

# Assessment of stress burden among dental students: A systematic literature review and meta-analysis of data

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## Abstract

**Background.** The education of dentists is associated with high levels of stress among students. This phenomenon is observed in many countries.

**Objectives.** The aim of the study was to sum up the knowledge about stress burden among dental students and to determine the causal factors on the basis of a quantitative systematic review of the literature.

**Material and methods.** The PubMed/MEDLINE and Cochrane Library databases were reviewed, and the literature was manually searched for the following keywords: ‘stress’; ‘dental student’; ‘dental education’; and ‘DES questionnaire’. The inclusion criteria for the systematic literature review were original papers and literature reviews, published after 1990, written in English, containing the analysis of the DES questionnaires, and on the topic of stress among students of dentistry. The inclusion criteria for the meta-analysis were publications with the same thematic structure of the DES questionnaire and with the number of survey participants provided.

**Results.** A total of 36 original papers were found, out of which 29 met the inclusion criteria, and thus were included into the systematic literature review analysis. Taking all the papers into consideration, the highest level of stress was caused by grades and examinations, and the atmosphere created by clinical professors. Nearly half of the studies demonstrated higher levels of stress in women. Also, students of higher years were characterized by higher stress indicators. The statistical analysis comprised data from 11 European universities that met the inclusion criteria. The highest mean scores were obtained for ‘performance pressure’, while the lowest mean scores for ‘relationship with sex/race’.

**Conclusions.** There was a great heterogeneity among the pooled estimates, which could be attributed to the varying levels of stress among dental students. The students’ ethnicity and cultural indicators have a decisive influence on the stress levels of dental students, not the characteristics of the field of study.

**Keywords:** stress, dental education, dental student, DES questionnaire

## Cite as

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## Introduction

Stress, which in the early 1930s was defined by Hans Selye as a dynamic adaptive relation between the abilities of an individual and the requirements of a situation,<sup>acc.1</sup> is now a significant part of our everyday lives. It partially provides stimulation that contributes to improved performance, but unfortunately, when this stimulation is prolonged or overlaps with another, it entails negative consequences, both emotional and somatic.<sup>2</sup> A recent report by the British Association for Counselling and Psychotherapy (BACP) states that in the student population, the number of people with emotional imbalance due to stress has increased significantly over the past few decades. The percentage of people who require the intervention of a therapist has been growing as well. One can dare to say that dental students, as compared to other fields of studies, are more vulnerable to prolonged stress, as they have to meet more than just theoretical requirements. Great emphasis is also put on clinical practical skills and a positive relationship with patients, which is indispensable in this profession.<sup>3</sup> Additionally, personal issues may also affect a future doctor, which intensifies negative effects.

The research on the stress levels and the specific causes of stress among dental students was begun by Goldstein in 1979.<sup>4</sup> He has been followed by other researchers. Garbee et al. developed a universal Dental Environment Stress (DES) questionnaire,<sup>5</sup> which after being modified by Grandy, has become the most popular tool in monitoring the sources of stress among prospective dentists.<sup>6,7</sup> Until now, it has been used in many studies around the world, often combined with other scales, such as the Perceived Stress Scale (PSS-10)<sup>8</sup> and the Maslach Burnout Inventory (MBI).<sup>9,10</sup> The DES questionnaire has been proven to cover all the most important aspects of the environment of dental students and can be successfully applied as an objective tool that points to the specific sources of psychological tension among students.

Originally, the DES questionnaire created by Garbee in 1980,<sup>5</sup> and then modified by Grandy in 1989<sup>7</sup> and by Westerman in 1993,<sup>6</sup> included 38 questions referring in their thematic structure to the following areas: self-efficacy beliefs; performance pressure; faculty and administration; academic performance; patient-related aspects; study conditions; and relationship with sex/race.<sup>4-7</sup> For each question beginning with the phrase "How often", a student answered with one numeric value. The scores were as follows: 1 – never; 2 – hardly ever; 3 – sometimes; 4 – quite often; and 5 – very often.

However, the researchers who used the abovementioned tool to measure stressors during dental studies have introduced their own amendments, which they considered appropriate due to cultural, social and economic differences between individual countries. Some questions have been added, others removed. In this way, a shortened DES-16 questionnaire was created, in which there were no questions about the aspects related to patient treatment.<sup>11</sup> It was

applied to students of lower years who had not had clinical classes yet.

The aim of the study was to sum up the knowledge about stress burden among dental students, as examined by the DES questionnaire, and to determine the causal factors on the basis of a quantitative systematic review of the literature and the meta-analysis of data.

## Material and methods

### Systematic literature review

The PubMed/MEDLINE and Cochrane Library databases were reviewed, and the literature was manually searched for the following keywords: 'stress'; 'dental student'; 'dental education'; and 'dental environment stress (DES) questionnaire'. The search was carried out independently by 2 researchers and was completed in December 2019. The inclusion criteria were original papers and literature reviews, published after 1990, written in English, containing the analysis of the DES questionnaires (with modifications), and on the topic of stress among students of dentistry. Study participants were undergraduate dental students, from the 1<sup>st</sup> to the 5<sup>th</sup> year of studies.

### Meta-analysis of data

The PubMed/MEDLINE and Cochrane Library databases were reviewed, and the literature was manually searched according to the previously described principles. Due to the lack of the structural homogeneity of the DES questionnaire in particular versions, it was decided to perform a meta-analysis of the mean DES scores for each of the items included in the thematic structure of the DES questionnaire. After analyzing all available DES modifications, it was found that the greatest amount of research was based on the following thematic structure: self-efficacy beliefs; performance pressure; university rules and regulations; academic performance; patient-related aspects; study conditions; and relationship with sex/race.<sup>10,12</sup> The inclusion criteria were publications with the same 7-point thematic structure of the DES questionnaire that contained the mean DES scores with standard deviation (*SD*) for each of the 7 items as well as the number of survey participants. Similarly to the systematic literature review, only original papers and literature reviews, published after 1990, written in English, containing the analysis of the DES questionnaires (with modifications), and on the topic of stress among students of dentistry were eligible. A small number of participants may present a risk of bias in a research paper. The meta-analysis of the scores was performed in the fixed-effects and random-effects models, depending on the result of the study heterogeneity test. Heterogeneity was determined with Cochran's *Q* test, which checks whether variability in the observed effect sizes or outcomes is larger than would be expected based

on sampling variability alone. A significant test suggests that the true effects or outcomes are heterogeneous. To assess the degree to which results from different studies were heterogeneous, the  $I^2$  coefficient was used. The DerSimonian–Laird estimator was used for the random-effects model. Statistical tests were performed using the R software, v. 3.5.1, the Metafor package.<sup>13</sup>

## Results

### Systematic literature review

A total of 36 original papers were found, out of which 29 met the inclusion criteria, and thus were included into the analysis (Fig. 1). The results came from 17 European, 12 Asian, 11 North American, 1 South American, 1 African, and 1 Australian university.

Taking all the papers into consideration, the highest level of stress was caused (in descending order) by:

- grades and examinations;
- the atmosphere created by clinical professors; and
- the amount of the assigned classwork.

Nearly half of the studies demonstrated higher levels of stress in women. The year of studies was also found to be crucial – students of higher years were characterized by higher stress indicators as compared to students of lower years.<sup>1–12,14–33</sup>

### Meta-analysis of data

The statistical analysis comprised data from 11 European universities that met the inclusion criteria. The investigated students were from the universities of Manchester (UK), Belfast (UK), Helsinki (Finland), Amsterdam (the Netherlands), Cork (Ireland), Athens (Greece), Zagreb (Croatia), Ljubljana (Slovenia), Dublin (Ireland), Santiago de

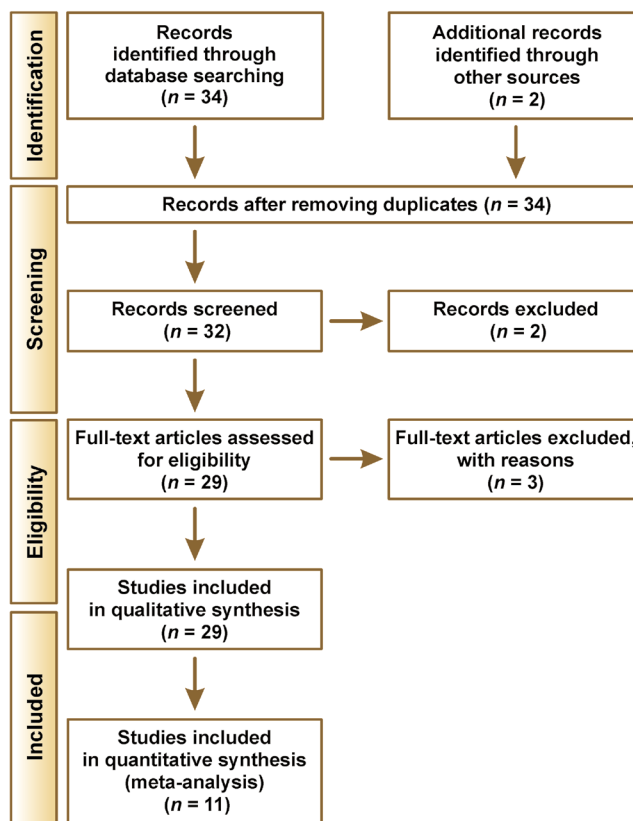


Fig. 1. PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) flow diagram

Compostela (Spain), and Malmö (Sweden). The following items of the DES questionnaire were analyzed (Table 1)<sup>10,12</sup>:

- self-efficacy beliefs;
- performance pressure;
- university rules and regulations;
- academic performance;
- patient-related aspects;
- study conditions;
- relationship with sex/race.

Table 1. Summary of the included studies

Subject of questions	Manchester UK	Belfast UK	Helsinki Finland	Amsterdam Netherlands	Cork Ireland	Athens Greece	Zagreb Croatia	Ljubljana Slovenia	Dublin Ireland	Santiago Spain	Malmö Sweden
Self-efficacy beliefs	2.04	2.40	1.67	1.67	2.00	2.73	2.59	2.66	2.61	2.58	2.32
Performance pressure	2.09	2.54	2.02	2.03	2.27	2.37	2.74	2.74	2.8	2.98	2.38
University rules and regulations	1.89	1.25	1.71	2.69	1.81	2.31	2.39	2.36	2.39	2.20	1.99
Academic performance	1.87	2.28	1.64	1.82	1.95	2.27	2.18	2.21	2.28	2.59	2.17
Patient-related aspects	2.34	1.96	2.00	2.47	2.31	2.55	2.20	2.23	2.25	2.06	1.99
Study conditions	2.77	2.55	1.95	2.15	2.73	2.74	2.71	2.61	2.52	2.50	2.21
Relationship with sex/race	1.43	1.11	1.15	1.19	1.33	–	–	–	–	–	–
Number of participants	32	22	17	39	22	580	372	131	153	110	146

Numbers describe the arithmetic means of the values the students assigned to each question from the given thematic structure.

The heterogeneity tests demonstrated a significant heterogeneity of the studies ( $p < 0.001$ ;  $p = 0.034$  was only for the item 'relationship with sex/race'); therefore the scores were obtained from the random model. The highest mean scores were obtained for 'performance pressure' (2.47) and 'study conditions' (2.50), while the lowest mean scores for 'relationship with sex/race' (1.21). The highest heterogeneity index  $I^2$  was recorded for the item 'performance pressure' ( $I^2 = 95.8\%$ ) and the lowest for 'relationship with sex/race' ( $I^2 = 61.6\%$ ). The results are graphically presented in Fig. 2–8.

For the 'self-efficacy beliefs' item, the mean result was 2.32 with 95% confidence interval (CI) 2.15–2.50, which means that only 5% of the results were beyond the stated norm. However, the coefficient of heterogeneity  $I^2$  was 94.9%, which suggests a large diversity of the trait and proves the heterogeneity of the studied population.

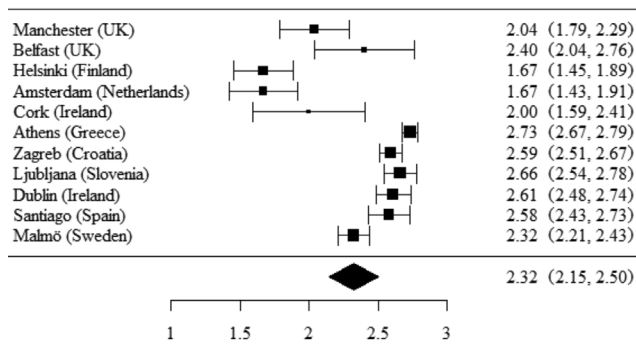


Fig. 2. Self-efficacy beliefs ( $M = 2.32$  (95% CI: 2.15–2.50);  $I^2 = 94.9\%$ )  
*M* – mean; *CI* – confidence interval;  $I^2$  – coefficient of heterogeneity.

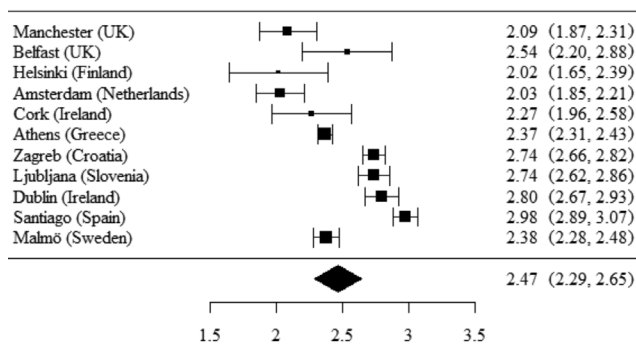


Fig. 3. Performance pressure ( $M = 2.47$  (95% CI: 2.29–2.65);  $I^2 = 95.8\%$ )

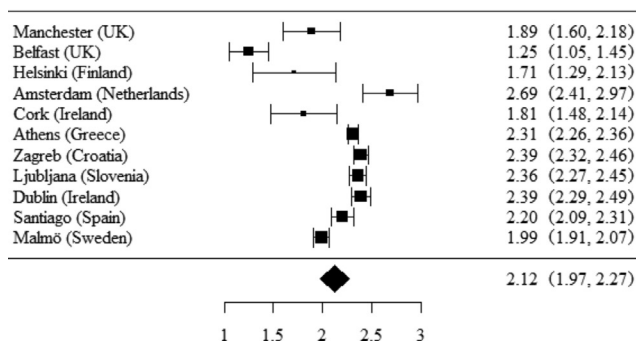


Fig. 4. University rules and regulations ( $M = 2.12$  (95% CI: 1.97–2.27);  $I^2 = 95.0\%$ )

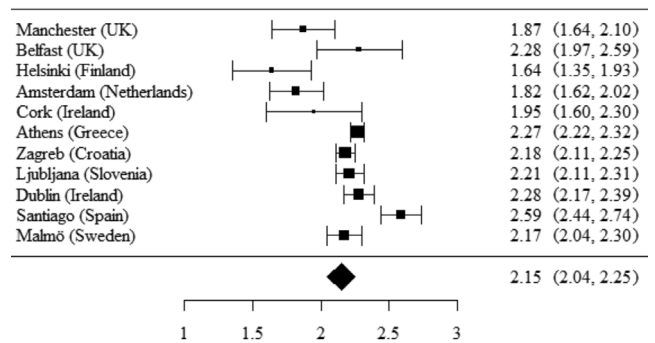


Fig. 5. Academic performance ( $M = 2.15$  (95% CI: 2.04–2.25);  $I^2 = 86.4\%$ )

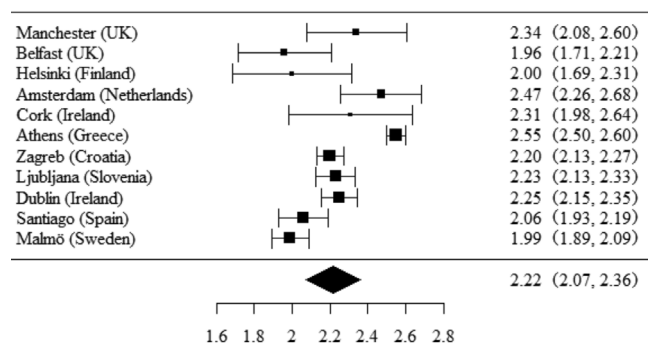


Fig. 6. Patient-related aspects ( $M = 2.22$  (95% CI: 2.07–2.36);  $I^2 = 94.3\%$ )

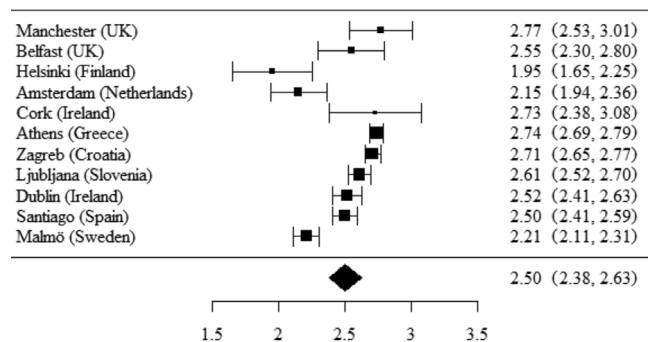


Fig. 7. Study conditions ( $M = 2.50$  (95% CI: 2.38–2.63);  $I^2 = 93.3\%$ )

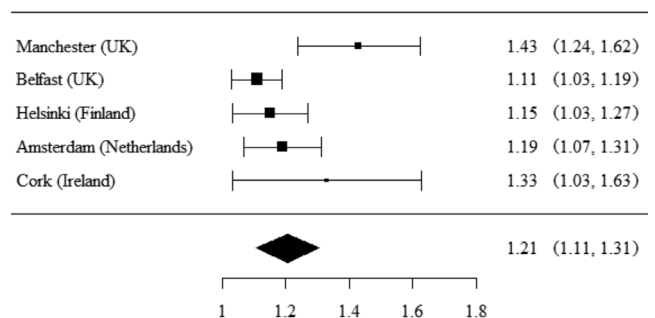


Fig. 8. Relationship with sex/race ( $M = 1.21$  (95% CI: 1.11–1.31);  $I^2 = 61.6\%$ )

For the 'performance pressure', 'university rules and regulations', 'academic performance', 'patient-related aspects', and 'study conditions' items, the results were similar. 95% CIs showed little statistical dispersion of the data, although the coefficients of heterogeneity were high (from 86.4% to 95.8%).

Only in the item ‘relationship with sex/race’, less heterogeneity of the results was noted. However, it was related to the smaller number of students surveyed, as only in 5 universities, the DES questionnaire contained questions related to this point.

## Discussion

Despite searching 2 databases and, additionally, a manual literature search, there is a risk of not including in the review and meta-analysis all available studies using the DES questionnaire. Access to the content of journals that are not included in the PubMed and Cochrane Library databases may be limited.

Furthermore, despite the seeming homogeneity of the studied group of students, the cultural, ethnic and, what is equally important, economic differences are enormous. Therefore, comparing reports from different countries should be done with great caution.

For instance, scores from the University of Lagos in Nigeria completely differ from others.<sup>14</sup> The authors of the study, being familiar with the economic situation of the country and the reality of studying, extended the DES questionnaire with questions regarding the availability of clinical materials and textbooks, the living conditions of future dentists as well as the problem of facing possible unemployment despite obtaining higher education. The authors’ predictions proved to be accurate. One of the biggest stressors turned out to be difficulties in obtaining clinical materials and textbooks in order to meet clinical requirements and to provide oneself with a favorable learning environment. The level of stress resulting from these difficulties was 3.82 for the male group and 3.77 for the female group. In comparison with the highest value obtained in the present meta-analysis (2.50 for ‘study conditions’), it was at a very high level. Grades and examinations were often beyond the top 5 factors causing the greatest stress.<sup>14</sup>

For students in countries where university education is compulsorily payable, the item ‘financial responsibility’ was scored higher among the stress indicators as compared to students from universities with no tuition fee.<sup>2,12</sup> For example, Greek students whose university is subsidized had an average DES score of 2.05.<sup>12</sup> On the other hand, students in San Diego, USA, who are charged the tuition fee, had a mean DES score of 2.70, whereas at the University of Trinidad and Tobago, West Indies, the highest mean DES score for ‘financial responsibility’ was found among 4<sup>th</sup> year students and amounted to 3.33. It seems quite obvious, since the tuition fee significantly increases the financial expenditure, which already includes accommodation, meals, textbooks, etc. For many students this means that they have to take a loan and pay off the debt after gradu-

ating. However, it is rightly suspected that this factor undergoes great individual variability and is influenced by the financial situation of particular students. For some students, the tuition fee and paying for convenient accommodation will not be the slightest problem, while for others, even the purchase of textbooks may be a considerable economic stressor. In such cases, university aid programs and scholarships for students may prove to be a factor that reduces the stress related to financial responsibility.

Being a woman is not a universal stress indicator, either. It mainly occurs at universities where male students significantly outnumber female students.<sup>1,14,29</sup> Most of the differences in the level of stress between the sexes are not significant. At the King Saud University, Riyadh, Saudi Arabia, women scored higher in each of the thematic structure items of the DES questionnaire, but a statistically significant difference was observed only for the ‘workload’ item (3.28 for males and 3.56 for females;  $p < 0.0001$ ). Religion and the traditions of individual countries also have a significant impact on this matter. Gorter et al. predict that these differences will diminish as women play more and more assertive roles in the society.<sup>9</sup>

The type of curriculum also has a considerable influence on the level of stress and its various factors. Polychronopoulou et al. showed that problem-based learning (PBL) compared to the traditional lecture-based learning (LBL) curriculum resulted in much lower DES values for the questions related to self-efficacy.<sup>12</sup> At Malmö University, Sweden, with the PBL curriculum type, the mean DES score for ‘self-efficacy beliefs’ was 2.32, whereas at the University of Athens, Greece, with the LBL curriculum type, the mean DES score was 2.73 for the same item of thematic structure.<sup>12</sup> This important finding is in line with the assumptions of the PBL method. Increased capabilities of independent assessment, better interaction of peers and collaboration between prospective doctors are integral parts of most PBL modules.<sup>16</sup> Moreover, a reverse association between the teaching methods and workload seems significant. For students following the PBL program, the item ‘excess workload’ was found lower among the stress indicators than for students implementing the traditional curriculum. The way of delivering content in the PBL module is more intuitive and it is easier to learn in a shorter time. In PBL, information is conceptually organized and interwoven into clinical scenarios, thus facilitating the education process in a constructive way, with emphasis on self-learning by students and greater freedom as to how and when students access medical information. Similarly, positive effects were observed in the fields of patient treatment and clinical training, which increases the value of problem-based education in preparing a student to meet patients and encounter real therapeutic problems.<sup>17</sup>



The literature review comprised papers that applied the DES questionnaire as an objective tool pointing to the specific sources of psychological tension among students. However, the questionnaire has many limitations. Firstly, it has been constantly altered and updated to match its content to the local reality. It has resulted in the changed number of questions and thematic structure in each paper evaluated, which made it difficult to perform a meta-analysis of the available data. The original language of the DES questionnaire is English. The translations in different countries slightly vary from the source text, which also hinders an objective comparison of the test results. As noted by Sanders and Lushington, the psychometric properties of the DES questionnaire have not been systematically verified with reference to the standard stress measure, nor was the reliability of the scale tested in the test–retest evaluation.<sup>18</sup> There are no specific standards or survey instructions, either. Strictly speaking, the DES questionnaire in fact is not a measure of stress among dental students, but rather a tool for identifying contextual stressors.<sup>19</sup>

The heterogeneous structure of the DES questionnaire hindered the statistical meta-analysis of all available data. In each paper, the DES questionnaire was slightly modified. It was only possible to analyze scores from 11 European universities, in which the identical thematic structure of the DES was found. The results of the statistical analysis indicate ‘performance pressure’ and ‘study conditions’ as the 2 biggest stressors. This coincides with general conclusions from the literature review and appears to be natural for students, whose responsibility at this stage of life is connected with gaining as much knowledge as possible and passing the examinations which authorize them to pursue the chosen profession. A positive surprise was a low score of the stressor of ‘relationship with sex/race’. In addition, this item demonstrated the lowest heterogeneity rate, which means that the answers were relatively unanimous and the scores from various universities did not differ significantly from each other. This shows the high personal culture of students and the resulting lack of prejudice in the context of sex or race. The indirect results of stressors such as ‘patient-related aspects’ or ‘self-efficacy beliefs’ suggest that students who undertake dentistry studies are aware of the need for frequent contact with patients and the correct implementation of the treatment procedures related to treatment planning and manual skills. The stress caused by the above situations is not significant, but it occurs, which can have a stimulative effect and lead to improved performance. However, the high heterogeneity of scores, being in the highest range of  $I^2 = 75\text{--}100\%$  (except for the item ‘relationship with sex/race’), seems to be staggering. This phenomenon is present even despite the relative homogeneity of the study group associated with a similar age and studying in European cities. According to the information provided by the textbook by Cochrane, in such cases, the combined data

analysis can only be carried out with special caution and the objectivity of interpretation.<sup>34</sup>

Students around the world are subject to a relatively high level of stress. The stressors perceived by students vary considerably depending on the institution and are associated with individual institutional parameters. Prolonged emotional exhaustion can quickly lead to professional burnout. The didactic role of the university seems indispensable in such cases. It is essential to identify the potential sources of stress to be able to effectively eliminate or minimize them. In some units, structural changes may be necessary (updating the curriculum, implementing student-centered methods, lowering educational costs), whereas in others, minor modifications will be sufficient, such as providing individual advice by academic teachers or senior students.<sup>14</sup> Unfortunately, it is not possible to eliminate all stressors at the university. Young people need to learn how to deal with problems, too. Nevertheless, there are some students who require help in this regard. Therefore, the next primary aim of research using the DES questionnaire should be to search for students who, without external support, could not emotionally cope with the excess of stress. University support in this area shall be seen as a good investment for the benefit of students, future dentists and their patients.<sup>9</sup>

## Conclusions

The statistical meta-analysis showed that the greatest stressors for the entire study group of dentistry students were the study conditions and performance pressure. However, the individual examination of each study highlighted the decisive influence of ethnic origin and cultural indicators on the greatest stressors in individual countries.

## Ethics approval and consent to participate

I state that the study protocol and the informed consent procedure were approved by the institutional Ethics Committee.




## Data availability

All data analyzed during this study is included in this published article.

## Consent for publication

Not applicable.

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