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ORIGINAL ARTICLE

Dental and endodontic-related stress amongst undergraduate students before and during the COVID-19 pandemic: A mixed-methods study

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Abstract

Aim: To determine and explain the principal sources of stress among preclinical and clinical dental undergraduate students with a particular focus on the stressors linked to endodontics.

Methodology: A mixed-methods study, with an explanatory sequential design, was employed. Volunteer students of second, third and fourth years were asked to complete both the Dental Environment Stress (DES) questionnaire and a bespoke questionnaire for endodontic-related stress assessment, which had 21 questions in common with the DES. The results were analysed by Kruskal–Wallis and Marginal Homogeneity tests. In the second part of the study, a qualitative phase was conducted through focus group interviews of students from each academic year included in the study. Interviews were analysed by inductive content analysis.

Results: The DES questionnaire determined that for all years the most stressful domains were ‘performance pressure’, ‘workload’ and ‘clinical training’. According to the endodontic stress questionnaire, the most stressful domains were ‘self-efficacy beliefs’, ‘endodontic clinical training’ and ‘faculty and administration’ in early years, while they were ‘endodontic patient treatment’, ‘performance pressure in endodontics’ and ‘clinical training’ in later years. Comparing questions common to both questionnaires revealed that the stress score was lower for the endodontic stress questionnaire than in the DES questionnaire for 17 questions, being significantly lower for 13 questions ($p < 0.05$) and significantly higher for no question. The qualitative study showed that students’ dental and endodontic-related stress was linked to different domains: patient, clinical procedure, organization, staff, academic education, evaluation and COVID-19-related issues. Qualitative aspects highlighted the important role that patients and COVID-19 have played in student stress. However, they suggested a possible explanation for the lower endodontic stress observed in this dental university hospital, which was based on: the nature of the teaching in endodontics, the consensus between endodontic supervisors, the use of a logical, progressive procedure and the considerable experience that students gain over the years.

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Conclusion: Students considered endodontics stressful; however, education can play a central role in reducing stress, particularly during the early parts of the undergraduate course.

KEYWORDS

COVID-19, dental education, endodontics, focus groups, questionnaires, student stress

INTRODUCTION

Stress represents external demands (physical or mental) that are placed on an individual's physical and psychological well-being (Atkinson et al., 1991). It describes processes that are reliant on the perception and adaptation of an individual to environmental threats and challenges (Yusoff et al., 2010).

Stress among dental students has been widely studied, with the recognition that Dentistry is one of the most stressful health care professions (Cooper, 1987). Stress levels and stressors in undergraduate dental students are commonly assessed using the Dental Environment Stress questionnaire (DES) (Garbee Jr., 1981) and various modified versions (Elani et al., 2014), either alone or in combination with other validated questionnaires (Abu-Ghazaleh et al., 2016; Ersan et al., 2018). Studies have highlighted that dental students experience moderate (54.5%) to high (34.1%) levels of stress during their studies (Elani et al., 2014).

In the preclinical years, stress is associated with academic aspects of students' dental studies (workload, examinations and grades), as well as with faculty-related factors (faculty rules, approachability of the staff, inconsistency of feedback etc.) (Elani et al., 2014; Heath et al., 1999). The transition from preclinical to clinic training represents a critical period (Dahan & Bedos, 2010), during which the role of dental staff appears crucial in moderating the student's level of stress (Frese et al., 2018). Stress in later clinical years is linked with academic factors, but also with patient care, including treatments that could potentially cause patient harm (Birks et al., 2009; Elani et al., 2014; Schmitter et al., 2008). Students consistently describe difficulty in learning some clinical procedures and in dealing with difficult patients (Muirhead & Locker, 2007; Rajab, 2001).

Student stress levels differ, based on demographic differences including year of study, country of study and ethnic origins (Ersan et al., 2018; Harrison et al., 2016), and can also be influenced by the students' personal problems (Alzahem et al., 2011; Divaris, 2008). Particularly high-level or uncontrolled stress can lead to physical and psychological disorders, which decrease well-being and student performance (Alhaji et al., 2018; Crego

et al., 2016). Conversely, a controlled level of stress can also be beneficial, as students have to learn how to cope and adapt to high-stress levels and demands throughout their course and career (Colley et al., 2018).

Despite a plethora of studies investigating stress among dental students, there is a relative paucity of literature addressing dental student stress during endodontic procedures. Notably, a study of senior students in three German dental schools highlighted that endodontics and prosthodontics were the most stressful of all dental disciplines (Pöhlmann et al., 2005). Another study demonstrated similar results, noting that endodontics was the discipline that provoked the highest stress level during the first weeks of clinical training, compared with restorative dentistry and periodontology (Frese et al., 2018). The authors suggested that endodontics should be introduced later in the clinical curriculum, starting with simple treatments, for example, root canal treatments on anterior teeth or simple premolars (Frese et al., 2018).

Two studies investigating tooth type noted that the majority of participants felt competent performing root canal treatment on anterior teeth, while only a few felt competent carrying out the same treatment on posterior teeth (Davey et al., 2015; Hattar et al., 2021). Davey's study, like other investigations (Grock et al., 2018; Luz et al., 2019), also highlighted that students lack confidence during access cavity preparation. Other stressful stages include root length determination and the adjustment of the master gutta-percha cone (Mirza, 2015; Luz et al., 2019).

In these studies, the assessment of stress during endodontic procedures was investigated using a range of questionnaires developed by the respective authors, with responses noted using Likert scales (Davey et al., 2015; Grock et al., 2018; Hattar et al., 2021; Luz et al., 2019; Mirza, 2015). Two studies have supplemented the questionnaire results with qualitative analysis, to get a better understanding of the exact nature of student's stress associated with endodontic procedures (Grock et al., 2018; Luz et al., 2019).

An analysis of the previous literature related to dental or endodontic-related stress highlighted that both types of stress were rarely investigated in depth within the same cohort. It is for this reason that the initial aims of this study were to determine and explain the principal sources of stress among preclinical and clinical dental

undergraduate students with a particular focus on the stressors linked to endodontics and root canal treatment. As the COVID-19 pandemic emerged during the course of this study, the further objective of investigating the effects of the pandemic on student dental and endodontic-related stress was added.

MATERIALS AND METHODS

Design

A mixed-method design was used in this study to increase robustness and confidence in the findings and to obtain qualitative data to explain in more detail the initial quantitative results. Both a quantitative study using questionnaires and a qualitative study by focus group interviews were carried out, according to an explanatory sequential design (Creswell & Creswell, 2017).

Study setting

This study was conducted in Dublin Dental University Hospital. In this dental university hospital, the undergraduate dental programme extends over a 5-year period (with three terms in each year) leading to the degree of Bachelor of Dental Science (B.Dent.Sc). Undergraduate students begin treating patients in the second year (preclinical year) and thereafter treat a greater volume of patients in the final 3 years of the course (clinical years).

Ethical considerations

The protocol was reviewed and approved by the local Research Ethics Committee (No 2019-11-01). Prior to engaging in any questionnaires or focus group interviews, all potential student participants were informed of the nature of the study, allowed to ask questions and only if content asked to complete a consent form.

Quantitative study

Questionnaires

Two questionnaires were used: The Dental Environment Stress (DES) questionnaire and a second bespoke questionnaire developed by the authors to assess stress in endodontics.

The DES questionnaire (Table 1) consisted of 41 closed-ended questions covering seven different domains,

as described in a previous study (Alhaji et al., 2018). These domains included the main stress sources in the dental environment: self-efficacy beliefs (D1), faculty and administration (D2), workload (D3), patient treatment (D4), clinical training (D5), performance pressure (D6) and social stressors (D7). The questions were not arranged by domain in the DES questionnaire, but in a random order. Responses were scored on a 4-point Likert scale: 0 = not applicable, 1 = no stress, 2 = moderate stress, 3 = severe stress. The score 0 was necessary because some questions were not applicable to all the students. To simplify the study, the 'slight stress' response from the original DES questionnaire was omitted, as previously carried out and described in other studies (Alhaji et al., 2018).

A specific questionnaire was developed to obtain information about the level and sources of stress experienced by the students in relation to endodontics (Table 2). This 'endodontic stress questionnaire' is based on the DES. The 21 questions marked with an asterisk come directly from the DES, with words specific to endodontics added; 'in/about/for endodontics or endodontic' (Table 2). The other questions are endodontic-specific closed-ended questions, added by the authors to reflect all the possible stress factors pertinent to a student endodontic environment. These questions can be regrouped under the domains D1 to D6 in order to align directly to the DES.

Quantitative data collection

During the second term of the 2019–2020 academic year, both questionnaires were distributed to all undergraduate dental students in the second year ($n=43$), third year ($n=45$) and fourth year ($n=43$), that is, 131 students in total. Within each cohort, the students completed the paper-based questionnaires at the end of a practical session or lecture. The participation was voluntary and anonymous. After the session, the volunteer students could complete the questionnaires and leave them with the principal researcher who was not involved in either their clinical training or assessment.

Quantitative data analysis

The results of all the questionnaires were analysed with IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp.). The internal consistency of each stress questionnaire was investigated by Cronbach's Alpha for each domain, as the measure of reliability of each domain. Descriptive analysis was presented through median, mode and range for each item.

TABLE 1 Dental environment stress (DES) questionnaire used in this study.

Please indicate the level of stress that you experience with regard to different aspects from the following fields using classification levels indicated below

Non-applicable	No stress	Moderate stress	Severe stress
0	1	2	3
1. Amount of assigned class work			0 1 2 3
2. Amount of cheating in dental school			0 1 2 3
3. Availability of qualified laboratory technicians			0 1 2 3
4. Being treated as immature and irresponsible by faculty			0 1 2 3
5. Clinical requirements			0 1 2 3
6. Competition for grades			0 1 2 3
7. Difficulty in learning clinical procedures			0 1 2 3
8. Difficulty in learning precision manual skills			0 1 2 3
9. Difficulty of class work			0 1 2 3
10. Examinations and quizzes			0 1 2 3
11. Fear of being unable to catch up if behind			0 1 2 3
12. Fear of dealing with patients			0 1 2 3
13. Fear of failing a course or the year			0 1 2 3
14. Fear of not being able to join a postgraduate programme			0 1 2 3
15. Financial responsibilities			0 1 2 3
16. Forced postponement of marriage or engagement			0 1 2 3
17. Getting study material			0 1 2 3
18. Inadequate number of instructors in relation to student			0 1 2 3
19. Inconsistency of feedback between different instructors			0 1 2 3
20. Insecurity concerning lack of employment positions			0 1 2 3
21. Insecurity concerning professional future			0 1 2 3
22. Lack of confidence in own decision making			0 1 2 3
23. Lack of confidence to be a successful dental student			0 1 2 3
24. Lack of confidence to be a successful dentist			0 1 2 3
25. Lack of cooperation by patients in their home care			0 1 2 3
26. Lack of home atmosphere in living quarters			0 1 2 3
27. Lack of input into the decision-making process of school			0 1 2 3
28. Lack of time for relaxation			0 1 2 3
29. Lack of time to do assigned school work			0 1 2 3
30. Language barrier			0 1 2 3
31. Late ending day			0 1 2 3
32. Marital adjustment problems			0 1 2 3
33. Necessity to postpone having children			0 1 2 3
34. Overloaded feeling due to huge syllabus			0 1 2 3
35. Patients being late or not showing for their appointments			0 1 2 3
36. Receiving criticism about work			0 1 2 3
37. Responsibility of getting suitable patients			0 1 2 3
38. Shortage of allocated clinical time			0 1 2 3
39. Shortage of allocated laboratory time			0 1 2 3
40. Transition from pre-clinic to clinic work			0 1 2 3
41. Working on patients with dirty mouths			0 1 2 3

TABLE 2 Endodontic stress questionnaire designed for use in this study, the 21 questions marked with an asterisk come directly from the DES, with words specific to endodontics added.

Additional questions about stress related to endodontic procedures

Please indicate the level of stress that you experience with regard to different aspects from the following fields using classification levels indicated below

Non-applicable	No stress	Moderate stress	Severe stress
0	1	2	3
*1. Amount of endodontic class work			0 1 2 3
2. Amount of endodontic lab work			0 1 2 3
3. Difficulty of endodontic lab work			0 1 2 3
4. Patients wanting to shorten their endodontic appointment			0 1 2 3
*5. Endodontic clinical requirements			0 1 2 3
6. Patients with high level of anxiety about endodontic treatments			0 1 2 3
*7. Difficulty in learning endodontic clinical procedures			0 1 2 3
*8. Difficulty in learning precision endodontic manual skills			0 1 2 3
*9. Difficulty of endodontic class work			0 1 2 3
*10. Examinations and quizzes			0 1 2 3
*11. Fear of being unable to catch up in endodontics if behind			0 1 2 3
*12. Fear of dealing with endodontic patients			0 1 2 3
13. Difficulty to work 'in the dark' during root canal treatment			0 1 2 3
14. Difficulty to have a 3-D representation of endodontic volume			0 1 2 3
15. Fear of perforation during root canal treatment			0 1 2 3
16. Fear of blockage and abutment during root canal treatment			0 1 2 3
*17. Difficulty getting study material for endodontics			0 1 2 3
18. Fear of instrument fracture during root canal treatment			0 1 2 3
*19. Inconsistency of feedback between different instructors about endodontics			0 1 2 3
20. Difficulty to obtain an effective anaesthesia			0 1 2 3
21. Difficulty to treat complex teeth (curved or mineralized root canals, resorption, ...)			0 1 2 3
*22. Lack of confidence in own decision making about endodontics			0 1 2 3
*23. Lack of confidence to be a successful student in endodontics			0 1 2 3
*24. Lack of confidence to be a successful dentist in endodontics			0 1 2 3
25. Difficulty to realize pre-endodontic restoration			0 1 2 3
26. Difficulty to set-up the rubber-dam for endodontic treatment			0 1 2 3
27. Difficulty to prepare access cavity			0 1 2 3
28. Difficulty with working-length determination during root canal treatment			0 1 2 3
*29. Lack of time to do endodontic school work			0 1 2 3
30. Difficulty with root canal preparation			0 1 2 3
31. Difficulty with root canal filling			0 1 2 3
32. Difficulty to realize good endodontic radiographs			0 1 2 3
33. Difficulty to make endodontic treatment predictable			0 1 2 3
*34. Overloaded feeling due to huge endodontic syllabus			0 1 2 3
*35. Patients being late or not showing for their endodontic appointment			0 1 2 3
*36. Receiving criticism about endodontic work			0 1 2 3
*37. Responsibility of getting suitable patients			0 1 2 3
*38. Shortage of allocated clinical time for endodontics			0 1 2 3
*39. Shortage of time to learn the basis of endodontics and endodontic procedures in pre-clinics			0 1 2 3

TABLE 2 (Continued)

*40. Transition from pre-clinic to clinic endodontic work	0 1 2 3
41. Difficulty of vital pulp procedures	0 1 2 3
42. Clinical qualitative evaluation	0 1 2 3
43. Fear of the duration of endodontic treatment	0 1 2 3

Mode of scores for each question were given, which in combination with figures for median assist in understanding the skewness of the scores' distribution.

In order to analyse the overall scores of domains, the scores for corresponding questions to each domain were calculated. The results were then used to calculate the normalized domain scores using the following equation.

$$\text{Normalised domain score} = \frac{\text{Domain score} - \text{Min (domain scores)}}{\text{Max (domain scores)} - \text{Min (domain scores)}}$$

The normalized scores range between 0 and 1 and are continuous measures. A normalized score of 0 means the participant scored the lowest possible score in that domain. A normalized score of 1 means the participant scored the highest possible score in that domain. Normalization helps in standardizing scores across different domains by removing the impact of varying question numbers between various domains.

The quantitative data assessed by each questionnaire domain were analysed with special regard to differences between the years of the students (e.g. second year, third year, fourth year) using Kruskal–Wallis with a post hoc Mann–Whitney *U*-test. To compare the scores given to similar questions in both DES and endodontic stress questionnaire, Marginal Homogeneity test was used. The significance level was set at $p \leq .05$ for all tests.

Qualitative study

Participant recruitment

To obtain a better understanding of student stress during their general dental studies and in endodontics in particular, focus group interviews were organized after the analysis of quantitative data. As a result of COVID-19 pandemic restrictions, an additional objective was added and consisted of investigating the impact of COVID-19 on student dental and endodontic-related stress. As a result of the COVID outbreak, the interviews were delayed and eventually occurred during the third term of the 2020–21 academic year. At that time, although the participating students (same students, now in third, fourth and fifth year) had returned to the dental school for laboratory and clinical training, their lectures and problem-based learning sessions had remained online. A focus group consisting of six randomly selected students was chosen by a random 'raffle' draw. In total, three focus groups were invited, one from each year.

Focus group interviews

All the interviews were conducted by the same moderator, a dental researcher trained in qualitative methodological techniques. This investigator was a visiting researcher and not a member of the teaching staff. The interviews all took place in a University seminar room and were recorded, after receiving explicit consent from the participants. The moderator reminded the students of the principles of a focus group discussion (there is no such thing as an incorrect response, as well as confidentiality and anonymity). During all interviews, the moderator attempted to make the students feel comfortable and encouraged all of them to share their perceptions and views, by being neutral and non-judgmental. The moderator used a question road map (Table 3), developed by the authors, to guide the discussion. This question map consisted of open-ended questions which were followed by supportive questions such as 'Could you explain?' or 'What do you mean?' to probe further into details.

Analysis by thematic content analysis

An inductive analytical approach was used, which means that the data was analysed with no pre-established theory or framework. The structure of analysis was derived from the data through a thematic content analysis, according to a previously published methodology (Burnard et al., 2008). This methodology finds themes and categories that appear within the data. Once these themes and categories have been identified, the researchers approve them by checking through the data, before repeating the method to search for other themes and categories (Burnard et al., 2008).

The interviews were transcribed verbatim in an anonymous manner by the principal researcher. After carefully reading the interview on several occasions, two clinical researchers skilled in qualitative methodology reflected on the data. Thereafter, the two researchers independently carried out the qualitative content analysis, to limit bias and contribute to the development of various themes and theories. Each of the researchers identified the words, sentences and concepts that were developed in each interview; constituting an open coding approach. Once all the transcripts were open-coded, the researchers noted all the codes on an empty

TABLE 3 Question road map.

1. What do you consider the most stressful aspects of your dental studies?
2. Specifically, what are the stressful elements in the preclinical and clinical elements of the course?
3. Has COVID-19 pandemic affected your stress? How?
4. What do you do to deal with stress?
5. Which improvements, educational or other, could you suggest to decrease that stress?
6. Last year, your responses in the questionnaires indicated that you considered endodontics <u>less</u> stressful than other areas of dentistry. Could you elaborate on this?
7. On reflection would you consider endodontics less or more stressful than other disciplines? Why?
8. What are the most stressful aspects of your endodontic training? Preclinical and clinical? Elaborate
9. Which improvements could you propose to reduce the stress in endodontics (preclinical/clinical improvements, including educational ones)?

page. Duplicate codes were consolidated into one. Next, the two investigators searched for overlapping or close codes, which were then merged to form broader categories. The final categories were verified by going back and reading all the data again. Finally, these categories were used to subdivide and analyse all the transcripts (Burnard et al., 2008). Finally, the other co-author, an endodontist, reviewed the findings of the qualitative analysis to enhance the trustworthiness of the study. In case of disagreement between the three authors, the question was discussed again until a consensus was reached.

RESULTS

Quantitative study

Demographic results

Of the 131 students invited to participate, 119 students (35 second-year students, 42 third-year students and 42 fourth-year students) completed the questionnaires, representing a response rate of 90.8%. The group consisted of 66.39% females ($n = 79$) and 33.61% males ($n = 40$).

Internal consistency

The internal consistency of the DES and the endodontic stress questionnaires was analysed for each included

domain (Tables 4 and 5). The Cronbach's alpha related to the DES ranged from 0.64 to 0.82 depending on the specific domain and was considered acceptable. The Cronbach's alpha related to the endodontic stress questionnaire ranged from 0.68 to 0.92 and was considered acceptable too.

Questionnaire analysis

A summary of the analysis of the score for both questionnaires are given in Tables 4 and 5, with the median and range of the scores for all questions. Modes of scores for each question are also given, which in combination with figures for median assist in understanding the skewness of the scores' distribution. The tables also present the descriptive statistics (Mean and SD) for normalized domain scores for students in years 2, 3 and 4 separately. The results of Kruskal–Wallis one-way ANOVA, as well as the associated post hoc Mann–Whitney test for pair-wise comparisons of normalized domain scores between groups of students are presented.

The DES questionnaire (Table 4), determined that the most stressful domains for second-, third- and fourth-year students were 'performance pressure' and 'workload', with 'clinical training' in the second and third years. For all 3 years, the least stressful domain was 'social stressors'. For all years, one of the most stressful items was: 'patients being late or not showing'. The items 'fear of failing a course or a year', 'responsibility of getting suitable patients', 'examinations and quizzes' and 'clinical requirements' were among the most stressful in both third and fourth years. In general, the second-year students were less stressed than the fourth-year students, who (4th years) were less stressed than the third-year students, in each domain, except for the 'clinical training' and 'performance and pressure' domains. The statistical results demonstrated no significant difference between students in different years in the domains 'patient treatment', 'clinical training' and 'social stressors'. Meanwhile, the other domains showed significantly different stress scores, at least between the second and third years, according to the results of Kruskal–Wallis and post hoc Mann–Whitney tests presented in Table 4 ($p < .05$).

According to the endodontic stress questionnaire (Table 5), the 3 most stressful endodontic domains, were 'self-efficacy beliefs', 'endodontic clinical training' and 'faculty and administration' for the second-year students; while they were 'endodontic patient treatment', 'performance pressure in endodontics' and 'clinical training in endodontics' for both third and fourth year students. Among the least stressful domains was 'endodontic workload' for the 3 years. The most stressful

TABLE 4 Summary for scores of the DES questionnaire.

Domains	Questions	Cronbach's alpha	Median/mode (range)			K-W test (chi-sq, df, p) with M-W post hoc (z, adj. p)
			2nd year	3rd year	4th year	
D1 Self-efficacy beliefs	11	0.76	2/3 (2)	3/3 (2)	2/3 (2)	(8.40, 2, .015)
	13		2/3 (2)	3/3 (2)	3/3 (2)	
	14		1/1 (1)	2/2 (2)	2/2 (2)	2nd-3rd (-2.77, .017)
	20		1/1 (2)	1/1 (2)	2/1 (2)	
	21		1/1 (2)	2/1 (2)	2/2 (2)	
	22		2/2 (2)	2/2 (2)	2/2 (2)	
	23		2/2 (2)	2/2 (2)	2/2 (2)	
	24		2/2 (2)	2/2 (2)	2/1 (2)	
	30		1/1 (2)	1/1 (2)	1/1 (2)	
Domain normalized score: Mean (SD)			0.47 (0.21)	0.61 (0.19)	0.58 (0.25)	All participants: 0.56 (0.23)
D2 Faculty and administration	2	0.79	1/1 (2)	1/1 (2)	1/1 (2)	(7.57, 2, .023)
	3		1/1 (2)	1/1 (2)	2/2 (2)	
	4		1/1 (2)	2/1 (2)	2/2 (2)	2nd-3rd (-2.61, .027)
	17		2/2 (2)	2/2 (2)	2/2 (2)	
	18		2/1 (2)	2/1 (2)	2/2 (2)	
	19		2/2 (2)	3/3 (2)	2/3 (2)	
	27		1/1 (2)	2/2 (2)	2/2 (2)	
	36		2/2 (2)	2/2 (2)	2/2 (2)	
	38		2/2 (2)	2/3 (2)	2/2 (2)	
39	2/2 (2)	2/3 (2)	2/1 (2)			
Domain normalized score: Mean (SD)			0.45 (0.18)	0.59 (0.19)	0.56 (0.18)	All participants: 0.54 (0.19)
D3 Workload	1	0.79	2/2 (2)	2/2 (2)	2/2 (2)	(10.03, 2, .007)
	9		2/2 (2)	2/2 (2)	2/2 (2)	
	28		2/2 (2)	3/3 (2)	2/2 (2)	2nd-3rd (-3.14, .005)
	29		2/2 (2)	2/3 (2)	2/2 (2)	
	31		2/1 (2)	2/3 (2)	2/2 (2)	
	34		2/2 (2)	3/3 (2)	2/3 (2)	
Domain normalized score: Mean (SD)			0.51 (0.22)	0.67 (0.21)	0.62 (0.21)	All participants: 0.61 (0.22)
D4 Patient treatment	12	0.74	2/2 (2)	2/2 (2)	2/2 (2)	(4.63, 2, .131)
	25		1/1 (2)	2/2 (2)	2/2 (2)	
	35		3/3 (2)	3/3 (2)	3/3 (2)	
	41		1/1 (2)	1/1 (2)	1/1 (2)	
Domain normalized score: Mean (SD)			0.50 (0.21)	0.59 (0.16)	0.57 (0.16)	All participants: 0.56 (0.18)
D5 Clinical training	7	0.71	2/2 (2)	2/2 (2)	2/1 (2)	(4.54, 2, .103)
	8		2/2 (2)	2/2 (2)	2/1 (2)	
	37		2/3 (2)	3/3 (2)	3/3 (2)	
	40		2/2 (2)	2/2 (2)	2/2 (2)	
Domain normalized score: Mean (SD)			0.61 (0.21)	0.65 (0.21)	0.54 (0.25)	All participants: 0.60 (0.23)
D6 Performance pressure	5	0.64	2/2 (2)	3/3 (2)	3/3 (2)	(14.73, 2, <.001)
	6		2/1 (2)	2/3 (2)	3/3 (2)	2nd-3rd (-2.85, .013)
	10		2/2 (2)	3/3 (2)	3/3 (2)	2nd-4th (-3.71, .001)
Domain normalized score: Mean (SD)			0.58 (0.21)	0.72 (0.20)	0.76 (0.22)	All participants: 0.69 (0.22)

(Continues)

TABLE 4 (Continued)

Domains	Questions	Cronbach's alpha	Median/mode (range)			K-W test (chi-sq, df, p) with M-W post hoc (z, adj. p)
			2nd year	3rd year	4th year	
D7 Social stressors	15	0.82	1/1 (2)	2/3 (2)	2/3 (2)	(1.66, 2, .436)
	16		1/1 (2)	1/1 (2)	1/1 (2)	
	26		2/1 (2)	1/1 (2)	1/1 (2)	
	32		1/1 (2)	1/1 (2)	1/1 (1)	
	33		1/1 (2)	1/1 (2)	1/1 (2)	
Domain normalized score: Mean (SD)			0.29 (0.21)	0.37 (0.26)	0.33 (0.23)	All participants: 0.33 (0.23)

item for all the academic years was 'responsibility of getting suitable patients'. Other stressful items were linked to endodontic complications, with 'fear of perforation during root canal treatment' in the second and third years, 'fear of instrument fracture' in the third and fourth years and 'fear of blockage and abutment' in the third year. Other stress-inducing questions were 'transition from pre-clinic to clinic endodontic work' and 'shortage of allocated time' in second year, 'examinations and quizzes' and 'difficulty to treat complex teeth' in the third year and 'patients being late or not showing for their endodontic appointment' in the fourth year. The third-year students were in general more stressed than both their second- and fourth-year equivalents in each endodontic stress domain, except 'endodontic patient treatment'. The results of the analysis of the domain normalized scores in Table 5 showed no significant difference between the three groups of students in the domains 'faculty and administration', 'endodontic workload' and 'endodontic clinical training'. Meanwhile, the other domains showed significantly different scores in at least two out of three cohorts of students according to the results of Kruskal-Wallis and post hoc Mann-Whitney tests presented in Table 5.

Questionnaire comparison

The results are provided in Table 6 for students in each year separately, as well as for all participants. A comparison of the 21 common questions in the DES questionnaire and the endodontic stress questionnaire revealed that the stress score (median and mode) was equal or lower for the endodontic stress questionnaire than in the DES questionnaire for 17 questions, being significantly lower for 13 questions, all years combined (Table 6). Among the 21 common questions, only the items 'transition from preclinic to clinic (endodontic) work', 'responsibility of getting suitable patients', 'lack of confidence in own decision making' and 'shortage of

allocated clinical time' recorded a higher stress score in the endodontic stress questionnaire than in the DES, but with no significant difference while considering all years combined (Table 6).

Qualitative study

The final number of interviewees was 17 (5 females and 1 male student from third year; 3 female and 2 male students from fourth year and 4 female and 2 male students from fifth year). The mean age of the focus group sample was 23.29 years (± 2.54). The average duration of the interview was 51.65 min (± 7.25). The students' perceptions of the stress related to their dental studies or specifically linked with endodontics were reported in direct quotes (year of the student-student number in his/her group), organized into main categories. Seven distinct categories were identified from the text.

Patients

Selected students reported that patient management could generate considerable stress: 'the patient stuff is probably the most stressful, because it is out of our control' (5-S1). For example, a patient's continual absence for long appointments (with loss of clinical time) or certain patient's high expectations are difficult to manage for students. The students suggested that a patient management team could be created to book patients, interact with patients on appointment and administrative queries and refer the patient to the emergency department if required. Further stress originated from the fact that the patients were not allocated to students for specific procedures but for holistic care; however, a predetermined volume of specific procedures was required in some disciplines, which led students to conclude 'dental studies here really rely on luck' (3-S3) and to propose: 'if they could allocate us patients' (3-S2).

TABLE 5 Summary for scores of the endodontic stress questionnaire.

Domains	Questions	Cronbach's alpha	Median/mode (range)				K-W test (chi-sq, df, p) with M-W post hoc (z, adj. p)			
			2nd year	3rd year	4th year					
D1 Endodontic self-efficacy beliefs	11	0.85	2/2 (2)	2/3 (2)	2/1 (2)	(8.26, 2, .016)				
	22		2/2 (2)	2/2 (2)	2/2 (2)					
	23		2/2 (2)	2/2 (2)	1/1 (2)					
	24		2/2 (2)	2/2 (2)	1/1 (2)					
Domain normalized score: Mean (SD)							All participants: 0.54 (0.26)			
D2 Faculty and administration	17	0.69	1/1 (2)	2/2 (2)	1/1 (2)	(1.06, 2, .589)				
	19		1/1 (2)	2/2 (2)	2/3 (2)					
	36		1/1 (2)	2/1 (2)	2/2 (2)					
	38		3/3 (2)	2/2 (2)	2/2 (2)					
	39		2/2 (2)	2/3 (2)	1/1 (2)					
Domain normalized score: Mean (SD)							All participants: 0.55 (0.21)			
D3 Endodontic workload	1	0.85	2/1 (2)	2/2 (2)	1/1 (2)	(2.95, 2, .228)				
	2		2/1 (2)	1/1 (2)	1/1 (2)					
	3		2/2 (2)	2/1 (2)	1/1 (2)					
	9		1/1 (2)	1/1 (2)	1/1 (2)					
	29		2/1 (2)	2/2 (2)	2/2 (2)					
	34		1/1 (2)	2/2 (2)	2/1 (2)					
	Domain normalized score: Mean (SD)							All participants: 0.49 (0.20)		
	D4 Endodontic patient treatment		4	0.79	2/2 (2)		2/3 (2)	2/2 (2)	(18.68, 2, <.001)	
6		2/1 (2)	2/1 (2)		2/2 (2)					
12		2/2 (2)	2/1 (2)		2/2 (2)					
35		2/2 (2)	2/3 (2)		3/3 (2)					
43		2/1 (2)	2/3 (2)		2/2 (2)					
Domain normalized score: Mean (SD)							All participants: 0.58 (0.25)			

(Continues)

TABLE 5 (Continued)

Domains	Questions	Cronbach's alpha	Median/mode (range)			K-W test (chi-sq, df, p) M-W post hoc (z, adj. p)
			2nd year	3rd year	4th year	
D5 Endodontic clinical training	7	0.92	2/1 (2)	2/2 (2)	2/1 (2)	(4.98, 2, .083)
	8		2/2 (2)	2/2 (2)	1/1 (2)	
	13		2/2 (2)	2/2 (2)	2/2 (2)	
	14		2/2 (2)	2/2 (2)	2/2 (2)	
	15		3/3 (2)	3/3 (2)	2/3 (2)	
	16		2/3 (2)	3/3 (2)	2/3 (2)	
	18		2/2 (2)	3/3 (2)	3/3 (2)	
	20		1/1 (2)	2/2 (2)	2/1 (2)	
	21		2/2 (2)	3/3 (2)	2/2 (2)	
	25		2/2 (2)	2/2 (2)	2/2 (2)	
	26		1/1 (2)	2/2 (2)	1/1 (2)	
	27		1/1 (2)	2/1 (2)	2/2 (2)	
	28		2/2 (2)	2/2 (2)	2/2 (2)	
	30		2/2 (2)	2/2 (2)	2/1 (2)	
	31		2/1 (2)	2/2 (2)	2/2 (2)	
	32		2/1 (2)	2/2 (2)	2/1 (2)	
33	2/2 (2)	2/2 (2)	2/2 (2)			
37	3/3 (2)	3/3 (2)	3/3 (2)			
40	3/3 (2)	2/3 (2)	2/1 (2)			
41	2/2 (2)	2/2 (2)	2/2 (2)			
Domain normalized score: Mean (SD)			0.53 (0.18)	0.63 (0.19)	0.54 (0.21)	All participants: 0.57 (0.19)
D6 Performance Pressure in endodontics	5	0.68	2/2 (2)	2/2 (2)	2/2 (2)	(11.00, 2, .004)
	10		2/2 (2)	3/3 (2)	2/2 (2)	2nd-3rd (-3.29, .003)
	42		2/2 (2)	2/2 (2)	2/2 (2)	
Domain normalized score: Mean (SD)			0.51 (0.19)	0.69 (0.22)	0.62 (0.26)	All participants: 0.61 (0.24)

TABLE 6 Results of analysis for common questions in both questionnaires.

Questions	2nd year	3rd year	4th year	All participants
	<i>p</i> -Value			<i>Z</i> (<i>p</i> -Value)
1	.023	.006	<.001	-5.37 (<.001)
5	1.000	.178	<.001	-3.04 (.002)
7	.007	.033	.071	-3.84 (<.001)
8	1.000	.394	.072	-0.64 (.522)
9	.008	.004	.007	-4.76 (<.001)
10	.005	.239	.002	-3.87 (<.001)
11	.105	.035	<.001	-4.92 (<.001)
12	.532	.516	.194	0.63 (.527)
17	.317	.012	.049	-3.17 (.002)
19	.018	.001	.095	-4.22 (<.001)
22	.068	.317	.439	1.41 (.159)
23	.117	.371	.013	-0.98 (.329)
24	.841	.637	.005	-2.12 (.034)
29	.068	.005	<.001	-4.72 (<.001)
34	.095	<.001	<.001	-5.53 (<.001)
35	.028	.014	.102	-3.62 (<.001)
36	.011	.275	.317	-2.67 (.008)
37	.48	.225	.467	0.74 (.460)
38	.194	.465	.532	0.00 (1.000)
39	.857	.289	.039	-0.44 (.659)
40	.371	.049	.102	0.62 (.535)

Clinical procedure

The majority of students described that a major component of their stress, particularly in the third year, stemmed from two principal factors: difficulty in transition between theory and clinical practice, and a lack of clinical experience 'because there are loads of procedures we have never done before' (4-S4). The students acknowledged the positive role of laboratory practical sessions to overcome these difficulties. They proposed more laboratory sessions in their curriculum and an open access policy to the clinical skills laboratory in order to practice. However, some of the students reported no laboratory experience can prepare the student for clinical endodontics (patient, pain, anaesthetic etc.). Other sources of stress during clinical endodontic procedures can relate to unclear diagnosis, difficulties and complications that arise during endodontic treatment or the fact that root canal treatment is a 'blind' procedure in that the effects of their instrumentation cannot be visualized. Endodontic treatment is considered by many students as the last conservative treatment before extraction and that increases the pressure, especially since they are aware that 'a lot of endos are best in hands of

endodontists... you feel that you are not the right person to do it' (4-S1).

Notably, the students also identified sources of confidence in endodontics. 'Before you learn endo, the concept of root canal is very scary... but in the lab it wasn't difficult on the moment. That's what makes you think that it is actually manageable' (4-S1). They also noticed that they always use the same logical procedure: 'I feel like endodontics itself is very logical. If you understand the concepts, you only have small adaptations' (4-S5). They also appreciated that the endodontic procedure is generally calm and peaceful, with all the necessary equipment available in the clinic. Some final-year students concluded that as they have done a lot of endodontic treatments over the years, they are not so stressed anymore and although endodontics is more stressful than periodontology, it is generally less stressful than either prosthodontics or surgery.

Organization

Most of the students complained about the workload, with many competing academic, clinical and administrative

tasks. Furthermore, they were requested to nurse for themselves and carry out prosthodontic laboratory work. In order to improve, some of them suggested 'if a bit of the administration was done for us, that would be great' (4-S1), while others proposed 'to ask first-year or second-year students to come and assist fourth or fifth-year students... not only do you get assistance, but they learn a lot as well' (4-S5). In addition to helping students, that could make the clinical system more efficient according to them. Finally, they would like to have more X-ray 'satellite' rooms and more clinical sessions.

Staff

Students felt that most supervisors were helpful and supportive, with only a few difficult to deal with and stressful to work under. There is often a lack of consensus between supervisors which can put students in a difficult situation. The undergraduate students reported less difference between supervisors' opinions in endodontics, even if they acknowledged that their stress level in the clinic 'depends on the personality of the endodontist' (5-S6). Due to the limited number of endodontists in the clinic sometimes students have to wait protracted periods for them or for the general supervisor and suggested that they should be increased in number. In relation to staff in general, the students proposed 'a counsellor in the building... a well-being officer... just someone you feel good to talk openly to' (5-S5), pointing out that 'there is not a lot of people looking at our mental health' (5-S4).

Academic education

In this University, the curriculum is taught using a problem-based learning (PBL) approach, supplemented with lectures in certain subjects and didactic laboratory sessions. The students recognized that PBL has advantages, by teaching how to look for information, to answer problems or to self-direct. However, no one has the same tutor and consistency in teaching suffers as the reading lists are too wide. That is why they would like more recap lectures, after the PBL, to avoid the situation where 'at the end, you end up with all these massive gaps in your knowledge' (5-S5). On the contrary, laboratory sessions are considered very helpful although they could still be improved using teeth resembling more closely actual teeth. The students also think that: 'it would be great to learn skills in the lab and then straight away turn to patients, to have some clinical experience just after learning it' (3-S2). The students suggested that they have a very good teaching in endodontics in general (theoretical, practical and

clinical teaching), which could still be improved by more endodontic clinical scenarios and by placing the use of rotary endodontic instruments earlier in the undergraduate course.

Evaluation

Evaluation is a source of considerable stress. It is organized through written and oral examinations, objective structured clinical examination (OSCE), reflective portfolios and documentation of procedure numbers, as well as formal observed laboratory and clinical competencies. While all the students reported that 'getting all the procedures done is stressful' (5-S5), final years also said that 'the numbers we are requested to complete, are very sensible though' (5-S4). In the same way, competencies (observed and graded clinical treatment) can be stressful for the students: 'because we have so few clinics this year, trying to make competencies as well is very stressful' (3-S2) and they call for centralized patient allocation for these assessments. This improvement could be particularly useful for the endodontic competence test (graded root canal treatment on a specific tooth), to avoid 'that pressure to find that patient, you know...' (4-S5).

COVID-19 related issues

In general, the influence of COVID-19 has exacerbated stress linked to other factors. During the COVID period, after the reopening of the dental university hospital, patient management was more complicated, due to more cancellations as a result of COVID positive and close contacts, but also more patients requesting appointments. Moreover, most of the students complained of a lack of clinical experience, either due to the COVID break in 2020 (fourth and fifth years impacted) or a reduced availability of the clinic (third years more impacted) when it reopened. Some students described a lack of confidence 'With COVID, it was super stressful because... I wasn't in a right mindset, I feel, I didn't know my stuff enough' (4-S4). Others reported a difficulty to meet the requirements, which were not significantly altered from pre-COVID times: 'that means that I feel pressured to treat as many patients as I can, to make up the loss of time that I had' (4-S5). However, students' perceptions differed according to their year of study, from 'to be fair to the dental hospital... our class feel that, we have been supported, in continuing our education and getting through' (5-S5) versus 'we are like forgotten' (3-S3). They acknowledged that COVID had a few positive effects in the clinic: the nurses and nurse students are now more available to help the students (as

a result of enhanced infection-control measures) and the third year-students now work in pairs, which 'is great to learn from your partner doing the treatment' (3-S4). They also highlighted that the laboratory sessions improved with a smaller number of students in each session and a better ratio of students to staff. They would like these changes to continue in the future. However, some students complained about the enforcement of strict COVID rules in School, with a limitation of the school social life, for example, a restricted access to the common room which was 'such a place for us to be close, after clinic... you could hang around there and laugh' (5-S4). They also regretted having online evening lectures since the COVID outbreak, which resulted in tiredness and a feeling of lack of personal time, which is also reinforced by the fact that the academic year was reorganized with a shorter break. Generally speaking, the students suffered from COVID in their extra-mural university life with restrictions, such as a limited social or leisure life, and a low access to family life for international students due to travel restrictions, which were usual ways to release pressure. The lack of relaxation could have an effect on their mental health: 'I had a lot of breakdowns this year, because of COVID and because of school' (3-S5).

It seems that student stress is multifactorial: 'It is all the moving pieces...it is not like one...it is not just the procedure, it is the moving pieces' (5-S5).

DISCUSSION

Mixed-method research is defined as a research that incorporates a combination of both quantitative and qualitative methods of data collection and analysis. This method was chosen specifically in this study in order to have qualitative data to put in context the initial quantitative results, and especially any confusing, contradictory or unusual survey or questionnaire responses (Creswell & Creswell, 2017).

The principal stressors identified in the DES questionnaire were, in descending order, 'performance and pressure', 'workload' and 'clinical training'. The corresponding items in the qualitative analysis were 'evaluation', 'organization' (and the resulting workload) and 'clinical approach', with discussions around these demonstrating that students find attaining the number of required clinical treatments and completing competencies particularly stressful due to a shortage of clinical time and lack of allocated patients. The fact that the students have multiple clinical and educational tasks to perform adds to their stress by increasing the workload and the mental load. Notably, the transition from preclinical to clinical years in the third year seems to be a particularly stressful

time because of the difficult switch from theory to clinical practice, and the obvious lack of clinical experience. Although patient-generated stress was identified by the DES (among the questions recording the highest level of stress), it was even more apparent from the subsequent qualitative analysis. The qualitative part also addressed the stress and stressors linked to COVID-19. Indeed, the pandemic also affected the study plan, with global events unintentionally separating the quantitative study from the qualitative part and the pandemic exacerbating the existing stress and having created new sources of stress. As a result, to address this issue within the study, and to assess the impact of COVID-19 on student stress, all COVID-19 aspects were gathered in a separate 'COVID-related issues' category within the qualitative study. This category highlighted difficulties in patient management after the pandemic (high demand for treatment, but frequent cancellation), a lack of clinical time, as well as a shortage of experience and confidence to perform clinical procedures. In a separate study, post-COVID stress gathered insecurity in their clinical treatment skills after the COVID break with an accompanying fear of COVID-19 infection (Garcia et al., 2022). In contrast within this study, the students of the present study did not mention any stress linked to contracting COVID-19 in the dental hospital, potentially because they were aware that strict infection control protocols ensure safety within the laboratory and clinics (Sukumar et al., 2021). The analysis also revealed social consequences including a loss of conviviality and interactions in the dental school environment, combined with a restricted extra-mural social and leisure life. Students' stress due to factors outside of the course, seems easily understandable because social support from family and friends and pursuit of hobbies are generally recognized to play a positive role in modulating stress (Muirhead & Locker, 2008; Freeman et al., 2000; Jenkins et al., 2019).

The results of the DES questionnaire demonstrated that clinical students had higher stress indicators compared with preclinical students, a finding that is in line with previous literature (Alhaji et al., 2018; Smolana et al., 2022). The DES questionnaire was used in other studies, which revealed that the three most stressful domains were 'performance and pressure', 'self-efficacy beliefs' and 'workload' (Alhaji et al., 2018; Polychronopoulou & Divaris, 2009). Notably in our study, 'clinical training' replaced 'self-efficacy beliefs' among the most stressful domains. According to the qualitative aspect of the study, this could be attributed to the problem-based learning (PBL) programme, which has been in the curriculum of this dental school for many years and may have resulted in higher self-efficacy beliefs among students through problem-solving and self-management skills. This could also be attributed

to the increased opportunities for self-assessment, peer interaction and collaboration that are inherent in the PBL design (Winning & Townsend, 2007). However, as in other studies, the transition from preclinical to clinical training remained stressful (Alzahem et al., 2013) and laboratory training was acknowledged as a helpful way to overcome some of these difficulties (Kashbour et al., 2019), even if it was not always described as ideal in literature (Botelho et al., 2018). Supervisors were considered helpful despite the fact that some could be stressful to deal with (Alzahem et al., 2011). The students pointed out that consensus between supervisors was an important factor to decrease stress and enhance learning (Botelho et al., 2018; Elani et al., 2014; Silverstein & Kritz-Silverstein, 2010). The most stressful items were linked with examination, quizzes and clinical requirements, as well as dealing with difficult patients or recruiting suitable patients, in line with the literature (Botelho et al., 2018; Elani et al., 2014).

The qualitative aspects of this study provided not only a better and deeper understanding of the stressors, but also gave students the opportunity to mention some sources of confidence and to propose potential improvements within each category (Table 7). While some of the suggestions are difficult to implement or are dependent on strategic decisions by senior members of faculty staff, other educational suggestions have previously been reported in the literature. For example, the students wished more structured and unstructured laboratory time, findings which were highlighted previously (Kashbour et al., 2019; Chevalier et al., 2021). Laboratory simulation sessions have proven to facilitate the development of specific psychomotor skills, which have been shown to improve the ability to carry out dental treatment (Perry et al., 2015; Widbiller et al., 2018). Interestingly, some students proposed to continue the practice of working in pairs, a policy that was only introduced after the start of the COVID-19 pandemic. Students generally perceive peer support activities as less stressful, as they involve open discussion (Kashbour

et al., 2019) and have noted the importance of a counsellor or a well-being officer. These support mechanisms could be accompanied by innovative teaching techniques to encourage stress management (Alzahem et al., 2011, 2014; Stormon et al., 2019).

With specific regard to endodontics, the qualitative study elaborated on the quantitative findings. It seems a component of student stress is linked to diagnostic uncertainties, and the inability to visualize the root canal preparation when working in the canal, while other stress was associated with a fear of complication and the effective acquisition of radiographs as has been shown elsewhere (Dahlström et al., 2017; Luz et al., 2019; Tavares et al., 2019). Students were also stressed about recruiting sufficient endodontic patients to meet the endodontic requirements to pass the year because in this dental school like in other ones, the distribution of endodontic patients is made randomly (Luz et al., 2019). As previously shown (Luz et al., 2019), students in this study emphasized, that the hands-on practical sessions helped to reduce their stress during endodontics; however, they also pointed out that a few aspects like the difficulty in gaining anaesthesia or pain management cannot be properly dealt with in laboratory sessions. The students also highlighted that their stress is reduced in endodontics because they are well-equipped to carry out endodontic treatments in the clinic, which is not always the case (Luz et al., 2019). A good level of consensus between endodontic supervisors is also mentioned as a source of confidence, in line with the literature (Botelho et al., 2018).

The comparison between the DES questionnaire and the endodontic stress questionnaire highlighted that the transition from pre-clinical training to the clinic was significantly more stressful in endodontics (Frese et al., 2018); this suggests that modifications may be necessary in the style or volume of preclinical training programme in order to make the transition to the clinic less stressful (Davey et al., 2015; Luz et al., 2019; Mirza, 2015). In contrast, a comparison of the common

TABLE 7 Students suggestions of improvements.

Categories	Improvements suggested by students
Patients	Creation of a patient management team
Clinical procedure	More laboratory sessions and a free access to the clinical skills laboratory
Organization	The dental university hospital to take responsibility rather than student for administrative, nursing or prosthodontic work
Staff	More staff and a counsellor in this dental university hospital
Academic education	More revision lectures after PBL
Evaluation	Patient allocation for assessment
COVID-19 related issues	Continuation of pair work in some clinics and of nurse assistance

items in both questionnaires generally highlighted lower stress scores for the endodontic questionnaire than for the DES. This was not shown in other investigations, which reported that students often consider endodontics a highly stressful area (Luz et al., 2019; Pöhlmann et al., 2005; Roudsari et al., 2022). The qualitative study provides a possible explanation for the lower endodontic stress observed in this dental university hospital which included; the nature of the teaching in endodontics (theoretical, practical and clinical teaching), the consensus between endodontic supervisors, the use of a logical, progressive procedure and the considerable experience that students gain over the years of their course.

The mixed-method of this study, both quantitative and qualitative, facilitated an analysis of the quantitative results that increased confidence in the findings. Another strength of this study is the comparison of general and endodontic-related stress within the same cohort of students, which is rare in the literature to date. The findings presented in this study could be extrapolated to other universities; however, this should be done with caution as the student cohort comes from a single dental university hospital with a unique academic teaching and clinical training organization. A potential limitation of this study is related to the use of endodontic stress questionnaire, which is bespoke and has not been tested through a pilot study and contains only 21 common questions; however, it is accepted that all questionnaires and even the established DES questionnaire have limitations (Sanders & Lushington, 2002; Schéle et al., 2012). For the sake of simplicity, a simplified version of the DES was used, in a similar way to another recent study (Alhajj et al., 2018), but the reduced Lickert scale may also be seen as a limitation. It would be worth to also use the extended normal version of the DES (Garbee Jr., 1981). Another limitation of a mixed-method study can be that the accuracy of the overall findings may be compromised because the researcher does not explore all of the options to follow up the quantitative results (Creswell & Creswell, 2017). To avoid this, the researchers, who came from different backgrounds, tried to consider together all options for identifying results that could be followed up before focusing on one approach. During the focus groups, some interviewees may be reticent to share their opinions in front of the group, while other speakers can monopolize the conversation (Dahlström et al., 2017). To limit this within this study, the investigator encouraged all the students to react and to reflect on other participants' opinions. However, the participants were not invited to read the verbatim and to check the findings after transcription and analysis which could constitute a limitation. Another limitation of this study is definitely/obviously linked to COVID-19 outbreak during the course of the study, which delayed the qualitative part

of the investigations and added new sources of stress. On the positive side, this enabled us to study the effects of such a pandemic on student stress.

CONCLUSIONS

Within the limits of this study, the principal sources of stress among preclinical and clinical dental undergraduate students were related to performance and pressure as well as workload and clinical training. The qualitative analysis highlighted that working with patients was very stressful as students felt it was not completely under the student's control. This analysis also showed that the outbreak of COVID-19 pandemic increased student stress. The stressors specifically linked to endodontics and root canal treatment were related to 'self-efficacy beliefs', 'endodontic clinical training' and 'faculty and administration' in early years, while they were 'endodontic patient treatment', 'performance pressure in endodontics' and 'clinical training' in later years. A comparison of the level of stress in general dentistry compared with endodontics generally showed a reduced stress in endodontics.

AUTHOR CONTRIBUTIONS

VC: conceptualization (equal), investigation (lead), formal analysis (equal), validation (equal) and writing (lead). ALFB: formal analysis (equal) and validation (equal). BH: statistical analysis. HFD: conceptualization (equal), project administration (lead), resources (lead), supervision (lead), methodology (lead), and writing—review and editing (lead).

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CONFLICT OF INTEREST STATEMENT

The authors deny any conflicts of interest related to this study.

DATA AVAILABILITY STATEMENT


The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The approval to conduct the work was obtained from the Research Ethics Committee of Dublin Dental University Hospital (DDUH) (N° 2019-11-01).

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