

REVIEW ARTICLE

How does gender influence student learning, stress and career choice in endodontics?

Johanna Kichenin¹  | Karen Vallaey^{1,2} | Reza Arbab Chirani^{1,2}  |
Henry Fergus Duncan³  | Valerie Chevalier^{1,4} 

¹Brest University Hospital, University of Bretagne Occidentale, Brest, France

²UMR 1101, LATIM, University of Bretagne Occidentale, Brest, France

³Division of Restorative Dentistry and Periodontology, Dublin Dental University Hospital, Trinity College Dublin, Dublin, Ireland

⁴UMR CNRS 6027, IRDL, University of Bretagne Occidentale, Brest, France

Correspondence

Valerie Chevalier, Brest University Hospital, University of Bretagne Occidentale, 22, rue Camille Desmoulins, 29200 Brest, France.
Email: valerie.chevalierherisset@univ-brest.fr

Abstract

The influence of gender is underexplored in endodontic educational research. This review examines the effect of gender on learning within the domains of skill acquisition, performance and difficulties encountered. It also analyses the stress and confidence experienced by male and female students during clinical endodontics, as well as their preparedness at the end of their undergraduate studies. Finally, this review analyses the influence of gender on student career choices in dentistry with a focus on endodontics. The review highlights that gender is invariably studied as a secondary outcome in endodontic education. Based on current evidence, it appears that female students tend to underestimate their skills and knowledge more than male counterparts in endodontics. They are also often more stressed than males, feeling less confident and not as prepared. A recognition of gender differences in learning and stress management is important. Student aspirations regarding their choice of endodontic postgraduate speciality appear to be relatively well balanced in terms of gender. Finally, there is a need for further research to elucidate more clearly the impact of gender in endodontic education and endodontic career choice.

KEYWORDS

career choice, dental education, endodontics, gender, learning, student stress

INTRODUCTION

A European Commission report on gender equality noted that gender stereotypes are obstacles for both men and women. These stereotypes influence family and individual choices such as education, training and employment, which contribute to the persistence of inequalities (European Commission, 2010).

From childhood, there remains a stereotype that females lack talent, a perception which is observed in almost all of the 72 participating countries in the Organization for Economic Co-operation and Development (OECD) Programme for

International Student Assessment (PISA) in 2018 (Napp & Breda, 2022). These stereotypes are also present in western countries that are considered more gender-egalitarian. There is also a gender gap in terms of self-esteem, with females generally exhibiting lower worth (Napp & Breda, 2022). Notably, females tend to have better academic performance than males (Parajuli & Thapa, 2017) despite similar intellectual abilities. Females outperform males in written expression and in exercises that require them to evaluate and improve on the ideas of others (OECD, 2024).

Specifically, regarding students, men have been shown to have a motor-speed advantage relating to

single mental and manual skills, whereas women are faster at programming a sequence of speech or manual movements (Nicholson & Kimura, 1996). Men tend to outperform women on mental rotation and spatial orientation tests, whilst conversely, women outperform men in object location memory tests (for test definitions see Table 1; Cimadevilla & Piccardi, 2020). A study using the Learning and Study Strategies Inventory (LASSI) scales (Table 1) amongst medical students demonstrated that women and men have different learning strategies (Saxena et al., 2024). Women performed better than men in their attitude and interest, and in using academic resources, whilst men had higher scores than women in information processing and identifying the main idea (Saxena et al., 2024). There were no differences; however, for concentration, motivation and time management (Saxena et al., 2024).

In dentistry, the same trends between both genders were also highlighted. A study using the Acquisition, Encoding, Retrieval, Support (ACRA) scale (Table 1) showed significant differences in some of the assessed learning strategies, with females scoring higher in the domains of cognitive and learning control strategies and learning support strategies, whilst there was no difference in other domains, such as study habits (Bordoni et al., 2022). Although female dental students prefer more varied learning modalities (e.g. auditory, kinesthetic, visual) than males, there is no significant difference between genders in the most common single learning preferences (aural [20 percent] followed by kinaesthetic [15.2 percent]; Al-Saud, 2013). Another study assessing spatial ability confirmed the significant gender differences, with male dental students scoring higher than females in the Revised Purdue Spatial Visualization Test and the Mental Rotation Test (Table 1; Sarilita et al., 2022).

Most studies showed higher levels of general and academic stress in female students than in their male counterparts (Graves et al., 2021; Shaw et al., 2017; Thawabien & Qaisy, 2012), with only a few investigations reporting the opposite (Rahardjo et al., 2013). Thawabien and Qaisy (2012) demonstrated that female students were more likely to experience higher levels of stress and that they reported stress-related issues, such as low self-esteem, exam pressure and depression. In medicine, female students are also often described as experiencing more academic stress than male colleagues (Backović et al., 2012; Dyrbye et al., 2006; Moutinho et al., 2017), a finding also shown in dentistry (Alzahem et al., 2011; Elani et al., 2014).

Although society continues to promote equality and diversity, the impact of gender stereotypes is still present in men's and women's career plans throughout medicine. It has been highlighted that for both genders, lifestyle

and work-life balance become the principal factors influencing the choice of medical specialty (Pugazenthi et al., 2023; Riedel et al., 2022). However, women remain more influenced than men by issues such as family concerns and maternity needs, whilst men place more weight on factors related to their careers, professional success, lifestyle and income (Pugazenthi et al., 2023, Riedel et al., 2022). Encouragement and the presence of a mentor or positive experiences during clinical internships have a major influence on career choice (Riska, 2011). A qualitative study focused on dental professions indicated that women choose dentistry as they want to work with people and prefer formal salaried employment. Men would desire it for professional status and the flexibility of being self-employed (da Graça Kfoury et al., 2017).

As gender differences have been demonstrated in general learning, in medicine and in dentistry, the aim was to assess the influence of gender on learning, preparedness, confidence, anxiety and stress on undergraduate dental students in endodontics worldwide. A further aim was to assess if choosing endodontics as their postgraduate speciality by undergraduate dental students was influenced by gender.

SEARCH METHODOLOGY

Although this review is a narrative review, the literature was searched using a systematic approach. Two authors (JK and VC) made a preliminary search in May 2024 in PubMed and Scopus with no publication date limit by applying appropriate keywords. Only publications in the English language were included. The search included keywords such as “gender”, “education”, “endodontics”, “perceived stress”, “dental students”, “undergraduate” and “confidence”. The titles and abstracts were selected, initially scanned for relevance before reading to consider if the manuscripts addressed the question of gender influence on student learning, stress (or confidence) as well as career choice in endodontics. If the article was deemed to be relevant, it was read in full to inform the review. Additionally, a manual search was performed in the *International Endodontic Journal*, *Journal of Endodontics* and *European Journal of Dental Education* to include articles that may not have been discovered during the online search.

RESULTS

The data search identified 35 original articles coming from 16 countries (Figure 1). The results were analysed in 6 subsections.

TABLE 1 Description of the measurement tools described in the review (Following references were used in this table; Bocchi et al., 2020; de la Fuente Arias & Justicia Justicia, 2017; Javed et al., 2024; Ray et al., 2016; Sarilita et al., 2022; Saxena et al., 2024; Spielberger, 1989; Tascón et al., 2017).

Abbreviated name of the measurement tool (if applicable)	Name of the measurement tool	Ability tested	Description of the tool
MRT	Mental rotation test	Mental rotation	Test which measures the ability to view a 3D object and to determine which two of several alternatives displays the same object, rotated to a different position (24 problems with two answers each)
	Spatial orientation test	Spatial orientation or memory	Set of virtual reality-based tasks with different scenarios testing the ability to navigate in an environment in constant change
	Object location memory test	Object location memory	For example, the Walking Corsi Test: persons asked to learn a path enriched with 3 landmarks. Then, they are asked to recognize the landmarks encountered along the path and locate them on a configuration of the spatial array
PSVT-R	Revised purdue spatial visualization test	Spatial visualization	Test which measures the ability to visualize an unfamiliar 3D object from a different perspective to that shown in the test (30 problems with one answer each)
LASSI scales	Learning and study strategies inventory	Learning strategies	The 10 LASSI scales are self-assessed by students: anxiety, attitude, concentration, information processing, motivation, selecting main ideas, self-testing, test strategies, time management, use of academic resources. Higher scores in a LASSI scale correspond with strength in that domain, whereas lower scores mean a need for improvement in this area
ACRA scale	Acquisition, Encoding, Retrieval, Support	Learning strategies	The ACRA instrument assess the 4 phases of processing an information: Acquisition, Encoding, Retrieval and Support through 14 self-assessed themes. These themes describe learning strategies relating to: conscientiousness, elaboration, motivation, planning, comprehension, underlining, support, repetition, timetabling, conditions, habits, control, motivation
STAI-T	Spielberger STAI-Trait	Anxiety	The STAI-T questionnaire contains 20 items rated one to four. The higher the score, the higher the anxiety. The STAI-T scale characterizes anxiety, by assessing the way subjects feel in general
STAI-S	Spielberger STAI-State	Anxiety	The STAI-S questionnaire contains 20 items rated one to four. The higher the score, the higher the anxiety. The STAI-S scale characterizes anxiety, by assessing the way subjects feel before a special event/action, which is important to them
DU-PAS	Dental Undergraduates Preparedness Assessment Scale	Preparedness	The Dental Undergraduates Preparedness Assessment Scale consists of 50 items divided in two sections. Section A has 24 items related to clinical skills and responses are measured on a three-point scale: 0 = no experience, 1 = with help, 2 = independently. Section B has 26 items related to cognitive and behavioural attributes and is also measured on a three-point scale: 0 = no experience, 1 = mostly, 2 = always. The cumulative score on DU-PAS is 100
GAPP	Graduate Assessment of Preparedness for Practice questionnaire	Preparedness	The questionnaire comprises 3 parts, the first of which collects respondent demographic data. The second is based on preparing for practice and is used to develop 34 'competence areas' and requires a tick-box response on a 7-category Likert Scale. The third comprises free text questions to further explore the subject's responses

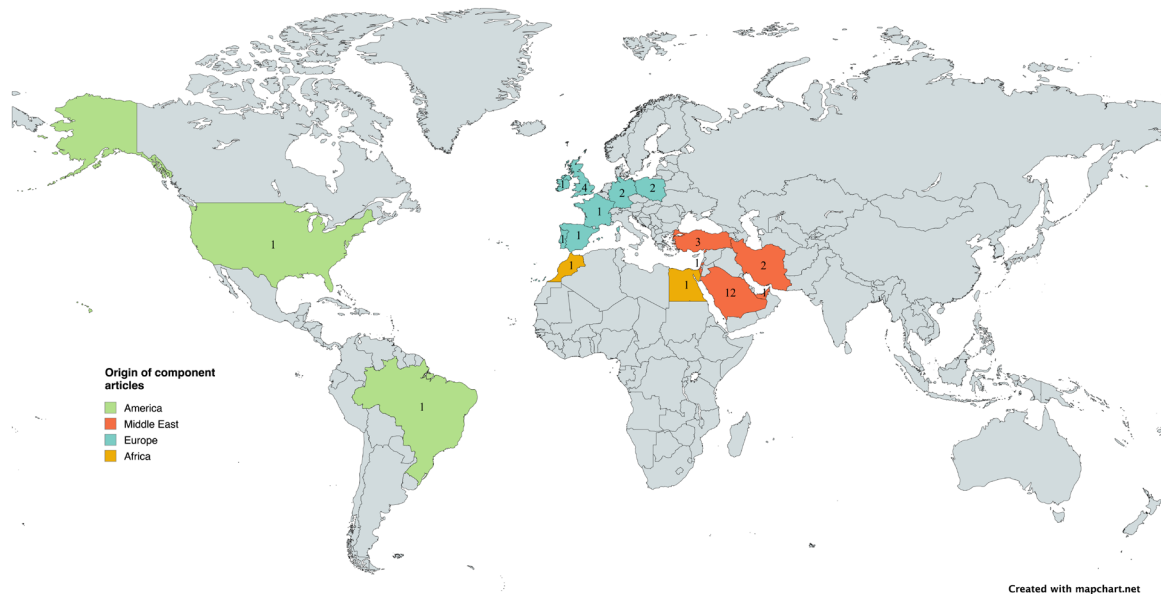


FIGURE 1 Geographical origin of component articles.

Influence of gender on knowledge and preclinical and clinical psychomotor skills in endodontics

Currently, there is a paucity of studies on the influence of gender on knowledge as well as preclinical and clinical psychomotor skills in endodontics amongst undergraduate students; however, recently, a limited number of surveys and self-assessments or assessments of undergraduate students by the teaching staff have emerged (Alghofaily et al., 2023; Alkahtany et al., 2024; Martín-Jiménez et al., 2018).

Didactic knowledge

A Spanish study investigating undergraduate dental students' knowledge of the indications for antibiotics in the management of endodontic infections highlighted that there was no significant difference between respondents in relation to gender (Martín-Jiménez et al., 2018). A separate study from Saudi Arabia demonstrated that female undergraduate students performed better in endodontic written knowledge tests/assessments with both traditional lectures and blended teaching methods, compared with male counterparts; however, there was not a significant difference between male and female students in practical exams (Alghofaily et al., 2023). The study had a significant methodological bias, as the male and female students were based in two separate campuses with likely differences in the learning environment (Alghofaily et al., 2023). The same methodological bias was present in another study, which compared male and female

undergraduate students on their didactic knowledge of master gutta-percha cone selection during root canal treatment (Alkahtany et al., 2024). Most students demonstrated a good knowledge of cone selection and were able to define procedural endodontic terms such as ‘tug -back’ and ‘apical stops’, but women understood significantly more about root canal flaring assessment techniques (Alkahtany et al., 2024).

Preclinical and clinical psychomotor skills

Gender influence on root canal filling was investigated by another study where instructors evaluated radiographically the technical quality of root canal fillings carried out by preclinical students in Saudi Arabia. They highlighted that female undergraduate students achieved significantly better results regarding the radiographic quality of root canal obturation (in length, density and taper) than male counterparts (Madfa et al., 2024). It was not clear in this study whether the male and female students were educated together or apart.

The effectiveness of a Peyton teaching approach (Table 2) during rotary root canal instrumentation instruction, in comparison with the traditional didactic demonstration methods, was investigated, and the results were compared by gender (Sturm et al., 2023). The root canal instrumentation procedures were assessed on video recording, with a checklist-based analysis employed for both educational approaches. The gender of the undergraduate students had no significant influence on the overall results or the results within the study groups, even if using the Peyton approach resulted in

TABLE 2 Description of the methodological aspects described in selected articles (from Holliday et al., 2020; Sturm et al., 2023).

Name	Description
Peyton teaching approach	The Peyton teaching approach consists of the following steps: (1) the instructor demonstrates of the entire procedure in real time; (2) deconstruction: the educator does the demonstration again, but all sub-steps are carefully described; (3) comprehension: the instructor repeats the procedure under the guidance of a student and feedback is searched; (4) performance: the student carries out the procedure on his own under supervision of the educator.
Imposter phenomenon	The imposter phenomenon is defined as a psychological construct characterized by feelings of inadequacy and an irrational fear of being discovered as a 'fraud' by colleagues and superiors.

improved performance of undergraduate students in general (Sturm et al., 2023).

The influence of gender on clinical skills was assessed by another study (Javed & Bhatti, 2023). The mean endodontic clinical grading of male undergraduate students was lower than that of female students, although male students were reported as being more confident than female students (Javed & Bhatti, 2023). Regarding the influence of gender on undergraduate student self-assessment skills and the comparison with the assessment of the teaching staff, only one study relating to Endodontics could be sourced. It highlighted that student self-assessment during practical tasks often showed over- and underestimation, with negligible differences between the genders (Huth et al., 2017); however, the study was small and this may have been due to the limited sample size.

Summary: Although there is a limited volume of available information that exhibits significant variation, based on current evidence it seems that women tend to underestimate their knowledge and psychomotor skills despite achieving equivalent, or even better academic and practical, and clinical results than their male colleagues. These observations underscore the importance of mentorship to promote the confidence, progress and development of male and female undergraduate students in endodontics.

Influence of gender on the challenges and difficulties encountered in clinical endodontics

In order to improve student learning, identifying challenges and difficulties is important. However, the influence of gender on managing the difficulties encountered during root canal treatment has not been extensively

studied, with the small number of existing investigations using mainly bespoke and non-validated questionnaires (Almutairi & Alharbi, 2024; Ghoul et al., 2023).

A recent Moroccan questionnaire with 24 items highlighted some differences between males and females regarding complications during endodontic access cavity preparation, with female undergraduate students exhibiting a higher level of fear of complications such as creating a ledge (Ghoul et al., 2023). This was used to explain why female students requested more additional sessions (Ghoul et al., 2023). This was corroborated in a second study that demonstrated a significant difference between men and women in their difficulty to de-roof the pulp chamber and to identify the number of canal entrances (Almutairi & Alharbi, 2024). Although men experienced less difficulty in these two stages, there were no significant gender differences amongst undergraduate students during the placement of the rubber dam, periapical radiography and the lateral condensation root filling technique (Almutairi & Alharbi, 2024). Another questionnaire-based study highlighted that male undergraduate students reported difficulty particularly in de-roofing the pulp chamber and determining the working length, whilst women said they encountered difficulties in positioning the X-ray tube for periapical radiography and during access cavity preparation. No statistical difference was shown between the genders regarding difficulties during the various stages of root canal treatment; the only exception was the use of mesial and distal shift techniques for periapical radiograph acquisition, which was considered significantly more difficult by women (Almutairi et al., 2023). Female undergraduates may also report making more errors in endodontics than their male counterparts; however, the outcomes of their treatments were equivalent (Abdulrab et al., 2018).

Summary: The results of the different studies highlight no clear influence of gender on the management of challenges and difficulties in clinical endodontics; however, it seems that undergraduate students of both genders need support during access cavity preparation.

Influence of gender on student stress and anxiety in endodontics

Stress

Stress is defined as mental or emotional strain placed on or experienced by a person as a result of adverse or demanding circumstances, especially the pressures of or problems (Oxford English Dictionary, 2024). The influence of gender on student stress in Endodontics has not been extensively investigated. The few available studies tend to use bespoke questionnaire surveys (combined with Likert scales) accompanied by stress-visual analogue scales (VAS). There is a strong consensus amongst dental students that endodontics is the most stressful or one of the most stressful dental disciplines (Mocny-Pachońska et al., 2021; Roudsari et al., 2022); however, there is no real consensus on the effect of gender on endodontic-related stress. The levels of perceived student stress during the initial experiences of general dental treatment were investigated by a questionnaire with no significant difference in endodontics between the stress of male and female undergraduate students (Roudsari et al., 2022). This differs from the findings of another study in which women in their first clinical year of study (third year dental science) perceived a significantly higher level of stress in endodontics than men in the same year of study (Mocny-Pachońska et al., 2021), a finding that was not significant in fourth- and fifth-year groups. Another investigation assessed the stress of final-year students during paediatric rubber-dam placement and root canal treatment (Davidovich et al., 2015). In agreement with Mocny-Pachońska et al. (2021) no differences were demonstrated between male and female final-year students in stress scores for both the procedures (Davidovich et al., 2015).

The relative physical and mental demands of several dental disciplines on fourth- and fifth-year undergraduate dental students were investigated. They highlighted that female students were more likely to perceive endodontics (and prosthodontics) as highly or very highly mentally demanding than men. Interestingly, female students were also more likely to perceive endodontics, paediatric dentistry and surgery as highly or very highly physically demanding than male counterparts (Pinho et al., 2014).

Anxiety

Anxiety is different from stress and can be defined as a worry over the future or about something with an uncertain outcome, uneasy concern about a person, situation, etc; a troubled state of mind arising (Oxford English Dictionary, 2024). The influence of gender on anxiety was generally measured by the STAI questionnaire (Table 1). Anxiety has been investigated during emergency endodontic treatment. Although undergraduate women had a significantly higher mean STAI-Trait score than males, suggesting a higher anxiety in general life, there was no statistical difference in STAI-State mean score in relation to the sex of participants, corresponding to no difference in the level of anxiety between males and females prior to starting the emergency endodontic treatment (STAI scores described in Table 1; Grock et al., 2018). In another study, 2 weeks after a lecture on vital pulp treatment, the pre-clinical undergraduate students had to scale their anxiety (STAI-State) and stress (stress-VAS) if they were to treat a clinical case with deep caries and probable pulp exposure. Female anxiety and stress were significantly higher than males. After a laboratory training session on vital pulp treatment, stress and anxiety regarding the clinical case were measured again. It was highlighted that anxiety and stress were reduced after the laboratory session; however, gender was not a significant factor (Chevalier et al., 2022).

Summary: Depending on the study's methodology, country and university of origin, a significant difference in stress and anxiety in endodontics according to gender may or may not be evident. If a difference was reported, men were less stressed and less anxious than women.

Influence of gender on student confidence in endodontics

Confidence is defined as 'the feeling or belief that one can have faith in their abilities' (Oxford English Dictionary, 2014). The influence of gender on student self-perceived confidence in Endodontics was mainly studied with bespoke, non -validated questionnaire surveys (combined with Likert scales).

One questionnaire asked the five dental procedures that the undergraduate students were the least confident about. The procedures selected were different for males and females, with pulpotomy amongst the five procedures for males; however, there were no endodontic procedures selected for women, with women being least confident with surgical extractions, prosthodontic procedures and orthodontic emergencies (Honey et al., 2011). Other studies have studied undergraduate students' perception regarding their self-confidence level on the clinic, whilst

performing different stages of root canal treatment. The results varied between universities and countries with some investigations not finding any significant differences between men and women regarding the stage of root canal treatment (AlMaslamani et al., 2024; Javed et al., 2021), whilst others highlighted some differences with male students more confident than female students, either regarding the student's global confidence score (Iranmanesh et al., 2021) or regarding specific steps (AlHamoudi et al., 2021; Gilmour et al., 2016). Gilmour et al. (2016) noted gender differences in self-reported confidence for carrying out treatment unsupervised, with females feeling unprepared for clinical work, and when the procedures became more technically challenging, such as molar root canal treatments, with females exhibiting less confidence. This is in line with the findings of Alhamoudi et al. (2021) who observed gender differences, with women less confident than men, in carrying out posterior root canal treatment. They also noted gender differences for anterior root canal treatment, in agreement with another study (Javed et al., 2021).

Summary: The bulk of endodontic studies reported higher confidence amongst male undergraduate students than female students. Dental and endodontic education providers need to be aware of the potential gender differences in self-perceived confidence levels and need for assistance to constructively support students.

Influence of gender on student preparedness in endodontics

'Preparedness for practice refers to a multifaceted concept, encompassing not only clinical skills, but also broader, non-clinical skills, such as communication and professionalism' (Donnell et al., 2022). Researchers often used dedicated and validated questionnaires such as the Dental Undergraduates Preparedness Assessment Scale (DU-PAS) (Table 1) or the Graduate Assessment of Preparedness for Practice (GAPP) questionnaire (Table 1), but also bespoke questionnaires.

In a recent Saudi Arabian study using the DU-PAS, whilst preparedness was high in carrying out root canal treatment in single-rooted teeth, it was low for root canal treatment in multi-rooted teeth. This could be related to a combination of technical difficulties in performing endodontics on multi-rooted teeth as well as limited availability of suitable patients (Javed et al., 2024). Higher scores of preparedness were reported in males, but the interaction between gender and DU-PAS scores was not significant. This interaction was not calculated for endodontic preparedness only, but for the entire questionnaire, which included all other dental subjects (Javed

et al., 2024). These results concur with an older study in the UK (Ali et al., 2017). In other studies, the influence of gender on students' preparedness in endodontics was more detailed. For example, Altan et al. (2024) also used the DU-PAS and demonstrated no significant difference between genders for the entire questionnaire, except for one item, with men feeling more prepared than women in, "I am able to perform an endodontic treatment on a multi-rooted tooth" (Altan et al., 2024). The preparedness of Polish dental students in endodontics was assessed with a bespoke questionnaire (Szalewski et al., 2020), which highlighted that students generally felt not ready to carry out endodontic treatment with rotary instruments (79.4%) and warm gutta-percha (89.2%). For the both stages, females felt statistically more often unprepared than their male counterparts (Szalewski et al., 2020). After the COVID-19 pandemic, other researchers investigated UK final year students' self-reported preparedness for practice and any perceived impact of the pandemic on final year experience with an adapted GAPP questionnaire (Donnell et al., 2022). They stressed that the COVID-19 pandemic was expected to have a major-to-severe impact on undergraduate experience. In general, male students reported feeling significantly more prepared than female students (in 33 out of 36 questions), with significant differences between them evident in diverse areas including patient examination, drug prescription, direct restoration placement, extractions, dentures, medical emergency management and endodontics (Donnell et al., 2022).

Summary: Studies investigating preparedness are useful to identify areas where students may benefit from further training, consolidation and encouragement. According to the results of the previous investigations, there is a need for students to accrue more experience of root canal treatment on molars, especially for females. In order to make undergraduate students more prepared for dental practice, the preclinical and clinical curriculum could be modified to enable students to practice more in simulation settings and to carry out more molar root canal treatment in the clinic (Altan et al., 2024). Structured remediation with close supervision and individualized feedback to underperforming students may be used to improve their confidence and preparedness in multi-rooted endodontics (Javed et al., 2024).

Gender influence on endodontic specialty choice

A limited number of studies have analysed the influence of gender on undergraduate students' future aspirations to choose a postgraduate specialty. These studies are based on questionnaire surveys sent to dental students.

Overall, it appears there is a gender influence regarding interest in different dental specialties. The influence of gender on subject choice varies according to the year of undergraduate study surveyed and diminishes in final year students and afterwards when choosing postgraduate areas of interest (Scarbecz & Ross, 2007). The impact of faculty mentoring, encouragement from significant others, and family support on postgraduate choice seems critical (Scarbecz & Ross, 2007).

Endodontics is a specialty that appears to be more balanced by gender, in contrast to oral surgery, oral and maxillofacial surgery or prosthodontics, which are traditionally predominately male (Halawany, 2014; Kabil et al., 2018; Kelsey 3rd et al., 2009; Scarbecz & Ross, 2007; Sezer et al., 2022) and in paediatric dentistry (Scarbecz & Ross, 2007; Sezer et al., 2022). Specifically referring to endodontic specialty choice by gender, the results vary, with females showing a greater interest than males in some studies (Kabil et al., 2018), the opposite in other studies (Halawany et al., 2017; Scarbecz & Ross, 2007; Sezer et al., 2022) or equal interest in others (AlMaslamani et al., 2024).

Despite a favourable general perception of endodontics (AlMaslamani et al., 2024), it is often not the specialty that is considered first amongst students. Reflecting the gender balance described above, oral surgery or oral and maxillofacial surgery (Halawany, 2014; Kabil et al., 2018; Khan et al., 2020; Sezer et al., 2022) is a popular first choice amongst males, whilst paediatric dentistry (Sezer et al., 2022; Scarbecz & Ross, 2007; Khan et al., 2020) is a more popular first choice among females, and restorative dentistry (Halawany, 2014; Halawany et al., 2017; Khan et al., 2020; Sezer et al., 2022) interests both genders.

These trends are starting to evolve. Indeed, more female students are now interested in specialty training in areas that were previously male-dominated specialties, such as oral surgery (Khan et al., 2020). That said gender inequity persists in dentistry in selected postgraduate specialties.

Summary: The aspirations for a postgraduate training and speciality among undergraduate students have often been gender-based. This is less evident in endodontics than in other areas such as oral surgery or paediatric dentistry.

DISCUSSION

After a preliminary literature search, a narrative review was selected. The search revealed a wide diversity of scientific articles, both qualitative and quantitative in nature, addressing many issues, so it was considered that this suited a narrative approach rather than a focused and narrow systematic review question. This approach enabled a summary and discussion on the topic of the influence of

gender on undergraduate student learning in endodontics, which allowed for a broad discussion about the research available and the need for future studies.

In this review, it was decided to extend the search to the themes of stress and confidence because both of them have an influence on the learning process. According to the classic 'inverted U theory', stress could actually drive learning as long as it remains at a moderate level. According to this theory, learning performance increases with stress to a point at which the stress becomes too great and learning decreases (Yerkes & Dodson, 1908). This theory has recently been questioned by those who claim that the cause of potential stress (a stressor) can be moderated by an educator and learner's influence by positively challenging the learner or by functioning as a hindrance to learning (Rudland et al., 2020). Studies have also shown that an adequate level of confidence improves students' clinical skills (Elzubeir & Rizk, 2001), whereas overconfidence can put patients at risk, with students attempting procedures that are beyond their level of competence. A lack of confidence can hinder the acquisition of skills, with students not prepared to carry out the procedure alone (Gilmour et al., 2016). The theme of students' aspirations for the future choice of endodontic specialty was an area of research activity identified from the literature search.

Amongst the articles discovered, around half of them came from the Middle-East, whilst 12 were sourced from Europe and two came from America and two from Africa. Although western countries consider themselves more gender-egalitarian, the bulk of research on gender influence in endodontic education is written by researchers in the Middle-East. This highlights certain issues around external validity as the culture of the Middle-East differs considerably from European or African countries, with undergraduate male and female dental students often educated separately in certain countries.

The conclusions from this review regarding the influence of gender on learning, stress, confidence and preparedness of undergraduate students in endodontics are broadly in line with the dental and medical literature. Other studies on self-assessment skills in medical areas have also shown that male students tend to overestimate their performance whilst female students tend to underestimate theirs, as compared with peer or faculty assessment (Blanch-Hartigan, 2011). Regarding confidence, a recent study addressed the confidence of dentists who graduated within the last ten years in Norway (Haug et al., 2021). The majority (72.4%) of respondents were either confident or very confident when performing root canal treatment, but a significantly larger number of men were very confident compared with women. Similar to another study (Karaharju-Suvanto et al., 2014) Haug et al. (2021) reported that more female than male dental practitioners

would have liked more clinical training during their undergraduate training. This difference in confidence is also shown in other domains and could be influenced by various factors, such as skills, social attitudes and regional culture (Lenney, 1977). In a broader study about the imposter phenomenon (IP) (Table 2), performed at Harvard University among medical and dental students, female gender was the sole significant predictor of intense IP, conferring a nearly twofold higher risk (Holliday et al., 2020). The authors suggested the need to cultivate female mentors and role models in order to encourage leadership training (Holliday et al., 2020). The development of such role models and female mentors could instil confidence in female students in dental and endodontic areas.

In terms of preparedness, a recent Middle Eastern study, using DU-PAS, showed no significant effect of gender on the total preparedness score (Alsoghier & Ali, 2024). The only statistically significant effect of gender amongst all the items of the DU-PAS related to the ability to perform root canal treatment on multirrooted teeth (Alsoghier & Ali, 2024).

In line with this review, if a significant difference in stress and anxiety was reported in dentistry, male dental students were less stressed and less anxious than female dental undergraduate students (Alzahem et al., 2011; Elani et al., 2014). This is also reflected in studies of medical students, where female medical students report higher levels of stress than male medical students (Compton et al., 2008; Dahlin et al., 2005). Therefore, in Endodontics, as in other dental and medical disciplines, the two main strategies are to decrease the stressors (e.g. reducing workload/exam pressure, modifying the curriculum and teaching methods, being supervised by a supportive and calibrated teaching staff) and increase the ability to cope with stress thanks to, for example, stress management training modules (Alzahem et al., 2014; Chevalier et al., 2024; Frese et al., 2018). These innovations may be particularly useful for female students.

With regards to the aspirations for postgraduate speciality, for comparison, in medicine, it has been shown that women are more interested in obstetrics and gynaecology, geriatrics, public health, paediatrics, dermatology and general medicine than in surgery, anaesthesia and emergency medicine, which are still more male-dominated domains (Khan, 2023; Levaillant et al., 2020). It should be noted that encouragement, the presence of a mentor, or a history of positive experiences during clinical internships have a major influence on career choice, especially in surgery (Riska, 2011). The presence of a mentor, staff encouragement and positive clinical experiences are important elements that influence the choice of a speciality. Moving forward, endodontic education providers could potentially consider developing such strategies to promote the future of their speciality.

Whilst there are some studies dedicated to investigating the influence of gender on learning and career choices in dentistry, there are very few in endodontics. In endodontics, analysing the influence of gender has invariably been a secondary objective or outcome. The findings of this narrative review suggest that there are gender influences in endodontics within learning, stress and anxiety among others. The role of gender on learning and accruing knowledge and competence is of particular educational interest with the development of virtual and artificial intelligence softwares that could increase preclinical confidence and improve learning; the role of these new technologies and their respective impact on males and females has to be investigated in the future. The findings presented follow the trends observed in other dental areas and medicine; however, further studies, with gender as a primary outcome, are necessary to improve and personalise more teaching and support in undergraduate endodontic education, notably at a period of feminisation of the dental profession.

CONCLUSION

Within the limitations of this narrative review and the limited number of articles available, it would appear that female students underestimate their skills and knowledge more than male counterparts in endodontics, despite generally achieving equivalent or better results. Female students are often more stressed and anxious than males, feeling less confident and not as prepared, especially when carrying out molar root canal treatment. A recognition that men and women may learn and manage stress differently and being aware of gender issues, are important in endodontic education and to promote endodontic career choice. Further research is needed to elucidate more clearly the impact of gender in endodontic education and endodontic career choice.

AUTHOR CONTRIBUTIONS

Johanna Kichenin: investigation (equal), writing – original draft preparation (equal), **Karen Vallaey:** investigation (equal), writing – original draft preparation (equal), **Reza Arbab Chirani:** visualization (equal), writing – review & editing (supporting), **Henry Fergus Duncan:** conceptualization (equal), supervision (equal), visualization (equal), writing – review & editing (lead), **Valerie Chevalier:** conceptualization (equal), investigation (equal), supervision (equal), validation (lead), writing– original draft preparation (equal).

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

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Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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The study is a review and does not need ethical approval.

ORCID

Johanna Kichenin  <https://orcid.org/0000-0002-4315-9420>

Reza Arbab Chirani  <https://orcid.org/0000-0002-0969-6177>

Henry Fergus Duncan  <https://orcid.org/0000-0001-8690-2379>

Valerie Chevalier  <https://orcid.org/0000-0001-9202-2677>

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