REVIEW

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Current status of predoctoral implant dentistry education – student's didactic performance and self-assessment: A Systematic Review.

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Abstract

Objectives: To describe the current state of predoctoral dental implant education in terms of educational outcomes and the student's perception of the associated curriculum. Methods: A database search was conducted using Medline (OVID), EMBASE, ERIC (Education Resources and Information Centre) and Web of Science electronic sources. Two reviewers thoroughly reviewed the papers in accordance with the specific selection criteria after carefully choosing the abstracts that seemed to meet the initial selection criterion for full article retrieval. Results: 15 articles were included, which were divided into two distinct groups: those that addressed educational outcomes and those that addressed students' perceptions. Knowledge was assessed by questionnaire surveys, and it was found that most of the students were poorly to moderately well informed. There was a positive increase in student perception after taking the implant courses. Clinical significance: Although predoctoral education in most dental schools across the world now includes implant dentistry as a core component, the degree of integration varies greatly. To increase the proficiency of predoctoral students around the world in performing implant treatments, it is necessary, according to this systematic review, to create a uniform, well-structured predoctoral implant curriculum and guidelines that include didactic, laboratory, preclinical, and clinical components.

Keywords: curriculum, dental school, dental student, dental implants, predoctoral.

Introduction

Over the last few decades, dental implants have gained popularity as a treatment option for replacing missing teeth. Dental implant training is often regarded elective during predoctoral education [1,2]. Nevertheless, predoctoral students must have sound knowledge, and clinical expertise in implant dentistry as they will be expected to provide this treatment once they graduate [3].

In 1974, 33% of US dental schools had some level of predoctoral implant dentistry program in their curriculum [4]. This rate increased drastically to 73% in 1989 and 86% in 1993 [5]. A study of the North American dental schools' deans, conducted in 2004 revealed that 97% of participants said the undergraduates receive some form of didactic education, and 86% said their students also obtain associated dental implants' clinical experience. [6]. There is a wide variation in the extent of integration of implant dentistry predoctoral programs worldwide owing to the challenges like the implementation cost, patient availability, and limited curricular time [7,8].

Theoretical knowledge is a foundation for implant dentistry teaching. A sound basic knowledge would not only make the students more competent to perform a proper clinical exam for appropriate diagnosis and treatment planning but also would enhance their clinical expertise [9]. Historically, predoctoral implant training has been predominantly didactic. However, simulation training and clinical experience improves undergraduate students' level of confidence, satisfaction, and perception of curriculum [7,10].

The ability of freshly graduated dentists to diagnose and manage implant patients by themselves is still questionable [11]. This is one of the less explored aspects of dental implant education. The available literature on these aspects is vast, discrepant, and unorganized to easily draw common conclusions. The most frequent type of the studies used to measure the educational outcomes are surveys with the aim to gauge the knowledge, attitude, and perception of dental predoctoral students towards dental implants [1,2,4,12]. There are

only a few consensus reports and opinions available about this topic [13,14,15].

This systematic review's objective was to systematically assess the state of predoctoral implant dental education in terms of the educational outcomes that result from the didactic component and how the students perceived the relevant curriculum.

Material and methods

This preferred reporting items for systematic reviews and meta-analyses (PRISMA checklist) was followed for this study [16].

Protocol and Registration

A search in PROSPERO - International prospective register of systematic reviews (Centre for reviews and dissemination, University of York, York, United Kingdom)- using terms implant education and predoctoral/undergraduate curriculum was done and no registered proposal was found.

Information sources and search

Searches were conducted in electronic databases such Medline (OVID), EMBASE, ERIC, and Web of Science. Based on prior knowledge about the topic, selected search phrases were identified for each database. The first 100 articles found by Google Scholar's grey literature search engine were chosen. (Appendix 1).

	exp Education Medical, Undergraduate OR exp Curriculum/ OR Schools, Dental/OR Students, Dental/ OR exp "Internship and
MEDLINE 1966 to Feb3, 2019	Residency"/OR ((dental or pre-doctoral or predoctoral or undergrad*) adj2 (school* or curriculum* or student* or resident* or educate* or teach* or train* or course* or intern*)). mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonym] AND exp; Dental Implantation/ OR Dental Implants/ OR (implant* adj2 (endosseous or tooth or teeth or dental or dentistry or oral)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier,
EMBASE (Excerpta Medica) 1980 to Feb 3,2019	Synonyms, using terms as in MEDLINE.
ERIC (Educational Resources	Curriculum.mp, OR Dental school*.mp OR Dental Student*.mp OR (Internship and Residency).mp OR ((dental or pre-doctoral
Information Center) 1970 to Feb3,2019	or predoctoral or undergrad*)adj2(school*or curricul*or student*or residen*or educat*or teach*or train*or course*or intern*).mp AND Dental implant*.mp OR (implant adj2(endosseous or tooth or teeth or dental or dentistry or oral)).mp
WEB OF SCIENCE was searched till Feb3,2019	TOPIC: ((((dental or pre-doctoral or predoctoral or undergrad*) NEAR/2 (school* or curricul* or student* or residen* or educat* or teach* or train* or course* or intern*)))) *AND* TOPIC: (((implant*)NEAR/2 (endosseous or tooth or teeth or dental or dentistry or oral))) *DocType=All document types; Language=All languages;*

To find any more references that were missed during the search of the online databases, the reference lists of the chosen articles were manually checked in the end.

Inclusion criteria

Only those articles were included where the status of implant education was studied by means of a survey or questionnaire to the undergraduates. For student perception of the curriculum, the studies where students filled

questionnaire about the program were included.

Exclusion criteria

Opinion papers, consensus reports, letters, and editorials were excluded. Papers that presented only a description of the program at a school without any assessment of the students' theoretical knowledge or their perception were excluded. Surveys of postgraduate students, general dentists or specialists were not included.

Using software applications (RefWorks eCOS, ProQuest), the references were handled, and duplicate references were eliminated. There were no restrictions on the online database searches for language, study kind, year, or any other known parameters. The search was most recently revised on February 3, 2019.

The articles were screened by two reviewers (DN and LL) independently. Any disagreements were discussed until a consensus was reached. If a consensus could not be reached, the participation of a third reviewer (CFM) was solicited. From the selected studies, the following details were noted: author(s), year of publication, research methodology, region, evaluation methods, participants and response rate, survey details, and result (main reported findings related to the research question).

Risk of Bias (RoB) among each study

The Joanna Briggs Institute (JBI) tool for cross sectional and cohort studies (as applicable) was used to assess the methodological quality of the chosen studies. For cross sectional research, the RoB was analysed using eight distinct features, and eleven for cohort studies with answers "yes", "no", "unclear" and "not applicable". The articles were scored according to a percentage scale (0-100%) which was calculated based on the number of positive responses [17,18].

Risk of Bias (RoB) across included studies

According to JBI guidelines, it is recommended that a grading system be utilized to review and evaluate the reliability as well as the quality of evidence within a systematic review. Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was designed initially for randomised controlled trials; however, there is currently no alternative evidence grading protocol for observational studies, and hence, in this study, GRADE approach was adapted, without validation, for observational studies to assess the certainty of evidence and to assign recommendations on a GRADE scale of very low, low, moderate or high [4,19].

Results

Study selection

Details of the search methodology are shown in the flow diagram according to PRISMA (Figure 1) [16]. At the start,1466 records were found After the duplicates were removed, 821 articles were considered. 41 papers were chosen after the authors read all the titles and abstracts in phase 1. One article was chosen from Google Scholar.

In phase 2, after the full-text assessment, 15 studies were found to be appropriate. Each stage of this selection procedure was carried out individually by the writers, and any disagreements were settled by discussion and agreement. These 15 studies were further divided depending on the outcome they measured-educational outcome (7) and student perception (15) [1,2,12,20-23 1,2,7,12,20-30]. A few of these studies addressed more than one outcome.

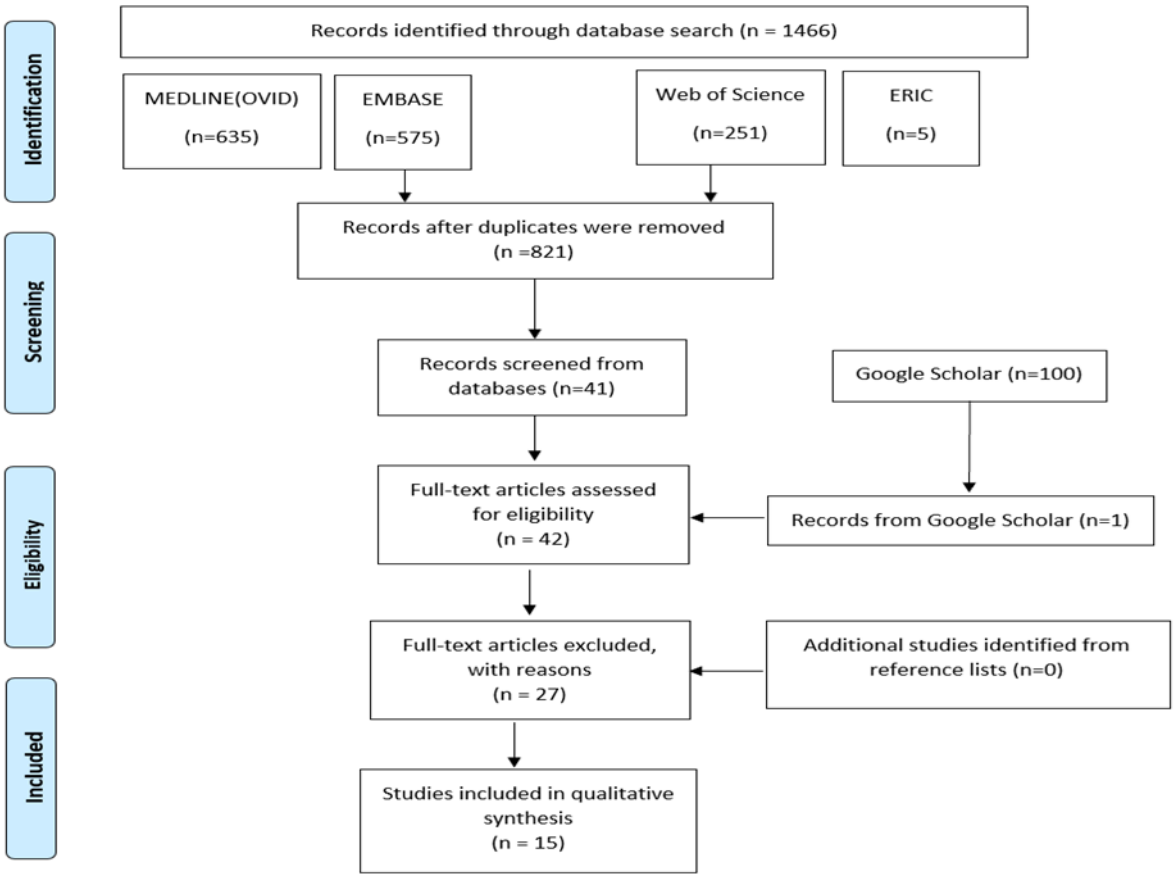

Figure 1: PRISMA 2009 Flow Diagram

Synthesis of Results

The included studies were observational studies that had a cross sectional or cohort component, or both. All selected articles were published in English language. Sample sizes were highly variable. The response rate for most of the studies was 72%-85%. Most of the surveys were divided into knowledge, attitude, and perception outcomes. A few studies included the surveys that were validated either from a previous study with some modifications or by conducting a pilot study [2,12,21,23]. The results for different outcomes are summarised below.

Educational Outcome:

This is mostly measured by asking students questions to gauge their level of theoretical understanding of implants. These questions corresponded to basic questions asked by patients like advantages, case selection, etc. [22]. The study population was the one at different levels of undergraduate training. The included studies were conducted in different parts of the world [1,2,12,22,23]. Overall, these surveys found that the participants were poorly informed [22] to moderately well informed [23] about the implants' selection and use. The majority of participants said that dental implants' key benefit was that they were additionally conservative:55.4% [12], 59.8% [2], 54.83% [21]. Few surveys used knowledge self-assessment the participating undergraduate students before and after the implant course [1,20,21]. The implant knowledge of the students improved for two studies [1,20] but not for one [21]. Table 1 describes the major study characteristics and outcomes of the selected studies.

Table 1: Educational outcome (From Cross Sectional Surveys)

Author /Year	Type of Study	Method to Assess	Population, country, response Rate	Details of Survey	Outcome	Additional Comments
Seitz SD, 2016[20]	Descriptive followed by cross sectional study	Questionnaire based survey	Of the 16 students in the selective in academic year 2014-15 at University of Texas San Antonio, United States. 15 participants finished the pre-survey, while12 finished the post survey.	Dental students' before and after-training self-assessment of the understanding of implant and CAD/CAM, Practical skills, and Degree of comfort by rating each response from poor, average and excellent.	Before and after the course, there were statistically significant improvements in the students' self-assessed understanding, involvement in implant therapy and restoration. Only one respondent had outstanding understanding of implants prior to the survey, but this number rose to seven thereafter. From 1 before the survey to 9/10 after the survey, the CAD/CAM Knowledge Level for Diagnosis and Therapy, Intraoral Scanning, and Placement of restorations increased.	
Sánchez-Garcés MA, 2017[21]	Cross sectional	Questionnaire based survey	Third and fourth years of the BDS programme at the Faculty of Dentistry at the University of Barcelona, Spain, were attended by 151 and 146 students, respectively. 107 students, 76 from the third year (Group A) and 31, from the fourth year (Group B), responded to the survey.	A survey with 11 questions was created: Basic knowledge (seven), views of training obtained (two), and potential training methods for students (2)	A higher percentage of students—more than half—thought they were ill-informed, with no statistically significant differences between the third- and fourth-year students (groups A and B, 59.81% and 61,29%), while only 19.73% and 32,25% (A and B, respectively) thought the same about their level of well-informedness.	
Chaudhary S., 2015[2]	Cross sectional	Questionnaire based survey	35 dental institutions in India with 2800 students. 2041 questionnaire replies were received out of a total of 2800 that were distributed. The response rate was 72.89%. Most of the respondents were female.	A total of15 questions that were divided into 3 parts: The sample population's demographic profile was discussed in the first section. The questions in the second segment measured the depth of knowledge regarding dental implants. The final portion of the questionnaire asked questions concerning the undergraduate dentistry students' sources of information and	When asked about their degree of knowledge regarding dental implants, 59.8% of respondents said that case selection, which is crucial for fixed partial dentures (FPD), was the biggest benefit of dental implants over surrounding healthy natural teeth. Additionally, 91.7% of the residents desired more knowledge regarding implants in their undergraduate curriculum, and 81.1% of the residents felt that they were not given enough information. 56.5% of the	

				their desire for further information.	respondents agreed that dental implants require more care and regular maintenance from the patient and dentist than do natural teeth, and that this is the most crucial factor in determining implant success.	
Aljohani HA, 2009[22]	Cross sectional	Questionnaire based survey	Dental students who recently graduated from King Abdulaziz University (KAU), Jeddah, Saudi Arabia. 66 /86 students responded to the uestionnaire. Response rate was 76.6%	A 21 multiple-choice questionnaire. The questionnaires covered the degree of oral implantology exposure as well as some fundamental information about dental implants.	The average number of participants who accurately and inaccurately answered the four questions was 32.5% and 67.5%, respectively. The questionnaire revealed that recent dental graduates from KAU had a poor degree of understanding of some fundamental concepts in dental implantology. The majority of the students skipped any implant surgeries. The majority of the students (61.1%), did not have knowledge about various dental implant systems, designs, or sizes (60.6%).	
Chaudhary S, 2013[12]	Cross Sectional	Questionnaire based survey. The questionnaires were mailed to the participants.	Respondents were the dental interns of the state of Karnataka, India. 417 /500 interns responded with a response rate of 83.4%.	4 divisions. Demographic questions were asked in the first segment. The second portion evaluated the participants' degree of knowledge of dental implants while the third question asked about the respondents' sources of information and their perception of the need for further information	According to 12.2% of respondents, the biggest benefit of implants is that they are more aesthetically appealing than alternative tooth replacement options. However, the "conservative aspect" of dental implants was cited as the cause by the majority (55.4%).The majority of responders (56.1%) ranked case selection as the most crucial factor. The majority of respondents (56.2%) stated that they knew "moderately well" about dental implants. A slightly higher percentage (64.5%) agreed that dental implants require more upkeep and attention from the patient and dentist than do natural teeth.	
Sharma A, 2018[23]	Cross Sectional	Questionnaire based survey	Interns in Nepal (n=350). The response rate was high 280/350 (80%).	A previously used questionnaire from a study (Chaudhary S, 2015)2 was utilised; after pilot research,	The majority of interns claimed to have a fair amount of knowledge about dental implants (50.36%); the main	For several comments, there were significant correlations

			32% of the participants were males and 68% were females.	a little alteration to the questionnaire was made.	benefit of dental implants is that they are conservative in design (58.6%); the case selection procedure is the most crucial aspect of implant success (51.07%); and the lifespan of dental implants is 10–20 years.	with the location of the college.
Homma S, 2015[1]	Cross-sectional	Questionnaire based survey	5th year students (139) at Tokyo Dental College who had completed a course in oral implantology comprising lectures and practical	1) Self-assessment of level of success in achieving each course objective.2) Evaluation of practical training in Oral Implantology.3) Attitudes regarding oral implants before and after course completion.4) Overall evaluation of Oral implantology lectures and practical training. Answers to questions 1,2 and 4-yes or no	1)Over 70% (71.7+ 7.8%)of the students thought they had achieved the course objective.2) Results for practical training-66.6+5.8% indicated that practice was easy to complete for tracing of X ray images, incision of mucosa and wound suturing.52.8% of participants indicated difficult for computer simulation of planning of implant placement. Implant placement was considered most difficult (65.7%).	

Student Perception:

Most of the included studies assessed pre- and post-course change in student perception via surveys. A few studies included validated surveys based on a questionnaire from a previous study [24,26,28,30]. A positive increase from 10% to 86% in student's perception of implant education was found in some studies [1,20,24,29,30]. On the contrary, participants in other studies were not satisfied with their level of education and clinical training in implant dentistry [2,12,21, 22, 25, 27]. The participants who thought they required more information ranged from 68.21% [25] to 100% [21] of those taking the surveys. An interesting finding was that the factors like laboratory exercises [26] and clinical training [7] increased the students' confidence. 90.8% of students who received such additional training were satisfied with the program [7]. A summary of the key study characteristics and results of the selected articles is presented in Table 2.

Table 2: Student Perception

Author /Year	Type of Study	Method to Assess	Population, Country, Response Rate	Details of Survey	Outcome	Additional Comments
Seitz SD, 2016[20]	Descriptive followed by cross sectional	Questionnaire based survey	Of the 16 students in the selective in academic year 2014-2015, University of Texas San Antonio, United States. 15 and 12 students participated in the pre and post survey, respectively.	Dental students' pre- and post-course assessments of their understanding of implants and CAD/CAM, as well as their practical exposure and degree of comfort choosing each answer as poor, average, and excellent. The students questioned on whether they had succeeded in achieving objectives for the select.	Statistically substantial improvements in students' self-reported knowledge, involvement in implant care, and comfort with implant restoration between pre- and post-selective responses. Dental students believed that guided surgery would be less difficult than previous techniques. However, after participating in the guided procedures, students found that it was not as simple as they had first imagined.	
Jahangiri L, 2008[24]	Cross-sectional	NYUCD exit surveys for senior students, given to graduating classes annually.	Four years of senior exit surveys starting from 2005-2008	A set of inquiries asking learners' perspectives on several subjects from the curriculum. This survey included a particular question about implant dentistry.	Students who were satisfied in each year from 2005 to 2008 increased from13%, 14.8%, 28.9% and 31.6%.	
Sánchez-Garcés MA, 2017[21]	Cross sectional	Questionnaire based survey	76 of 151 and 31 of 146 in third and fourth year of BDS respectively, partici-pated in the survey. This study was conducted at Faculty of Dentistry of University of Barcelona, Spain.	11 questions were included in a survey that was created. Basic knowledge (seven), perceptions of training obtained (two), and potential training methods for students (2)	93.54% of fourth-year students and nearly 100% of third-year students said that the material they had learned during their dental degree programme was insufficient. Both groups concurred that they had wanted to learn more during their undergraduate education (100%)	
Chaudhary S., 2015[2]	Cross sectional	Questionnaire based survey	2041 internees participated from 2800 dental internees (response rate 72.89%) From 35 dental institutions in India	The questionnaire had 3 sections with 15 questions The divisions included the demographics, level of implant knowledge and the source of information of undergraduate dental students as well as their need for more information.	81.1% of the participants felt that they received an inadequate knowledge about implants and 91.7% wanted that more knowledge be provided during their undergraduate degree.	
Aljohani HA, 2009 [22]	Cross sectional	Questionnaire based survey	66 of 86 dental	The inquiries centered on the experience of oral	The students were not really content with their dental education and	

			students (76.6% response rate) of King Abdulaziz University (KAU), Jeddah, Saudi Arabia, participated in the study.	implant dentistry and some fundamental understanding of dental implants	clinical training implant. The majority of the students—52 students, or 78.8%—thought there had not been enough instruction on dental implants, while 21.2% disagreed.	
Chaudhary S, 2013[12]	Cross sectional	Questionnaire based survey. The questionnaire was mailed to the colleges of the participants.	417/500 dental interns of the state of Karnataka, India, participated in this study (83.4% response rate)	The survey had 3sections that asked about demographics, level of information about dental implants and their source of information as well as perceived need for more information.	73.3% of the participants indicated that they did not have enough information while only 26.6% reported that they had a lack of enough information. 95.7% agreed that more information about implant treatment should be provided in the undergraduate degree.	
Sharma A, 2018[25]	Cross sectional	Pre used survey from Chaudhary S, 201416	All the undergraduate dental students (2400) of Nepal from 1st year to 5th year excluding interns),1700/1850 questionnaires were received. The response rate was 70.83%.	At each level of their BDS course, from the first year to the fifth year, a total of 4 questions were asked concerning their preferred knowledge sources and perceptions of the need for greater information about dental implants.	A large majority of the respondents overall concurred that they did not receive enough knowledge on implant treatment methods during their BDS degree and desired more information to be included in the curriculum. There was a substantial association of the response with the academic level.	The survey was conducted at different times of their academic year. In some colleges, it was done during the middle of their session, whereas in other colleges, it was done before their annual exams. An equal number of participants were not included at different academic levels.
Sharma A, 2018[23]	Cross sectional	Survey conducted for one year (June 2016 to 2017)	Interns in Nepal (n=350). The response rate was high 280/350 (80%). 32% of the participants were males and 68% were females.	The survey was used earlier in a different research w (Chaudhary S,2015),[2] a pilot study was carried out and minor modification was made in the questionnaire.	Many of the students (67.14%) felt that the BDS curriculum should include more information about implant treatment techniques since they felt that they were not given enough information. 33.21% and 48.57% of respondents, respectively, stated that they would prefer to learn more credible information regarding dental implants from implantologists who have completed a one-year certificate programme	

					The response of this depends on the location of the school.	
Homma S, 2015[1]	Cross sectional	Questionnaire based survey	5th yr students at Tokyo Dental College who had completed a course in oral implantology comprising lectures and practical training bet Oct 2013 and Feb 2014. Total 139. M/F 79/60	1) Self-assessment of level of success in achieving each course objective. 2) Evaluation of practical training in oral implantology 3) Attitudes regarding oral implants before and after course completion 4) Overall evaluation of Oral implantology lectures and practical training. Questions to 1,2 and 4- yes or no	Attitudes regarding oral implants before and after course completion. 10% increase in affirmative responses to the questions- Are u interested in OI treatment and Do u want to be involved in implant treatment as a dentist. 40% participant selected that they may not select implant themselves or a missing tooth after completing the program.	
Yuan CC, 2011[26]	Cross sectional	Two surveys	Second year to Fourth year dental students (Class of 2009-2011). A total of 195 dental students at Chicago College of Dentistry, University of Illinois	Survey 1 was given to second year students towards the completion of pre-patient care implant curriculum in May 2009. These students were questioned about their opinions of the significance of implants education, the quality with which PCLEs equipped them with care for patients, and whether these encounters may sway their upcoming plans to administer implant treatment. Third- and fourth-year students were given Survey 2. This survey evaluated students' opinions of their stress levels, skill, training, practical exposure, and productivity in addition to similar items from Survey 1.	Both the surveys had a high response rate- 95 % and 89% for Survey 1 and 2, respectively. 99% of those surveyed said implant instruction in predoctoral dentistry education was crucial or extremely crucial. Many respondents from all courses said that they intended to offer DxTP (68.9%), STI (61.2%), and IOD restorations (62.1%) following graduation. Most of the participants felt that how well they were prepared after the laboratory procedures, influenced their plan to do diagnosis and treatment planning, STI and IOD restorations.	1. Laboratory exercises (PCLEs) are crucial for undergraduat e implant training and preparing future dental implant therapy providers. 2. There were distinctions between male and female students in terms of how prepared they felt they were for the future. 3. Fourth year students were more stressed than third year students while doing dental implant treatment.
Afshari S, 2014[27]	Cross sectional	The focus Group discussion during which the students completed a survey.	All the students participating in APIP -Nine students (100% response rate) Chicago College of Dentistry, University of Illinois	Advanced Predoctoral Implant programme (APIP) has been developed by the College of Dentistry that gives the students the chance to putting implants for single tooth as well as overdentures for the mandible.	1. All participants agreed that the program's implant placement component was the most alluring. 2. The students claimed that because of the programme, they felt more confident recommending implants to patients. 3. The variation in the number of implant	

					procedures among the students was the program's main point of concern from the students. This was ascribed to the fact that the students had to choose their own implant patients, and externships at institutions other than the UIC College of Dentistry made it difficult for them to do so. 4. After graduating or in the future, all of the students said they will seek more training in implant dentistry through either a specialized programme or a general dental residency.	
Ariani, 2013[28]	Cross sectional study	Questionnaire based survey	141/166 undergraduate students from third and fourth year at the Faculty of Dentistry, University of Indonesia participated in a questionnaire-based survey.	The survey consisted of a total of 14 multiple-choice and yes/no questions. These were divided into three sections that consisted of questions regarding Students' perspectives on implant therapy, undergraduate implant education, and students' futures with reference to implant treatment	Dental implants were thought to be the best option for missing teeth replacement in the mandibular first molar and the maxillary anterior tooth, but not in the mandible as a whole. The majority of students felt that undergraduate education did not go far enough in covering the subject of implant dentistry. They were eager to learn more and intended to include implants into their area of practice.	A national conversation over the inclusion of a thorough implant dentistry curriculum in undergraduat e dental education is required.
Prasad S, 2017[7]	Cross sectional	Questionnaire based survey	The group of students with only didactic training (control) participated in a survey in 2014. In 2015, the survey was given to the students with both didactic and simulation training.	78.7% of the students participated in the control group and 81.3% in the test group.	85.7% of the students in the control group, reported being satisfied with implant training compared to 90.8% of students in the test group. Restorative clinical experience increased the rate of satisfaction to almost five times among the students.	
Tammerman A, 2016[29]	Cross sectional	Survey Questionnaire s assessing the students' perceptions of the educational program.	90 students at the clinical program at KU Leuven, Belgium that got the chance to insert implants received a survey following surgery A year following graduating, the participants were asked if they were working as a general dentist or started a		80% students were satisfied with the training, 60% of students would like extra course in implant dentistry after graduation. Of the 56 students, 26% declined placing implants themselves when they practice, 37 of 56 students practiced as general dentist and all of them restored implants. 7 of these 37 general	

			post graduate programme.		dentists enrolled in oral implantology course to further improve their skills.
Vandeweghe S, 2014[30]	Cross sectional	Questionnaire based survey	Questionnaire on patients' perspective about their dental Status, surgical and restorative experience The questionnaire also enquired about their experience of the program. The study was conducted at Ghent University, Belgium.	At the conclusion of the therapy, students were also required to complete a questionnaire and consider the appropriateness of complexities of the programme (RQ3). 15 statements have to be rated that range from 1 to (completely disagree) 5 (completely agree) and were prompted to evaluate five elements of the surgical experience from 1 (simple) to 5 (difficult). For analytical justifications, 4-5 were chosen at random were regarded favorable, while 1-2-3 received poor ratings.	86% participants were adequately prepared for the surgical procedure because of the theoretical instruction delivered. The topics connected with proper case selection, individual monitoring and advising during the pre-preparation and execution of the operation, as well as during the logistics achieved a score of over 75%. Approximately 40% were not persuaded that the significant preparation is necessary as a therapy plan was required. 72% considered documentation and case preparation challenging and time-consuming.

Risk of Bias (RoB) among individual studies

A summary of the RoB assessment is presented in Table 3. The score for both the cross-sectional and cohort studies ranged between 66 to 100% implying moderate to high methodological quality (or moderate to low risk of bias). Common flaws included failing to recognise confounding circumstances and, thus, failing to develop methods to address them. Also, there was a high variation for the question on assessing the exposure and outcome in a valid and reliable way. In most of the cases, these were self-assessed.

Table 3: JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies (Educational Outcome and Student Perception)

Ref. No.	Study	1	2	3	4	5	6	7	8	RoB
(20)	Seitz SD,2016	Y	Y	N	Y	N	N	N	Y	Mod**
(21)	Sanchez- Garces MA,2017	Y	Y	Y	Y	N	N	N	Y	Mod**
(2)	Chaudhary S,2015	Y	Y	Y	Y	N	N	Y	Y	Low*
(22)	Aljohani HA,2009	Y	Y	N	N	N	N	N	NC	High***
(12)	Chaudhary S, 2013	Y	Y	Y	Y	N	N	Y	Y	Low*
(23)	Sharma A, 2018	Y	Y	Y	Y	N	N	Y	Y	Low*
(1)	Homma S,2015	Y	Y	N	Y	N	N	N	UC	High***
(24)	Jahangiri L,2008	Y	Y	N	N	N	N	N	Y	High***
(25)	Sharma A, 2018(all Nepal)	Y	Y	Y	Y	N	N	N	Y	Mod**
(26)	Yuan JC,2011	Y	Y	Y	Y	N	N	Y	Y	Low*
(27)	Afshari S,2014	Y	Y	N	Y	N	N	N	Y	Mod**
(28)	Ariani N,2013	Y	Y	Y	Y	N	N	Y	Y	Mod**
(7)	Prasad S,2017	Y	Y	N	Y	N	N	Y	Y	Mod**
(29)	Temmerman A,2016	Y	Y	N	UC	N	N	N	Y	High***

(30)	Vandeweghe,2014	Y	Y	Y	N	N	N	Y	Y	Mod**

Scale: 33%=High RoB and Low quality*
33-66% =Moderate RoB and Moderate Quality**
>66%=Low RoB and High Quality***

Risk of Bias (RoB) across studies

In the GRADE analysis, certainty level was found to be low. The level of certainty was graded down based on imprecision and inconsistency in the results as well as the fact that there was no standard tool used to assess the outcome. Nevertheless, the studies directly compared the knowledge level and student perception in the participants and reported the outcome. Thus, the certainty level was upgraded for the indirectness domain. As the included studies were very specific in assessing participants implant programs where the provided information was not standardized the level of certainty was also downgraded. For these reasons for both educational outcome and student perception the certainty level was low.

Analysis of results- Quantitative assessment

Five studies used same questionnaire [2,6,20,22,25]. Although a meta-analysis could not be done because of the lack of groups in the study, an attempt to quantify the responses of questions using common questionnaire was done by calculating and comparing the average mean for each answer (Table 4). It was found that a few studies had modified the common questionnaire by adding or eliminating a few questions.

Table 4. Average / mean of responses[2,6,24,26,29]

	Chaudhary S,2015(2)		Chaudhary S,2013(6)		Sanchez- Graces MA,2015(20)		Sharma A, 2018(22)		Sharma A, 2018(25)		AVERAGE
Questions on the level of Information on dental implants	2041 responses		417 responses		107 respondents		280 respondents		1700 respondents		
					3rd Yr (%,n)	4th Yr (%,n)					
How well informed are you about dental implants?											
Very well	8.00%	163.28	3.10%	12.92	1.31 % (1)	0	12.50% 35				53.05
Well	29.60%	604.13	18.50%	77.14	11.84 % (9)	6.45 % (2)	32.14% 90				195.5675
Moderately well	46.00%	938.36	56.80%	236.85	19.73 % (15)	32.25 % (10)	50.36% 141				335.3025
Poorly	14.80%	302.06	18.90%	78.81	59.21 % (45)	61.29 % (19)	5% 14				114.7175
Not at all	1.60%	32.65	2.60%	10.84	7.89 % (6)	0	-				16.49667
On a scale of 1–10, how difficult do you feel is it to place implants as compared with other dental procedures?											
5: average	69.80%	1424.61	68.60%	286.06	23.68 % (18)	48.38 % (15)* (p=0.012)	33	64.30% 180			480.9175
10: very difficult	25.70%	524.53	28.10%	117.77	9.21 % (7)	3.22 % (1)	8	14.60% 41			172.825
Difficult	X	X	X	X	60.52 % (46)	41.93 % (13)	59	X			59
Cannot say	X	X	X	X		6.45 % (2)	5	X			5
What do you think is the main advantage of dental implants as compared with other tooth replacement modalities											
Aesthetic	10.90%	222.46	12.20%	50.87	13.15 % (10)	3.22 % (1)	11	3.20% 9			73.3325
More conservative	59.80%	1220.51	55.40%	231.01	7.89 % (6)	54.83 % (17)	23	58.60% 164			409.63

Longevity	20.00%	408.2	30.90%	128.85	60.52 % (46)	9.67 % (3)*	49	34.60% 97			170.7625
No added advantage	4.90%	100	0.70%	2.9	6.57 % (5)	25.80 % (8)	13	1.80% 5			30.225
Do not know	4.30%	87.76	0.70%	2.9	10.52 % (8)	0	8	1.80% 5			25.915
What do you think is the most important factor for implant success?											
Case selection	65.10%	1328.69	56.10%	233.93	30.26 % (23)	41.93 % (13)	36	51.07% 143			435.405
Implant type and material	8.00%	163.28	7.70%	32.1	19.73 %(15)	9.67 % (3)	18	5.00% 14			56.845
Patient compliance	8.00%	163.28	12.70%	52.9	27.63 %(21)	35.48 % (11)	32	3.92% 11			64.795
Surgical technique	8.10%	165.32	9.60%	40.03	15.78 %(12)	0	12	4.64% 13			57.5875
Experience of operator	8.80%	179.6	12.20%	50.8	6.57 % (5)	3.22 % (1)	6	34.28% 96			83.1
Do not know	2.10%	42.86	1.70%	7.08	X	X	X	1.07% 3			17.64667
What do you tell your patient is the longevity of dental implants?											
2–5 y	4.90%	100	3.40%	14.17	0	0	0	-			38.05667
5–10 y	31.40%	640.87	36.90%	153.87	14.47 % (11)	16.12 % (5)	16	5.35% 15			206.435
10–20 y	39.80%	812.31	25.40%	105.91	61.84 % (47)	64.51 % (20)	67	57.85% 162			286.805
Lifetime	17.10%	349.01	25.20%	105.08	10.52 % (8)	3.22 % (1)	9	36.07% 101			141.0225
Do not know	6.90%	140.82	9.10%	37.9	13.15% (10)	16.12 % (5)	15	0.71% 2			48.93
Do you feel that dental implants require additional maintenance and care by the patient and dentist?											
No, are cleaned like natural teeth	29.40%	600.05	24.20%	100.9	10.52% (6)	6.45 % (2)	8	12.14% 34			185.7375
Yes, needs more care than natural teeth	56.50%	1153.16	64.50%	268.96	56.57 % (43)	64.51 % (20)	63	81.78% 229			428.53
No, needs less care than natural	7.30%	148.99	3.10%	12.92	0	0	0	3.57% 10			42.9775
Do not know	6.80%	138.78	7.90%	32.94	2.63% (2)	0	2	2.50% 7			45.18
It depends on the risks to which the patient is subject (periodontitis, diabetes, etc.)					30.26 % (23)	29.03 % (9)	32	X			32
What according to you is the cost of procuring a dental implant from an implant company?											
Rs. 6000–10,000	26.90%	549.02	25.40%	105.91			30.35	85			246.6433
Rs. 10,000–15,000	28.90%	589.84	20.90%	87.15			34.28	96			257.6633
Rs. 15,000–20,000	22.50%	459.22	18.50%	77.14			21.07	59			198.4533
Rs. 20,000–25,000	14.60%	297.98	14.10%	58.79			12.5	35			130.59
Do not know	7.10%	144.91	21.10%	87.98			1.78	5			79.29667
How much do you feel is the initial setup cost required to incorporate implant surgery into practice?											
Rs. 200,000–300,000	28.20%	575.56	14.40%	60.04			32.14%	90			241.8667
Rs. 400,000–500,000	20.30%	414.32	26.4	110.08			40.71%	114			212.8
Rs. 500,000–100,00,00	27.00%	551.07	22.30%	92.99			19.28%	54			232.6867
,Rs. 100,00,00	9.00%	183.69	29.70%	123.84			7.85%	22			109.8433

Do you think that dental implants are an acceptable solution for missing teeth in the Indian scenario?											
Yes, implants are here to stay	21.40%	436.77	31.20%	130.1	28.94 % (22)	38.70 % (12)	34	41.07% 115			178.9675
No, economic feasibility will limit its usage	57.60%	1175.61	63.50%	264.79	56.57 % (43)	38.70 % (12)	55	50.71% 142			409.35
No, too invasive for patient acceptance	14.40%	293.9	4.60%	19.18	1.31 % (1)	0	1	7.14% 20			83.52
This depends on the educational level of the patient					11.84 % (9)	16.12 % (5)	14	X			14
QUESTIONS ON SOURCE OF INFORMATION AND NEED FOR MORE INFORMATION ABOUT IMPLANTS											
Were you provided sufficient information about implant procedure during your BDS program?											
Yes	18.90%	385.74	26.60%	110.9	1,31 % (1)	6,45 % (2)	3	32.85% 92	34.70 %	590	236.328
No	81.10%	1655.25	73.30%	305.66	98,68 % (75)	93,54 % (29)	104	67.14% 188	65.30 %	1110	672.582
Would you like more information about the implant treatment procedure to be provided in the BDS curriculum?											
Yes	91.70%	1871.59	95.70%	399.06	100 % (76)	100 % (31)	107	68.21% 191	95.10 %	1617	837.13
No	8.20%	167.36	4.30%	17.93	0	0	0	31.78% 89	4.90%	83	71.458
From where would you like to get more reliable information about dental implants?											
Short-term CDE programs and workshops conducted by the implant companies (2–3 days workshops)	10.20%	208.18	27.30%	113.84	13,15 % (10)	9,67 % (3)	13	24.28% 68	22.80 %	387	158.004
1-year certificate or module - based courses conducted by colleges or trained implantologists	67.50%	1377.67	57.60%	240.19	71,05 % (54)	70,96 % (22)	76	33.21% 93	24%	408	438.972
Professional newsletters and books	10.90%	222.46	5.00%	20.85	7,89 % (6)	3,22 % (1)	7	20.00% 56	8.50%	145	90.262
Dental consultants and specialists	8.50%	173.48	7.20%	30.02	7,89 % (6)	9,67 % (3)	9	10.35% 29	40.70 %	692	186.7
Study groups and internet	3.00%	61.23	2.90%	12.09	0	0	0	12.14% 34	4%	68	35.064
From where would you like to receive training on dental implants?											
Short-term CDE programs and workshops conducted by the implant companies (2–3 d workshops)	12.50%	255.12	15.10%	62.96	3,94 % (3)	3,22 % (1)	4	12.85% 36	19.50 %	332	138.016
1-year certificate or module-based courses	52.00%	1061.32	57.90%	241.44	32,89 % (25)	19,35 % (6)	31	48.57% 136	30.20 %	513	396.552

conducted by colleges or trained implantologists											
Fellowship programs conducted by the universities	25.10%	512.29	20.40%	85.06	14,47 % (11)	6,45 % (2)	13	31.42% 88	39.20 %	667	273.07
MSc programs (full time: 1 y, part time: 2 y)	10.30%	210.22	6.00%	25.02	7,89 % (6)	0	6	7.14% 20	11.10 %	188	89.848
Specific Courses during the Degree 3 – course in Dentistry	X	X	X	X	42,10 % (31)	64,51 % (20)*	51	X	X	X	51

The averages of each response showed a generalized pattern. Most students were moderately well informed regarding dental implants, and they thought placing implants was roughly as difficult as other dental treatments (mean=480.9). The most and least important factor for implant success was case selection and operator experience, respectively. Case selection and operator experience ranked as the highest and least relevant factors for implant success, respectively. Many students (mean=409.3) believed that dental implants were not a viable option for replacing missing teeth in India and that their use would be constrained by cost. Also, most students wanted more education about implant treatment procedure.

Discussion

Dental schools must train students due to the widespread clinical approval and rising patient demand for dental implants [31]. The theoretical knowledge serves as the base for the education in implant dentistry, as was determined at the First European Consensus Workshop on Implant Dentistry in 2008.

There is significant variation in the extent, timing, nature, and delivery of implant training in most schools [13]. Thus, leading to a great variation in student's clinical experience and perception of implant dentistry. This variety is reflected in the heterogeneity of the studies done.

A similar review was conducted by Koole and Bruyn in 2013 to explore reports on undergraduate oral implantology education, since the ADE workshop in 2008 [10]. However, the parameters assessed in that study were different from our study. Also, the literature was reviewed from only 5 years (2008-2013) and included all publication types.

In our study, there was no such restriction of timeline for the included studies. Only survey questionnaires were included. Consensus documents, opinions, letters, or commentaries were all excluded as they had no open questions. Moreover, the surveys provided the objective assessment. It was found that different survey designs were used in different studies. Hence, arriving at a common conclusion and generalizing the results of these studies was a challenge. Five studies used similar questionnaire and hence, an attempt to quantitively assess the responses to summarize and substantiate the results was done by calculating and comparing the means of the responses.

Most of the studies had a moderate to low risk of bias. This is mainly attributed to the lack in the study design with no identification of the confounding factors and hence, no measures to overcome those issues.

The included studies were conducted in different parts of the world. This led to an interesting finding that there is a worldwide lack of integration of implant dentistry in undergraduate education and there is a need for revising curricula. Our results agree with the studies conducted by Afsharzand et al where they found that predoctoral implant dentistry educational programs vary between European dental schools from a survey of

implant dentistry director [32]. Koole S et al, 2013 through a systematic review found that there was conflicting data on how implantology is integrated at an undergraduate level [10].

The student perception is an important indicator for further curriculum development. Most of the students felt that they were poorly to moderately well informed about the dental implants. This may be because of the limited course hours and hands on clinical experience. These results agree with the studies by Moest T and Nicolas E where the students indicated that inadequate implant education and a more thorough training was needed [33,34]. Pre- and post-course surveys showed that the students' perception and satisfaction increased after taking implant course. This difference was statistically significant in studies by Seitz SD et al, Ariani N [20,28]. Positive student perception motivated them to practice implant dentistry after graduation as assessed by Tammerman et al [29].

The level of certainty for this systematic review was considered low according to the use of an adapted GRADE criteria and our assessments, supporting the need for well-designed research to fill the knowledge gaps. There should be standard protocols and validated questionnaires so that the results can be easily derived and analyzed to make and apply worldwide, the students' perception should be studied.

At the minimum, it is a must for an undergraduate to have an adequate knowledge and understanding of the surgical and prosthetic implant procedures before they graduate [35]. Curriculum congestion is the real barrier to delivery of training at undergraduate level [3]. The fact that different specialist programs use the same patient population adds to the difficulty of the situation. Thus, where surgical training of the undergraduates negatively impacts specialized experiences, justifying it becomes challenging. [36]. To overcome these barriers, various non-traditional teaching methods can be used like online and multimedia resources, problem-based learning, and student–teacher-centered education [3]. To avoid making the curriculum overwhelming for the students and the staff, the timings when the course would run could be altered like during the summer break [20].

Conclusions

Based on a low-level certainty identified in this systematic review it is suggested that although predoctoral education in most dental schools across the world now includes implant dentistry as a core component, the degree of integration varies greatly.

To increase the competency of predoctoral students around the world in performing implant treatments and making related decisions, it is implied that a typical, well-designed predoctoral implant curriculum and standards that include didactic, laboratory, preclinical, and clinical components are needed.

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