



BIODENTAL ENGINEERING



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Biodental Engineering II

Editors

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Table of contents

Acknowledgements	VII
Preface	IX
Invited Lectures	XI
Scientific Committee	XIII
 How do dental students perceive profession demands? <i>M.E. Pinho, M.A. Vaz, J.R. Campos & P.M. Arezes</i>	 1
Designing dental implant surfaces by Laser microtexturing <i>M. Oliveira, J. Machado & A. Reis</i>	7
Three-dimensional visualization of teeth by magnetic resonance imaging during speech <i>S.R. Ventura, D.R. Freitas, I.M. Ramos & J.M.R.S. Tavares</i>	13
Backscattered electron imaging for the interface analysis of dental biomaterials <i>S.A. Bote, J.M. Osorio, J.M. Arroyo, P.C. Lobato & M.C.M. Céspedes</i>	19
Finite element analysis applied to a dental implant-supported structure <i>U. Garitaonaindia & J.L. Alcaraz</i>	25
Design of orthodontic mini-implants contributing to implantation torque <i>V. Katić, S. Špalj, M. Opalić & Z. Domitran</i>	29
Effectiveness of passive ultrasonic irrigation time in the smear layer removal <i>F. Tadeu, R. Madureira, O. Oliveira & L. Forner</i>	35
Impact of fluoride agents on mechanical properties of orthodontic wires <i>V. Katić, S. Špalj, J.L. Horina & D. Vikić-Topić</i>	39
Use of a clinical decision-support system in implant-supported rehabilitations <i>V. Correia, A. Correia & J. Rocha</i>	45
Composite-reinforced glass fiber morphology <i>S.A. Bote, J.M. Arroyo, J.M. Osorio, P.C. Lobato & M.C.M. Céspedes</i>	49
Biomaterials in critical-size bone defects: pointers for a standardized analysis <i>M.C. Manzanares, P. Carvalho, O. Torres, B. González, A. Fuertes, S. Arroyo & J.J. Echeverría</i>	55
Fluorescence <i>versus</i> confocal microscopy for the assessment of bone remodelling <i>P. Carvalho, B. Gallardo, M. Bosch, S. Arroyo & M.C. Manzanares</i>	59
Evaluation of the mechanical environment of the median palatine suture during rapid maxillary expansion <i>L.C.T. Serpe, L.A. González-Torres, R.L. Utsch, A.C.M. Melo & E.B. de Las Casas</i>	63
Numerical model of thermal necrosis due a dental drilling process <i>E.M.M. Fonseca, K. Magalhães, M.G. Fernandes, M.P. Barbosa & G. Sousa</i>	69
The occlusion in total prosthesis <i>P. Fonseca, M.H. Figueiral & M. Vaz</i>	75
Implant-abutment geometry and its role in bone level preservation <i>J. Ferreira, M. França, A. Correia & A. Reis</i>	79
Risk factors for implant treatment failure: a case-control study <i>C. Sedarat, S. de Chalvron, B. Ella, M. Mesnard & A. Ramos</i>	85

Biomodelling partial anodontia case for analysis and surgical implant rehabilitation <i>L. Queijo, J. Rocha & A. Ramos</i>	89
In vitro pilot study on bone heating during surgical implant bed preparation <i>S. Fangaia, M. Almeida, L. Carvalho & P. Nicolau</i>	93
<i>In vivo</i> dental implant micro-movements measuring with 3D digital image correlation method <i>T. Rodrigues, F. Moreira, F. Guerra, P. Nicolau & A. Neto</i>	97
Projection and construction of universal testing machine to simulate fatigue cycles during the insertion/detachment of implant attachments <i>C. Aroso, S. Silva, J.M. Mendes, R. Ustrell, M.C. Manzanares, J.M. Ustrell & T. Escuin</i>	101
3D evaluation of dental impaction using Computed Tomography <i>S.B. Goncalves, J.H. Correia & A.C. Costa</i>	107
Nasal bone in prenatal ultrasound and genetic changes with orofacial manifestations <i>P. Vaz, M.J. Catita, M.J. Ponces, A.C. Braga, O. Iskenderova & F. Valente</i>	111
Guided tissue regeneration and genetics <i>P. Vaz, B.M. Assunção, M. Henriques, C. Pintado, P. Mesquita & M.H. Figueiral</i>	115
Different methods for composite removal after bracket debonding <i>F.M. Lourenço, S. Castro, M.J. Ponces, J.D. Lopes, P. Vaz & L. Rocha</i>	123
Modified core design in an all-ceramic CAD-CAM crown – a numerical stress analysis <i>I. Lopes, A. Correia, J.C. Sampaio, Z. Kovacs, N.V. Ramos & M. Vaz</i>	127
New method and software prototype for automatized measurement of crestal bone levels around implants <i>A. Messias, R. Reis, S. Rocha, P. Nicolau, P. Cunha & M. Lopez</i>	131
X-ray fluorescence technique to evaluate in vitro the de/remineralization in bovine enamel <i>F.S. Calazans, R.F. Moreira, M.S. Miranda, R.S. Santos, M.J. Anjos & J.T. Assis</i>	135
Analysis of a bar-implant using a meshless method <i>H.M.S. Duarte, J. Belinha, L.M.J.S. Dinis & R.M. Natal Jorge</i>	139
Analysis of dental implant using a meshless method <i>J.R. Andrade, J. Belinha, L.M.J.S. Dinis & R.M. Natal Jorge</i>	145
Mandible bone tissue remodelling analysis using a new numerical approach <i>J. Belinha, L.M.J.S. Dinis & R.M. Natal Jorge</i>	151
A meshless method analysis of maxillary central incisor <i>S.F. Moreira, J. Belinha, L.M.J.S. Dinis & R.M. Natal Jorge</i>	159
Effects of Hydrogen Peroxide on the inorganic composition of bovine enamel <i>R.F. Moreira, F.S. Calazans, R.S. Santos, M.J. dos Anjos, J.T. de Assis & M.S. Miranda</i>	163
Analysis of failure cobalt-chromium alloy for partial removable dental prostheses <i>C.P.S. Porto, E.A. Monteiro, P.G.A. Borges, M.A.R. Nunes & S. Griza</i>	167
Stress distribution in a zirconia one-piece dental implant <i>A. Correia, J.C.R. Campos, P.C. Viana, Z. Kovacs, N.V. Ramos & M. Vaz</i>	173
Clinical records in removable prosthodontics: Paper vs computerized format <i>A. Cunha, A. Correia, J.C.R. Campos, M.H. Figueiral & J. Fonseca</i>	177
Development of a thematic learning object for removable partial denture teaching <i>S. Alves, M.H. Figueiral, A. Correia & A.V. de Castro</i>	181
Multimedia tools in the teaching of removable denture prosthesis <i>P. Rolino, A. Correia & A.V. de Castro</i>	187
Author index	193

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Preface

This book contains full papers presented at BIODENTAL 2012 – 2nd International Conference on Biodental Engineering, which was held in Porto, Portugal, during the period 7–8 December 2012. The event had 2 invited lectures, and 46 contributed presentations originated from 8 countries: Brazil, Croatia, France, Germany, Iran, Poland, Portugal and Spain

The dentistry is a branch of medicine with its own peculiarities and very diverse areas of action which means that it can be considered as interdisciplinary field. The use of new techniques and technologies is currently the subject of great interest, and this conference was intended to be a privileged space for discussion among all stakeholders.

The purpose of these BIODENTAL Conferences on Biodental Engineering, initiated in 2009, is to solidify knowledge in the field of bioengineering applied to dentistry promoting a comprehensive forum for discussion on the recent advances in the related fields in order to identify potential collaboration between researchers of different sciences. Henceforth, BIODENTAL 2012 brought together researchers representing fields related to Biomechanical disorders, Orthodontics, Implantology, Aesthetics, Dental, Medical device, Medical imaging.

The conference co-chairs would like to take this opportunity to express gratitude to all sponsors, to all members of the Scientific Committee, to all Invited Lecturers, to all Session-Chairs and to all Authors for submitting and sharing their knowledge.

R.M. Natal Jorge
J.C. Reis Campos
João Manuel R. S. Tavares
Mário A.P. Vaz
Sónia M. Santos
(Conference co-chairs)

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Invited Lectures

During BIODENTAL 2012, were presented Invited Lectures by 2 Expertises:

- Luís Pires Lopes, Faculdade de Medicina Dentária, Universidade de Lisboa, Portugal
- Christoph Bourauel – University of Bonn, Germany

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Scientific Committee

All works submitted to BIODENTAL 2012 were evaluated by an International Scientific Committee composed by 44 expert researchers from recognized institutions:

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How do dental students perceive profession demands?

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ABSTRACT: This paper aims to study dental students' perceptions on work demands and risk factors for the adoption of awkward working postures, and their association with socio-demographic variables. A self-administered questionnaire survey was carried out among dental students of 4th and 5th class years at the Faculty of Dental Medicine of the University of Porto. Results showed that participants perceive Oral Surgery, Paediatric Dentistry, Endodontics and Fixed Prosthodontics as the most demanding dental activities. Conversely, the majority of respondents reported visual demands, work precision, accessibility to the site to treat, fatigue, tasks duration, support of an assistant, required manual dexterity, stress and working tools location/position as important work-related risk factors for the adoption of awkward working postures. Although some statistically significant associations have been found between socio-demographic variables and either perceived work demands or perceived risk factors for the adoption of awkward working postures, no consistent pattern could be recognized.

1 INTRODUCTION

Despite the improvements in aspects such as technology, ergonomics and work environment (Leggat et al., 2007, Lindfors et al., 2006), dental practitioners are still at higher risk of musculoskeletal disorders (MSDs) than most of the other occupational groups (Akeson et al., 1999, Finsen et al., 1998, Kerosuo et al., 2000). Increased risk of MSDs was also found among dental students, indicating that musculoskeletal symptoms may appear very soon after a short period of clinical training (Melis et al., 2004, Rising et al., 2005, Tezel et al., 2005). However, even if work-related MSDs are recognized as the most concerning occupational health problem among dentists (Chowanadisai et al., 2000), the clinical practice is still centred on patients and little attention is paid to the practitioners while performing the treatments (Pentikis, 1998).

The complexity and multifactorial nature of MSDs may explain some ineffectiveness of "the current methods for identifying and reducing or eliminating MSDs in today's industries" (Allread, 2006). In this context, Allread (2006) highlights the importance of individuals' personal aspects and perceptions of the work environment for the development of MSDs. On the other hand, individuals' awareness on work demands and the perception on risk factors for MSDs are fundamental steps for the adoption of ergonomic principles and in the changing process of attitudes and behaviours which play a central role in the prevention of disease

(Abduljabbar, 2008, Rucker & Sunell, 2002, Sunell & Rucker, 2003). Therefore, the purpose of this preliminary study is twofold: (1) to assess dental students' perception on the level of both physical and mental demands associated to dental medicine practice, as well as on the importance of some work-related risk factors for the adoption of awkward working postures (WRRFFAAWP), and (2) to find out if there are significant differences in dental students' perceptions, based on their socio-demographic characteristics.

2 MATERIAL AND METHODS

A self-administered questionnaire survey was carried out, in April–May 2012, among 92 dental students of 4th and 5th class years at the Faculty of Dental Medicine of the University of Porto. Beyond some socio-demographic characteristics, the questionnaire included three different parts. In the two first parts, students were asked to rank, respectively, the physical demands and the mental demands of nine different dental activities included in their curricular plan (Oral Surgery, Dentistry, Endodontics, Preventive Dental Medicine, Occlusion, Paediatric Dentistry, Periodontology, Fixed Prosthodontics, and Removal Prosthodontics), by using a five level Likert-type scale (1 – not demanding at all; 2 – low demand; 3 – average demand; 4 – high demand; 5 – very high demand). In the third part, students were asked to report the

Table 1. Number (and %) of dental students participating in the survey, by gender and class year.

Gender	Students' class year		
	4th year	5th year	Total
Female	20	50	70 (76.1%)
Male	8	14	22 (23.9%)
Total	28 (30.4%)	64 (69.6%)	92 (100.0%)

perceived importance of twelve WRRFFAAWP, using a five level Likert-type scale (1 – not important at all; 2 – low importance; 3 – average importance; 4 – high importance; 5 – very high importance). The twelve work-related risk factors are (1) visual demands, (2) work precision, (3) accessibility to the site to treat, (4) required manual dexterity, (5) dentist chair, (6) working tools location/position, (7) tasks duration, (8) tasks cognitive demands, (9) stress, (10) fatigue, (11) patient chair, and (12) support of an assistant.

The questionnaires were distributed to students during 4th and 5th year classes. The 92 volunteers to participate in the survey were distributed according to Table 1.

Microsoft Office Excel 2007 and IBM SPSS Statistics 20 were used in data analysis. Contingency Tables and Chi-Square Tests were performed to analyse the association between variables under investigation (perceived work physical demands, perceived work mental demands and perceived risk factors for the adoption of awkward working postures) and the socio-demographic variables (age, gender, height, body mass index (BMI), dominant hand, class year, clinical and/or pre-clinical practice hours per week, regular physical exercise practice). Pearson Chi-Square and, when appropriate, Fisher's Exact Test were used. For analysis purpose, all non-dichotomous variables were dichotomised. Two-tailed tests were used and the significance level was set at $\alpha = 0.05$. For the statistically significant associations found, relative risk (RR), and 95% confidence intervals (95% CI) were computed to estimate the effect size.

The study was submitted to and approved by the Commission of Ethics of the Faculty of Dental Medicine of the University of Porto.

3 RESULTS

Response rates of 32.6% in 4th class year and 70.3% in 5th class year were achieved, representing an overall response rate of 52.0% (92/177).

3.1 Sample characterisation

Survey participants (92) were mostly female (76.1%), right-handed (94.6%) and a little less than half (46.7%) of them reported to practice regular physical exercise. Other demographic characteristics of survey participants are presented in Table 2.

Table 2. Demographic characteristics of survey participants.

Variable parameters	Gender		
	Female	Male	Total
Age (in years) (n = 88)			
Mean	23.4	23.3	23.4
SD*	3.1	1.9	2.8
Range	21–45	21–30	21–45
Height (in cm) (n = 92)			
Mean	165.3	177.6	168.2
SD*	6.4	6.4	8.3
Range	150–178	170–191	150–191
BMI (in Kg/m ²) (n = 92)			
Mean	21.0	23.6	21.6
SD*	2.5	2.1	2.7
Range	15.2–29.2	20.3–28.9	15.2–29.2

*SD = standard deviation.

3.2 Physically demanding dental activities

Oral Surgery (72.8%), Paediatric Dentistry (70.7%), Endodontics (67.0%), Fixed Prosthodontics (63.1%) and Dentistry (58.7%) were perceived as the most physically demanding dental activities by students who ranked them in the “high” or “very high” demand levels. Conversely, Preventive Dental Medicine (68.2%) and Occlusion (65.9%) were perceived as the less physically demanding activities by students who ranked them in the “not demanding at all” or “low demand” levels.

The perceived physical demands (PPD) of Endodontics ($\chi^2 = 6.113$, $p = 0.019$) and Paediatric Dentistry ($\chi^2 = 8.854$, $p = 0.004$) were found significantly associated to students' gender. Female students seem more likely to perceive Endodontics (RR: 1.626, 95% CI: 1.007–2.625) and Paediatric Dentistry (RR: 1.729, 95% CI: 1.076–2.776) as “high” or “very-high” physically demanding than their male colleagues.

On the other hand, the PPD of Paediatric Dentistry was found significantly associated to students' height ($\chi^2 = 5.904$, $p = 0.021$). Students below 170 cm height seem more likely to perceive Paediatric Dentistry (RR: 1.405, 95% CI: 1.043–1.892) as “high” or “very-high” physically demanding than their taller colleagues.

Furthermore, the PPD of Oral Surgery ($\chi^2 = 5.510$, $p = 0.022$), Dentistry ($\chi^2 = 6.255$, $p = 0.021$) and Paediatric Dentistry ($\chi^2 = 5.663$, $p = 0.025$) were found significantly associated to students' class year. 4th year students seem more likely to perceive Oral Surgery (RR: 1.361, 95% CI: 1.093–1.693) as “high” or “very-high” physically demanding while 5th year students seem more likely to perceive Dentistry (RR: 1.710, 95% CI: 1.046–2.795) and Paediatric Dentistry (RR: 1.458, 95% CI: 1.009–2.108) as “high” or “very-high” physically demanding than their counterpart colleagues.

Finally, the PPD of Removal Prosthodontics was found significantly associated to students' BMI

($p = 0.030$). Overweight students seem more likely to perceive the activity as “high” or “very-high” physically demanding (RR: 3.500, 95% CI: 1.448–8.463) than their colleagues under BMI 25.

Apart from these, no other statistically significant association was found between the PPD of the investigated dental activities and students’ socio-demographic characteristics.

3.3 Mentally demanding dental activities

Fixed Prosthodontics (73.3%), Endodontics (71.7%), Pediatric Dentistry (57.6%), Occlusion (54.7%) and Oral Surgery (53.3%) were pointed out as the most mentally demanding dental activities by survey participants who classified them in the “high” or “very high” demand levels. Conversely, Preventive Dental Medicine and Periodontology were perceived as the less mentally demanding activities by, respectively, 70.0% and 41.3% of the respondents, which classified them in the “not demanding at all” and “low demand” levels.

The perceived mental demands (PMD) of Endodontics ($\chi^2 = 6.740$, $p = 0.014$) and Fixed Prosthodontics ($\chi^2 = 6.180$, $p = 0.022$) were found significantly associated to students’ gender. Female students seem more likely to perceive Endodontics (RR: 1.571, 95% CI: 1.017–2.429) and Fixed Prosthodontics (RR: 1.527, 95% CI: 0.998–2.337) as “high” or “very-high” mentally demanding than their male colleagues.

The PMD of Endodontics ($\chi^2 = 7.077$, $p = 0.010$) and Fixed Prosthodontics ($\chi^2 = 8.200$, $p = 0.006$) were also found significantly associated to students’ height. Unexpectedly, students below 170 cm height seem more likely to perceive Endodontics (RR: 1.438, 95% CI: 1.072–1.930) and Fixed Prosthodontics (RR: 1.475, 95% CI: 1.098–1.982) as “high” or “very-high” mentally demanding than their taller colleagues.

On the other hand, the PMD of Dentistry ($\chi^2 = 4.789$, $p = 0.034$), Endodontics ($\chi^2 = 6.112$, $p = 0.022$) and Preventive Dental Medicine ($p = 0.010$) were found significantly associated to students’ class year. 4th year students seem more likely to perceive Dentistry (RR: 1.882, 95% CI: 1.085–3.264), Endodontics (RR: 1.394, 95% CI: 1.114–1.743) and Preventive Dental Medicine (RR: 11.071, 95% CI: 1.356–90.424) as “high” or “very-high” mentally demanding than their 5th year colleagues.

Furthermore, the PMD of Dentistry ($\chi^2 = 5.408$, $p = 0.032$) and Endodontics ($\chi^2 = 4.353$, $p = 0.045$) were found significantly associated to clinical and/or pre-clinical practice hours per week. Students practicing up to 15 hours per week seem more likely to perceive Dentistry (RR: 1.940, 95% CI: 1.122–3.353) and Endodontics (RR: 1.326, 95% CI: 1.048–1.679) as “high” or “very-high” mentally demanding than their colleagues with a heavier load of clinical and/or pre-clinical practice.

Apart from these, no other statistically significant association was found between the PMD of

the investigated dental activities and students’ socio-demographic characteristics.

3.4 Most important work-related risk factors for the adoption of awkward working postures

Visual demands (95.6%), work precision (94.5%), accessibility to the site to treat (93.4%), fatigue (65.9%), tasks duration (62.6%), support of an assistant (62.6%), required manual dexterity (59.3%), stress (52.7%) and working tools location/position (50.5%) were perceived as the most important WRRFFAAWP by survey participants who classified them in the “high” or “very high” importance levels. Conversely, tasks cognitive demands, patient chair and dentist chair were perceived as the less important ones.

The perceived importance of the required manual dexterity was found significantly associated with students’ gender ($\chi^2 = 4.085$, $p = 0.050$) while the perceived importance of the support of an assistant was found significantly associated with students’ height ($\chi^2 = 4.870$, $p = 0.031$). Female students seem more likely to perceive the required manual dexterity as highly or very-highly important WRRFFAAWP (RR: 1.594, 95% CI: 0.937–2.711) than their male colleagues. On the other hand, Students under 170 cm height seem more likely to perceive the support of an assistant as highly or very-highly important WRRFFAAWP (RR: 1.451, 95% CI: 1.020–2.065) than their taller colleagues.

Based on students’ socio-demographic characteristics, no other significant differences were found in the perceived importance of the investigated WRRFFAAWP.

4 DISCUSSION

Perceived workload is often used in the assessment of occupational risk factors for MSDs (Vieira & Kumar, 2007), since high perceived workload has been found associated with musculoskeletal symptoms (Bongers et al., 2002). A recent study carried out among Iranian operating room nurses found significant association between PPD and musculoskeletal symptoms (Choobineh et al., 2010). Also dentists participating in a Swedish study reported high levels of perceived workload and work demands (Jonker et al., 2009).

The first aim of this preliminary study was to investigate how dental students perceive the work demands of dental practice. In line with the conclusions of former studies that have showed dental practice as a physically demanding work (Puriene et al., 2008, Rolander, 2010), most of the survey participants perceived Oral Surgery, Paediatric Dentistry, Endodontics, Fixed Prosthodontics and Dentistry as highly or very highly physically demanding. On the other hand, dental practice has also been indicated as requiring high levels of mental demands and a New Zealand’s study found them “as the highest general work-related stressor” (Palliser et al., 2005). In the

present investigation, most of survey respondents perceived Fixed Prosthodontics, Endodontics, Pediatric Dentistry, Occlusion and Oral Surgery as highly or very highly mentally demanding. Conversely, Preventive Dental Medicine was perceived as either the less physically or the less mentally demanding dental activity what, partially, seems to contradict the findings of a Danish study where the physical load on the musculoskeletal system for the three most common tasks (dental examination, cleaning and filling) performed by the dentists participating in the study, regardless of their technical differences, was similar (Finsen et al., 1998).

Individual factors such as age (Augustson & Morken, 1996) and gender (Lin et al., 2012, Marshall et al., 1997, Puriene et al., 2008) are often indicated as influencing perceived musculoskeletal symptoms. Since these are associated with perceived work demands, it was expected that females and males perceived differently the work demands of the investigated dental activities. However, in the present study, females only perceived Endodontics and Paediatric Dentistry as more demanding (either physically or mentally) than their male colleagues, what seems to indicate an inconclusive relationship between gender and perceived work demands. Conversely, neither perceived work demands of the investigated dental activities nor the perceived importance of the investigated WRRFFAAWP were found significantly associated to students' age, although this may be explained by the small range of students' ages.

On the other hand, a greater body height (e.g. > 178 cm) has been indicated as risk factor for musculoskeletal symptoms (Lin et al., 2012). Despite it could be easily understood that "taller individuals probably have to work with more neck flexion to compensate for their body height" (Rolander et al., 2005) and, therefore, survey participants should have perceived the investigated activities as more physically demanding than their shorter colleagues, our findings doesn't support that statement since only a few significant associations were found between students' height category and the perceived work demands of the investigated dental activities. Even so, unexpectedly, it was the students under 170 cm height, and not the tallest, who perceived the activity as more demanding.

Conversely, BMI is often recognized as a risk factor for MSDs (Gilleard & Smith, 2007, Wearing et al., 2006), particularly in some occupations (see e.g. Pensiri et al., 2009). A Swedish study seems to indicate that in individuals exposed to higher physical workloads, such as nurses, MSDs in neck-shoulder region are associated to BMI, while in individuals exposed to lower physical workloads (teachers), such an association was not found (Arvidsson et al., 2012). However, in the present study, only the PPD of Removal Prosthodontics was found significantly associated to students BMI, indicating that the higher the students BMI the more demanding they perceive the activity. Neither the PPD of the remaining activities and the PMD of all the investigated dental activities nor the

perceived importance of WRRFFAAWP, were found associated to BMI.

On the other hand, despite Tezel et al. (2005) have found that left-handed dental students reported more musculoskeletal symptoms than their right-handed colleagues, other authors did not find significant differences in the reported musculoskeletal symptoms when considering dentists dominant hand (Chamani et al., 2012). Since perceived work demands have been found associated to the musculoskeletal symptoms, the present study seems to support Chamani et al. (2012) findings because none significant difference was found in the investigated variables based on students' dominant hand.

Although significant differences have been found in musculoskeletal symptoms reported by students of different class years (Abou-Atme et al., 2007, Rising et al., 2005, Thornton et al., 2008), in the present study, no consistent pattern could be identified in the relationship between students' class year and the variables under investigation, regardless of some significant associations between the perceived work demands of some of the investigated dental activities and students' class year.

Among dental practitioners, the high perceived physical load is often attributed to the high precision demands and uncomfortable work postures (Rolander, 2010). Since awkward working postures have been indicated as one of the most important risk factors for MSDs (Aarabi et al., 2009, Morse et al., 2010), particularly among professional groups such as dental practitioners (Finsen et al., 1998), it is important to identify the main work-related factors leading to the adoption of such working postures. However, no studies were found on this particular issue. Therefore, this study also aimed to find out how students perceive the importance of some work-related risk factors for the adoption of such postures while performing dental work. The results obtained show that more than 50% of the students perceive visual demands (95.6%), work precision (94.5%), accessibility to the site to treat (93.4%) fatigue (65.9%), tasks duration (62.6%), support of an assistant (62.6%), required manual dexterity (59.3%), stress (52.7%) and working tools location/position (50.5%) as highly or very highly important for the adoption of awkward postures during dental practice. However, only two statistically significant associations were found between the perceived importance of the WRRFFAAWP and students socio-demographic characteristics, indicating an inconsistent pattern.

Due to the difficult access to and visibility inside oral cavity, dental practitioners are often forced to adopt awkward working postures (Al Wassan et al., 2001). High visual demands, work precision, manual dexterity and working with unsupported and elevated arms have been indicated as the main causes for the high frequency of MSDs among dental professionals (Abduljabbar, 2008, Akesson et al., 2000). Despite the multifactorial origin of awkward working postures adopted by dental practitioners, they have often

been recognized as a consequence of high work visual demands (Abduljabbar, 2008, Akesson et al., 1999, Marshall et al., 1997, Morse et al., 2010). In the present study, over 93% of the respondents reported visual demands, work precision and accessibility to the site to treat as highly or very highly important risk factor for the adoption of awkward working postures.

On the other hand, a cross-sectional study carried out among female dentists, dental hygienists and dental nurses showed the highest levels of fatigue in dentists (Lindfors et al., 2006) whereas a study carried out among Lithuanian dentists found fatigue (94.7%) as the most prevalent physical complaint reported (Puriene et al., 2008). Although fatigue is often indicated as a common outcome of awkward and/or static working postures, fatigue itself may be a contributing factor for the adoption of non-neutral postures (Anghel et al., 2007). Furthermore, a significant increase of stress amongst dental students has been shown in studies published in the last decades (Alzahem et al., 2011). In the present study, fatigue and stress are among the most important perceived risk factors for the adoption of awkward working postures, what seems to be in line with the findings of those studies.

5 CONCLUSIONS

Dental students of the 4th and 5th years at the Faculty of Dental Medicine of the University of Porto seem to be aware of both physical and mental demands associated to the dental practice and, simultaneously, show an accurate perception concerning WRRFFAAWP. This may indicate that education and training on prevention strategies during undergraduate years could contribute for a better musculoskeletal health and quality of life of future dentists. The results of the present study do not show consistent patterns in the association between socio-demographic variables and either the perceived work demands of the nine dental activities or the perceived importance of WRRFFAAWP. Therefore, further research is needed to understand the mechanisms leading to the adoption of critical working postures. Besides, more comprehensive studies are required to investigate risk factors and identify effective strategies to be implemented in order to avoid awkward and prolonged static working postures and, thus, prevent the development of work-related MSDs.

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