	
Sex		
Male	10 (7.7)	0.045
Female	48 (14.2)	
Year of education		
II year	12 (19.4)	0.362
III year	14 (13.2)	
IV year	18 (11.9)	
V year	9 (8.3)	
VI year	5 (12.5)	

The onset of skin symptoms was predominantly in the second year of education (n=34, 58.6%). 12 (20.7%) students developed symptoms in the third year, 10 (17.2%) and 2 (3.4%) in the fourth and fifth year, respectively.

Coughing was the most frequently reported symptom (69.0%), followed by irritation and lacrimation of the eyes (48.3%), rhinorrhea (17.2%), and dyspnea (15.5%). Pharyngitis, conjunctivitis, and hoarseness were also reported (6.9%, 5.2% and 1.7%, respectively) (Table 2).

Table 2. Work-related respiratory symptoms reported by dental students (n=58, multiple answers)

Symptoms	n	%
Cough	40	69.0
Irritation and lacrimation of eyes	28	48.3
Rhinorrhea	10	17.2
Dyspnea	9	15.5
Pharyngitis	4	6.9
Conjunctivitis	3	5.2
Hoarseness	1	1.7

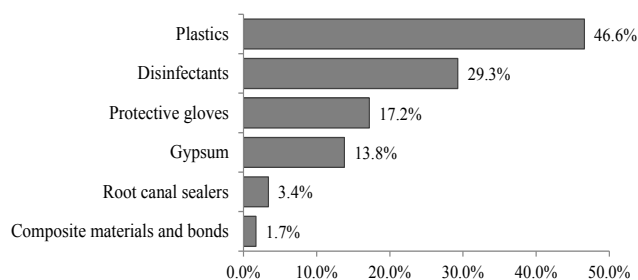


Figure 1. Self-reported suspected causes for work-related respiratory symptoms among dental students (n=58).

The most common causes of respiratory reactions were attributed to plastics, disinfectants, protective gloves, and gypsum (Fig. 1).

Regarding the protective mask use, 403 (86.3%) dental students reported that they used masks. A similar percentage of work-related respiratory symptoms was found in students who either used or not used protective mask (12.4% and 12.5%, respectively). Of 420 students wearing protective gloves, 317 (75.5%) used latex gloves, 146 (34.8%) used nitrile rubber gloves, 15 (3.6%) polyvinyl chloride gloves, 2 (0.5%) used neoprene gloves, and 10 (2.6%) were not aware of the material from which their gloves were made (multiple answers were possible).

Table 3. Association between work-related respiratory symptoms and potential risk factors

Risk factor	Total N (%)	Respiratory symptoms N (%)	OR (95%CI) Crude	p-value	OR (95%) Adjusted	p-value
Sex						
Male	130 (27.8)	10 (17.2)	1		1	
Female	337 (72.2)	48 (82.8)	1.99 (0.98-4.07)	0.058	1.49 (0.67-3.33)	0.332
Latex gloves use						
No	91 (22.3)	10 (20.0)	1		1	
Yes	317 (77.7)	40 (80.0)	1.17 (0.56-2.44)	0.676	1.57 (0.69-3.60)	0.283
Exposure*						
1-3	224 (48.0)	25 (43.1)	1		1	
4-6	205 (43.9)	22 (37.9)	0.96 (0.52-1.76)	0.887	0.73 (0.35-1.50)	0.387
>6	38 (8.1)	11 (19.0)	3.24 (1.44-7.33)	0.005	3.60 (1.21-10.70)	0.021
Allergic rhinoconjunctivitis						
No	356 (76.2)	25 (43.1)	1		1	
Yes	111 (23.8)	33 (56.9)	5.60 (3.15-9.96)	<0.001	6.34 (3.14-12.78)	<0.001
Asthma						
No	440 (94.2)	50 (86.2)	1		1	
Yes	27 (5.8)	8 (13.8)	3.28 (1.37-7.89)	0.008	1.28 (0.40-4.13)	0.676
Atopic dermatitis						
No	410 (87.8)	40 (69.0)	1		1	
Yes	57 (12.2)	18 (31.0)	4.27 (2.24-8.15)	<0.001	2.81 (1.26-6.26)	0.012

OR: odds ratio; CI: confidence interval;

* Daily exposure (hours) to chemicals from dental environment

A history of atopy defined by presence of childhood dermatitis, allergic rhinitis and/or asthma was present in 143 (30.6%) of the respondents. Dental students with a history of allergic rhinoconjunctivitis, asthma or atopic dermatitis were more affected by work-related respiratory reactions compared to those without history of allergic rhinoconjunctivitis, asthma or atopic dermatitis (56.9% vs. 19.1%, $p<0.001$; 13.8% vs. 4.6%; $p=0.012$, and 31.0% vs. 9.5%; $p<0.001$, respectively). The prevalence of drug allergy and food allergy was 14.6% and 9.6%, respectively. There was no statistically significant difference with respect to history of drug and food allergy between the students who reported work-related respiratory symptoms and the other students ($p>0.05$).

According to logistic regression analyses, atopic disease history was the most significant risk factor for work-related respiratory symptoms. Allergic rhinoconjunctivitis (OR 6.34, 95% confidence interval (CI): 3.14-12.78; $p<0.001$) was more strongly associated with work related respiratory symptoms than that of atopic dermatitis (OR 2.81, 95%CI: 1.26-6.26; $p=0.012$). Another significant risk factor was exposure to chemicals from the dental environment for >6 hours per day (OR 3.60, 95%CI: 1.21-10.70; $p=0.021$) (Table 3).

DISCUSSION

This survey was conducted in two of the three existing Faculties of Dental Medicine in Bulgaria with response rate of 51.8%. This relatively large study revealed a high prevalence (12.4%) of self-reported respiratory symptoms related to airborne irritants and allergens from dental environment among the population of dental students in Bulgaria. The review of literature revealed many surveys concerning work-related skin reactions amongst dentists^{1,3,4,10,11} or dental students¹²⁻¹⁴ but questionnaire studies on work-related respiratory symptoms have not been carried out among dental students, except for a few studies of airway symptoms related to latex gloves. The incidence of latex-attributed rhinitis and asthma among dental students were reported to be 8% and 3%, respectively.¹² According to the logistic regression analysis of our study, the use of latex gloves was not shown to be a risk factor for respiratory symptoms. There was an increase in Type I latex allergy in healthcare workers in the 1980s and early 1990s due to the increased demand for latex protective gloves and poor manufacturing control. The introduction of low protein powder-free latex gloves over recent years resulted in a reduction of the exposure of healthcare workers to latex antigens, and served to prevent sensitization to NRL (natural rubber latex).¹⁴⁻¹⁶

Dental students pointed out plastics as the major cause for adverse respiratory reactions. Plastic materials used in dentures are based on acrylic resins. Acrylates are well known contact allergens^{4,17} but can also induce respiratory

hypersensitivity.^{18,19} Cases of respiratory hypersensitivity in dental personnel, e.g. pharyngitis^{9,19}, laryngitis^{18,20}, rhinitis¹⁸, asthma^{18,19,21}, and conjunctivitis⁸ have been reported. In our study, 46.6% of the students with respiratory symptoms pointed out plastics as a causative factor. Students' exposure to airborne methacrylates takes place mainly when mixing of the material is carried out and during the finishing and polishing of the denture. According to the dentistry program, students have to perform a set of dentures per term starting from the second year. In addition, they come into contact with acrylics in clinical training courses during the placement or removal of composite restorations. Gypsum powder should also be considered as a factor for adverse respiratory reactions. It was registered that 13.8% of the students related their respiratory symptoms to dental gypsum. Exposure to high dust levels may irritate the nose, throat, or upper respiratory tract. The students do their cast gypsum models in a large room where the different laboratory steps of denture fabrication procedures are performed. In fact they are simultaneously exposed to gypsum dust and volatile acrylic monomers.

Other aerosolized products that can irritate the respiratory tract and may provoke even the development of asthma are disinfectant agents.²²⁻²⁴ Dental students come into contact with these agents mainly when using disinfectant sprays for handpieces and disinfectants for hands before clinical practice in oral surgery.

Logistic regression analysis showed that a history of atopic disease was a strong predictor for work-related respiratory symptoms among dental students, with a much stronger association with allergic rhinoconjunctivitis than atopic dermatitis. This is in accordance with other studies suggesting that dental staff with atopic disorders is more susceptible to the harmful effects of airborne methacrylates, disinfectants and latex proteins.^{5,7,19}

We found that the risk of work-related respiratory symptoms increases significantly with daily exposure to dental environment chemicals. Dental students with >6 hours of daily exposure had a significantly higher risk of developing work-related respiratory symptoms (OR 3.60, 95%CI: 1.21-10.70) than those with 1-3 working hours a day. Long-term exposure to airborne chemical substances and dust in the workplace increases the irritation of the eyes and respiratory tract and determine the onset of adverse respiratory reactions.

CONCLUSION

The study revealed that dental students have relatively high risk of respiratory problems related to the exposure to irritants and allergens from dental environment and they should particularly be cautious because these reactions can occur as soon as they start the preclinical dental work. An existing history of allergic rhinitis and atopic eczema, as well as long-term exposure to chemicals and dust from

dental environment, was significantly associated with such reactions. This indicates the need for efforts to establish effective primary prevention programs for occupational respiratory disorders in dental students on a national level.

ACKNOWLEDGEMENTS

This study was supported by a grant from Medical University – Plovdiv.

REFERENCES

- Lugović-Mihić L, Ferček I, Duvančić T, et al. Occupational contact dermatitis amongst dentists and dental technicians. *Acta clinica Croatica* 2016; 55(2), 293-300.
- Alanko K, Susitaival P, Jolanki R, et al. Occupational skin diseases among dental nurses. *Contact Dermatitis* 2004; 50(2): 77-82.
- Wallenhammar LM, Ortengren U, Andreasson H, et al. Contact allergy and hand eczema in Swedish dentists. *Contact Dermatitis* 2000; 43(4): 192-9.
- Kanerva L, Estlander T, Jolanki R. Occupational skin allergy in the dental profession. *Dermatol Clin* 1994; 12: 517-32.
- Jaakkola M, Leino T, Tammilehto L, et al. Respiratory effects of exposure to methacrylates among dental assistants. *Allergy* 2007; 62: 648-54.
- Piirila P, Hodgson U, Estlander T, et al. Occupational respiratory hypersensitivity in dental personnel. *Int Arch Occup Environ Health* 2002; 75: 209-16.
- Malo JL, Chan-Yeung M. Agents causing occupational asthma. *J Allergy Clin Immunol* 2009; 123: 545-50.
- Estlander T, Kanerva L, Kari O, et al. Occupational conjunctivitis associated with type IV allergy to methacrylates. *Allergy* 1996; 51: 56-9.
- Kanerva L, Estlander T, Jolanki R, et al. Occupational pharyngitis associated with allergic patch test reactions from acrylics. *Allergy* 1992; 47: 571-3.
- Burke FJ, Wilson NH, Cheung SW. Factors associated with skin irritation of the hand experienced by dental practitioners. *Contact Dermatitis* 1995; 32(1): 35-8.
- Munksgaard E, Hansen E, Engen T, et al. Self-reported occupational dermatological reactions among Danish dentists. *Eur J Oral Sci* 1996; 104: 396-402.
- Tarlo S, Sussman G, Holness L. Latex sensitivity in dental students and staff: A cross-sectional study. *J Allergy Clin Immunol* 1997; 99: 396-400.
- Vangveeravong M, Sirikul J, Daengsuwan T. Latex allergy in dental students: a cross-sectional study. *J Med Assoc Thai* 2011; 94 Suppl 3: S1-8.
- Schmid K, Christoph Broding H, Niklas D, et al. Latex sensitization in dental students using powder-free gloves low in latex protein: a cross-sectional study. *Contact Dermatitis* 2002; 47(2): 103-8.
- Jones K, Rolf S, Stingl C, et al. Longitudinal study of sensitization to natural rubber latex among dental school students using powder-free gloves. *Ann Occup Hyg* 2004; 48(5): 455-7.
- Japundžić I, Vodanović M, Lugović-Mihić L. An analysis of skin prick tests to latex and patch tests to rubber additives and other causative factors among dental professionals and students with contact dermatoses. *Int Arch Immunol* 2018; 177(3): 238-44.
- Björkner B. Plastic materials. In: Rycroft RJG, Menne T, Frosch PJ, eds. 2nd ed. *Textbook of Contact Dermatitis*. Berlin-Heidelberg-New York: Springer-Verlag; 1995; 539-72.
- Piirilä P, Kanerva L, Keskinen H, et al. Occupational respiratory hypersensitivity caused by preparations containing acrylates in dental personnel. *Clin Exp Allergy* 1998; 28:1404-11.
- Savonius B, Keskinen H, Tuppurainen M, et al. Occupational respiratory disease caused by acrylics. *Clin Exp Allergy* 1993; 23: 416-24.
- Sala E, Hytonen M, Tupasela O, et al. Occupational laryngitis with immediate allergic or immediate type specific chemical hypersensitivity. *Clin Otolaryngol* 1996; 21: 42-8.
- Lozewicz S, Davidson A, Hopkirk A, et al. Occupational asthma due to methyl methacrylate and cyanoacrylates. *Thorax* 1985; 40: 836-9.
- Dumas O, Donnay C, Heederik D, et al. Occupational exposure to cleaning products and asthma in hospital workers. *Occup Environ Med* 2012; 69: 883-9.
- Pechter E, Davis L, Tumpowsky C, et al. Work-related asthma among health care workers: surveillance data from California, Massachusetts, Michigan, and New Jersey, 1993-1997. *Am J Ind Med* 2005; 47: 265-75.
- Purohit A, Kopferschmitt-Kubler M, Moreau C, et al. Quaternary ammonium compounds and occupational asthma. *Int Arch Occup Environ Health* 2000; 73: 423-7.

Респираторные симптомы после воздействия вещества на рабочем месте среди болгарских студентов-стоматологов: исследование с применением анкеты самоотчёта

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Дата получения: 15 апреля 2019 ♦ **Дата приемки:** 31 июля 2019 ♦ **Дата публикации:** 31 марта 2020

Образец цитирования: Stoeva I, Dencheva M, Mircheva K, Chonin A. Respiratory symptoms of exposure to substances in the workplace among Bulgarian dental students: a self-report questionnaire survey. Folia Med (Plovdiv) 2020;62(1):141-6. doi: 10.3897/folmed.62.e48268.

Абстракт

Введение: Студенты-стоматологи подвержены высокому риску развития респираторных реакций во время практической деятельности в рамках программы по специальности „дентальная медицина“, когда они сталкиваются с многочисленными раздражителями и аллергенами, распространяющимися воздушно-капельным путём.

Цель: Оценить распространённость респираторных симптомов, возникающих в результате воздействия веществ на рабочем месте и связанных с ними факторов риска среди болгарских студентов-стоматологов.

Материалы и методы: Перекрёстный опрос был проведён среди студентов-стоматологов в Медицинском университете - Пловдив и в Медицинском университете - София посредством самоотчётов (анкеты, заполненные самими студентами). В общей сложности 467 студентов заполнили анкету (51,8 % ответили).

Результаты: Распространённость респираторных симптомов, отмеченных самими учащимися в связи с доклиническими и клиническими учебными курсами в рамках программы по специальности „дентальная медицина“, составила 12,4%. Согласно логистическому регрессионному анализу, наиболее важными факторами риска респираторных симптомов, связанных с работой, были личный анамнез аллергического риноконъюнктивита (соотношение шансов (OR) 6,34, доверительный интервал 95% (CI): 3,14-12,78), атопический дерматит (OR 2.81, 95%CI: 1.26-6.26), и воздействие химических веществ стоматологической среды в течение более 6 часов в день (OR 3.60, 95%CI: 1.21-10.70).

Выводы: Результаты этого исследования указывают на то, что связанные с работой респираторные проблемы распространены среди студентов-стоматологов и указывают на необходимость создания учреждений для разработки эффективных программ первичной профилактики профессиональных респираторных расстройств на национальном уровне.

Ключевые слова

Респираторные симптомы, студенты по специальности „дентальная медицина“, стоматологические материалы, латексные перчатки
