

Knowledge and Attitude of Undergraduate Students and Interns toward Stem Cells and Their Implications in Dentistry: A Cross-sectional Study

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ABSTRACT

Aim: The primary ideology of this research was to evaluate both the knowledge and attitude of undergraduate students and interns regarding stem cells and their use in dentistry.

Materials and methods: A cross-sectional observational study was conducted among 310 dental students of Jazan University by making use of a self-explanatory questionnaire, containing a set of 25 questions and was sent as e-mail through Google e-forms.

Results: There was a good response rate of around 81.2%, of which 80.16% were aware of the fact that stem cells are unspecialized types of cells that come with the potential to turn into any cell type. Almost 65.08% of the participants considered the possibility to continue root formation post-trauma as the fundamental use of stem cells, and a majority (71.43%) of the participants showed great interest in garnering more knowledge and training in the area of stem cells. About 50% of the participants showed strong opposition to the concept of embryonic stem cells as these are basically fetched from an aborted fetus or from an embryo. There was a major section of the participants (79.76%) who were even keen on organizing more programs to create public awareness regarding stem cells. Mean knowledge and attitude scores among the participants were reported to be 7.57 ± 3.10 and 36.04 ± 6.51 respectively.

Conclusion: Overall, the level of knowledge and attitude of dental students and interns at Jazan University towards stem cells and their implications in dentistry can be interpreted as adequate.

Clinical significance: Advanced training and awareness campaigns on stem cells and dentistry would improve their knowledge and attitude.

Keywords: Attitude, Dental stem cells, Dental students, Interns, Knowledge.

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INTRODUCTION

The pluripotent status of certain cells in our human body equips them with the ability to divide and procreate. Such cells can also self-renew and differentiate in the future.^{1,2} Stem cells, specialized cells in the human body, are bestowed with this potential to regenerate into various cells and parts of the body whenever the need arises.^{3,4} The two dominant stem cell categories include embryonic (fetal) stem cells and adult (post-natal) stem cells. Adult stem cells retrieved from the tooth structure, have a dental origin. The periodontal ligament, dental pulp, dental follicle progenitor cells, apical papilla, and exfoliated primary teeth are valuable sources of postnatal dental stem cells.⁵

In dentistry, mesenchymal stem cells (MSCs)—a type of adult stem cells have significant potential for regenerating vital structures such as bone, cementum, periodontal ligament fibers, and dental pulp.⁶ The regeneration of bone is a crucial concern in current tissue engineering applications, and osteoprogenitor cells are readily accessible for this purpose. Natural and synthetic biomaterials are incorporated as delivery vehicles for MSCs, with osteoconductive biomaterials being preferred.⁷

Several craniofacial structures, such as the mandibular condyle, calvarial bone, cranial suture, and subcutaneous adipose tissue, have been produced using MSCs cells, growth factors, and/or gene therapy techniques.⁷ When it comes to tissue engineering of the mandibular condyle, adult MSCs offer several benefits over embryonic stem cells, as they can be obtained from the same

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individual and can be easily induced to differentiate into both chondrogenic and osteogenic cells.^{6,7}

The potential of MSCs lies in the regeneration of dental tissues in mammals. Tooth bud cells can be cultured to create bioengineered teeth. While deciduous teeth contain more immature multipotent

stem cells that can create dentin-like structures, they cannot form a complete dentin-pulp complex.⁷ The resulting bio-engineered tooth includes a well-defined pulp chamber, odontoblasts, pre-dentin, and dentin, as well as a morphologically correct enamel organ comprising stellate reticulum, stratum intermedium, ameloblasts, and dental enamel. Additionally, putative Hertwig's root sheath epithelia are present. Moreover, dental pulp stem cells can produce a reparative dentin-like structure directly on the surface of human dentin.^{7,8}

Irrespective of their origin, stem cells hold a significant ability that encompasses far beyond regenerative medicine.⁶ Present in both deciduous and permanent teeth, stem cells find themselves useful in manufacturing life-saving medications that are prolifically used by dentists for treating their patients.^{6,8} There is complete potential for dentists in collecting stem cells to contribute meaningfully to two areas, primarily dental applications and in treating medical-related illnesses.⁹ But to succeed in using stem cell therapy in dentistry, the underlying requirement for any dentist is to have an insight about stem cells and a positive approach in putting them to use in areas of tissue engineering, developing therapies to restore dental tissue integrity, and reconstructing pulp tissue. As a result, undergraduate, graduate, postgraduate, and practicing dentists require a deeper understanding of this subject for future practice and must integrate this subject into their curriculum.^{9,10}

Research done in Saudi Arabia in the year 2018, clearly showed a lack of knowledge and an average positive attitude of graduates regarding the application of stem cells in the field of dentistry.⁵ To reanalyze the situation and assess where exactly students stand in using stem cells for therapeutic applications, this study was undertaken to evaluate the knowledge and attitude of undergraduate students and interns at Jazan University toward stem cells and their implications for dentistry.

MATERIALS AND METHODS

Between September 2021 and December 2021, a cross-sectional observational study was performed among dental students and interns at Jazan University. Ethical clearance with a registration number of CODJU - 2103S was obtained before initiating the study.

Sample size Calculation

Sample size calculation was done using the formula

$$\text{Sample Size } (n) = \frac{Z(1-\alpha/2)^2 \times p \times (1-p)}{d^2}$$

Where,

$Z(1-\alpha/2) = 1.96$ for 95% confidence interval;

p = Proportion of the participants (10.2%) strongly aware of stem cell research and its implications in dentistry;⁵

d = Precision of the study.

With a precision of 4%, the sample size required for the present study is calculated as 219

10% of calculated sample size was added to compensate for sampling loss if any, thus final sample size was accounted to a total of 240 participants.

Selection Criteria

Dental undergraduate students who were inclined towards giving informed consent via Google e-forms were allowed to participate in the study. After sending five reminders with a two-day interval in between, those students who did not respond to them were excluded from the study.

Data Collection Instrument

This self-administered closed-ended questionnaire had 25 questions adopted from a previously validated questionnaire by Alhadlaq A and colleagues.⁵ It consisted of three parts, the first part comprised of questions concerning the basic demographic data, the second part included all those questions that helped in assessing the knowledge of the students and the interns doing dentistry at Jazan University, and the third part contained all questions that gauged their attitude. While there were 15 statements in the knowledge-based questionnaire that had three potential answers, the attitude part of the questionnaire comprised 10 questions, all of which were assessed on a 5-point Likert scale.

As per the scoring system, the correct answer was awarded a score of 1, while the wrong answer received a score of 0. In case a respondent replied with "I don't know", a score of 0 was assigned. Each participant's level of knowledge was then classified into one of three categories based on their total score: poor (0–5), moderate (6–10), or high (11–15). The questionnaire's attitude section included 10 statements that asked participants to indicate their level of agreement or disagreement using a 5-point Likert scale. Participants were allowed to select only one response for each statement. A score was assigned to each response ranging from (1) for an extremely negative answer to (5) for an extremely positive answer, resulting in a total score between (10) and (50). Attitude scores were then categorized into four levels such as poor (10–29), moderate (30–39), good (40–44), and excellent (45–50).⁵

Study Procedure

The study team came up with a self-explanatory questionnaire which was sent together with a consent form via online mode. An email containing the link 25 questions was sent as Google e-forms to 310 dental students. Only one response was allowed for each student. Participants were automatically directed to the study details and informed consent after obtaining and clicking the link which was followed by a series of questions.

Statistical Analysis

Descriptive statistics of student's responses to different questions were assessed using IBM SPSS (Statistical Package for Social Sciences) version 21.0, Chicago. Independent sample *t*-test and ANOVA was used to assess the variation in knowledge and attitude scores across gender and level of education. The level of significance was set at p -value < 0.05.

RESULTS

Among the 310 students, 252 completed the questionnaire yielding a response rate of 81.2%. Of them, 51.9% of the study participants were females, and most of the students (36.1%) who responded were in their 6th year of studies.

The point about stem cells being unspecialized cells that have the potential to form any cell type was a well-known fact among most of the participants (80.16%). Almost 45.2% of the participants knew that the eggs and sperm of humans were not considered sources of adult stem cells. The fact about stem cells obtained from adults are specialized cells capable of forming bone or cartilage was known by 41.27% of the participants. Almost 57.94% of the participants agreed that the umbilical cord exists as the source for the embryonic stem cells, and more than half (51.98%) of them valued stem cells taken from the dental tissues as adult stem cells. The fact that the exfoliated deciduous teeth's dental pulp was a prominent stem cell source was acknowledged by 54.37% of the

participants. Around 48.41% believed that dental stem cells could form neural cells. A majority (52.38%) of them were outspoken about retrieving the dental stem cells from the apical papilla of the tooth, and almost 65.08% of them agreed to the ideology of incorporating stem cells primarily for root formation post-trauma. A major population (55.56%) believed that adult bone marrow stem cells were obtained from the spine. There was also a common opinion among a sizeable population (53.97%) that sound deciduous incisors and canines proved to be a better source of dental stem cells compared to deciduous molars. Immunogenic reaction existed as the common reason behind the failure of autologous transplant of adult stem cells wasn't believed by many (53.57%) participants. For around 46.03% of the participants, chondrocytes were not considered as one of the stem cell types. About 42.46% of the participants were not sure about the possibility of using stem cell-based dental implants as a substitution for missing teeth. Sadly, the availability of stem cell banks in Saudi Arabia was known by only 34.52% of the participants (Table 1).

Analyzing the attitude-based questionnaire revealed that almost 58.74% (agree – 32.54%, strongly agree – 26.2%) of the participants were aware of ongoing research about stem cells and their promising benefits for use in the field of dentistry. Around 36.11% strongly agreed that they would recommend treatment with stem cells if available. About 45.64% (agree – 23.02%, strongly agree – 22.62%) acknowledged the presence of concrete information about stem cells in their curriculum and its persuasive use in the dental field. A majority (62.08%) of them strongly recommended (agree – 34.3%, strongly agree – 27.78%) adding a special course concerning stem cells to the dental curriculum. Around 46.43% (disagree – 17.86%, strongly disagree – 28.57%) had not attended any scientific activities related to stem cells outside the curriculum. A majority (71.43%) were interested (agree – 38.1%, strongly agree – 33.33%) to gain better insight regarding stem cells and their potential application in the dental field via advanced training courses. Around 39.68% of the participants (agree – 23.81%, strongly agree – 15.87%) felt that implementing stem cells use in dentistry could pave the way for religious and ethical conflicts. A common concern among most (50%) of the participants (agree – 27.38%, strongly agree – 22.62%) was the utilization of embryonic stem cells got from an aborted fetus or an embryo. Incrementing the count of public awareness programs concerning stem cells and their potential application was a widespread idea among 79.76% of the participants (agree – 38.89%, strongly agree – 40.87%). Most (65.08%) of the participants (agree – 35.71%, strongly agree – 29.37%) were ready to specialize in stem cell-based dental treatment if and only if stem cells become an integral and recognized branch of dental therapy in the years to come (Table 2).

The statistically significant difference was not observed when analyzing the differences in knowledge and attitude scores across gender (Fig. 1) and academic year (Fig. 2). Mean knowledge and attitude scores among the participants were reported to be 7.57 ± 3.10 and 36.04 ± 6.51 respectively as depicted in Tables 3 and 4.

DISCUSSION

In recent times, we have witnessed significant development in dental research and the prolific application of such results for practical use in the dental field. The study of stem cells is the most valuable contemporary research in regenerative dentistry. According to various research results, stem cells are capable of

rapid growth and thrive as the perfect platform for conceiving specialized bone, dentin, and brain cells.⁷ Making use of such neuronal cells for dental procedures prevails as one of the best ways of treating patients. Stem cell therapies assist in coming up with better improvements in repairing broken teeth, stimulating bone regeneration, and even treating neurological injuries.^{11,12}

It's not only dental applications that rely upon stem cells but also the treatment of various illnesses including correction of cranial abnormalities, neural tissue regeneration, and heart illness treatment seek the assistance of these cells and dentists hold a huge responsibility for procuring them.⁹ Peter Murray et al.¹³ Identified several major areas of research in the field of dentistry based on basic tissue engineering principles which include tooth and root regeneration, bone and craniofacial regeneration, periodontal regeneration, dental pulp regeneration, and root canal vascularization.

Healthcare providers are the single point of contact for patients and hence, their proficiency and outlook on stem cells are integral in circulating authentic data on these cells. Getting hold of valuable information helps patients take sensible decisions regarding using stem cells as a viable therapeutic source for its ingenious technique. As far as we know, our study takes pride in being the first one to shed light upon the knowledge and attitude of undergraduate students and interns of Jazan University toward stem cells and their implications for dentistry.

In our research, most of the participants were aware of the concept of stem cell research which was similar to the findings of Alhadlaq et al.⁵ where most of the participants knew stem cell research and its possible use in the field of dentistry. Even in our study, a considerable portion of the population knew well about stem cells and their serviceability in dentistry. On a global level, different studies proved that healthcare professionals had varying levels of knowledge and outlook about stem cells and their use in therapy.

A study conducted among medical and dental college students of Jof University exhibited medium knowledge and high attitude scores on stem cell research and its significance.¹⁴ In another study conducted by Al Abdulqader et al.,¹⁵ participants exhibited poor attitudes toward blood, organ, and stem cell donation. When the knowledge and attitude of Nigerian dentists were assessed, a majority had insufficient knowledge about the application of stem cells in dentistry. However, they exhibited a positive attitude toward stem cell use.¹⁶ Cross-discipline studies, one of which was conducted among nursing students in Malaysia, showed that the students favored the application of stem cells in the field of medicine and also possessed an average knowledge about it.¹¹ Similarly, the majority of the physicians who participated in a study conducted in Italy didn't have any proper knowledge about stem cells.¹⁷

As per the research conducted by Alhadlaq et al.,⁵ graduates in various Saudi Arabia dental schools displayed poor knowledge in the field of stem cells and how they could be used therapeutically, and this was in contrast with our research where moderate knowledge and moderately positive attitude towards the same was reported. Low knowledge levels observed among the participants in the former study can be due to the inclusion of many dental graduates from several dental schools. However, in this research, we attempted to evaluate the level of knowledge and attitude regarding stem cells exclusively among undergraduate students and interns of Jazan University.

Table 1: Analysis of knowledge regarding stem cells among study participants

S. No.	Knowledge	Responses	N (%)
1	Stem cells are unspecialized type of cells which are capable of forming any cell type	Yes	202 (80.16)
		No	20 (7.94)
		I don't know	30 (11.9)
2	Human sperms and eggs are considered a source of adult stem cells	Yes	72 (28.57)
		No	114 (45.24)
		I don't know	66 (26.19)
3	Stem cells obtained from adults are specialized cells that can form either bone or cartilage	Yes	104 (41.27)
		No	91 (36.11)
		I don't know	57 (22.62)
4	Embryonic stem cells can be obtained from umbilical cord	Yes	146 (57.94)
		No	35 (13.89)
		I don't know	71 (28.17)
5	Stem cells obtained from dental tissues are considered adult stem cells	Yes	131 (51.98)
		No	43 (17.06)
		I don't know	78 (30.95)
6	Dental pulp of exfoliated deciduous teeth is considered a useful source of stem cells	Yes	137 (54.37)
		No	33 (13.1)
		I don't know	82 (32.54)
7	Dental stem cells can form neural cells	Yes	122 (48.41)
		No	40 (15.87)
		I don't know	90 (35.72)
8	Dental stem cells can be retrieved from apical papilla of the tooth	Yes	132 (52.38)
		No	29 (11.51)
		I don't know	91 (36.11)
9	One potential application of stem cells is to allow root formation to continue following trauma	Yes	164 (65.08)
		No	25 (9.92)
		I don't know	63 (25)
10	Adult bone marrow stem cells are usually taken from the spine	Yes	140 (55.56)
		No	45 (17.86)
		I don't know	67 (26.59)
11	Sound deciduous incisors and canines are better source of dental stem cells than deciduous molars	Yes	91 (53.97)
		No	25 (9.92)
		I don't know	136 (36.11)
12	Autologous transplant of adult stem cells can fail mainly because of immunogenic reaction	Yes	38 (15.08)
		No	135 (53.57)
		I don't know	79 (31.35)
13	Chondrocytes are considered one type of stem cells	Yes	60 (23.81)
		No	116 (46.03)
		I don't know	70 (30.16)
14	Dental implants derived from stem cells are now available to replace missing teeth	Yes	58 (23.02)
		No	87 (34.52)
		I don't know	107 (42.46)
15	Stem cell banks are now available in Saudi Arabia	Yes	87 (34.52)
		No	66 (26.19)
		I don't know	99 (39.29)

Table 2: Analysis of attitude regarding stem cells among study participants

S. No.	Attitude	Responses	N (%)
1	I am aware of stem cell research and potential applications of stem cells in dentistry	Strongly disagree	5 (1.98)
		Disagree	34 (13.49)
		Neutral	65 (25.79)
		Agree	82 (32.54)
		Strongly agree	66 (26.2)
2	I will recommend treatment with stem cells if it is available	Strongly disagree	1 (0.4)
		Disagree	15 (5.95)
		Neutral	59 (23.41)
		Agree	91 (34.13)
		Strongly agree	86 (36.11)
3	The curriculum that I have studied contained good amount of information about stem cells and their potential applications in dentistry	Strongly disagree	57 (8.73)
		Disagree	63 (25)
		Neutral	52 (20.63)
		Agree	58 (23.02)
		Strongly agree	57 (22.62)
4	Adding a special course concerning stem cells to the dental curriculum is advisable	Strongly disagree	7 (2.78)
		Disagree	26 (10.32)
		Maybe adding topics not courses	1 (0.4)
		Neutral	62 (24.6%)
		Agree	86 (34.13)
		Strongly agree	70 (27.78)
5	I have attended scientific activities related to stem cells outside the curriculum	Strongly disagree	45 (17.86)
		Disagree	72 (28.57)
		Neutral	40 (15.87)
		Agree	49 (19.44)
		Strongly agree	45 (17.86)
		I don't hear or see any announcement about this topic	1 (0.4)
6	I am interested in attending advanced training course about stem cells and their applications in dentistry	Strongly disagree	5 (1.98)
		Disagree	26 (10.32)
		Neutral	41 (16.27)
		Agree	96 (38.1)
		Strongly agree	84 (33.33)
7	Use of stem cells in dentistry contradicts ethical and religious principles	Strongly disagree	23 (9.13)
		Disagree	55 (21.83)
		Don't know	1 (0.4)
		Neutral	73 (28.96)
		Agree	60 (23.81)
		Strongly agree	40 (15.87)
8	Use of embryonic stem cells should be prohibited as they are taken from embryo or aborted fetus	Strongly disagree	15 (5.95)
		Disagree	28 (11.11)
		Neutral	83 (32.94)
		Agree	69 (27.38)
		Strongly agree	57 (22.62)
9	There should be more public awareness programs about stem cells and their therapeutic application	Strongly disagree	3 (1.19)
		Disagree	12 (4.76)
		Neutral	36 (14.29)
		Agree	98 (38.89)
		Strongly agree	103 (40.87)
10	I will consider specializing in dental treatment with stem cells if it becomes a recognized dental specialty in the future	Strongly disagree	2 (0.79)
		Disagree	17 (6.75)
		Neutral	69 (27.38)
		Agree	90 (35.71)
		Strongly agree	74 (29.37)

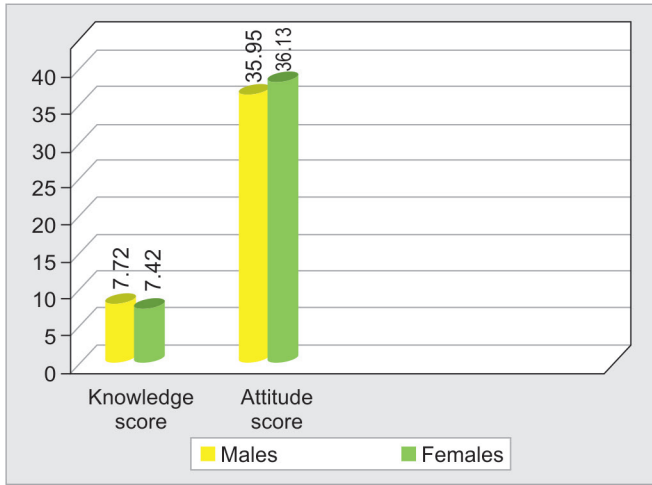


Fig. 1: Distribution of knowledge and attitude score across gender

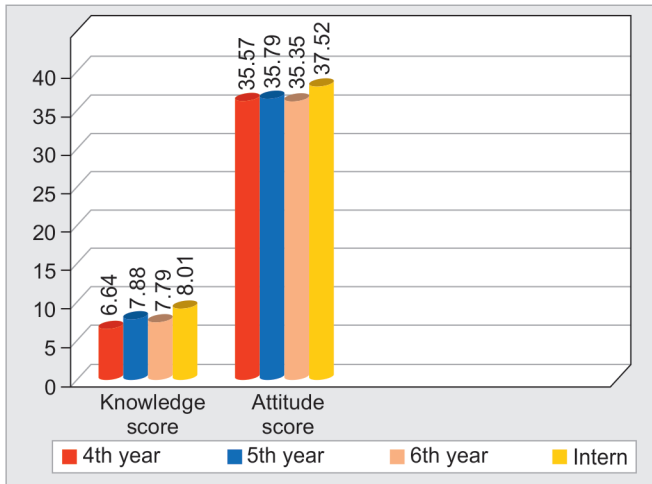


Fig. 2: Distribution of knowledge and attitude score across academic year

Despite the availability of stem cell banks in Saudi Arabia since the year 2006, most of the participants remained unaware of this.⁵ One common concept universally accepted among most participants included making use of stem cells for root formation post-trauma. This was similar to the findings of Alhadlaq et al.⁵ where the majority of them were aware of this concept.¹¹ Most of the nursing students had raised anxiety regarding embryo research, in the study conducted by Lye et al.¹¹ and suggested that this could have resulted in the gross misuse of research goals and even a marketing push that could lead to corruption. These findings were in parallel with our research where several participants had strongly raised concerns regarding the same. On the other hand, while various participants in this study strongly supported the ethical and religious contradictions that could arise from using stem cells in dentistry, the same ideology wasn't seen in the study by Alhadlaq et al.⁵ as most participants found it ethical.

One must weigh the findings of this study and interpret the same in the context of its strengths and limitations. Data were taken from a sample of a homogenized population and pre-validated tools were used in assessing the level of knowledge and attitude among the participants. But, as this was a cross-sectional study

Table 3: Distribution of knowledge and attitude score across gender

Variable	Gender	Frequency	Mean score	p-value
Knowledge score (7.57 ± 3.10)	Male	127 (50.4%)	7.72 ± 3.20	0.22
	Female	125 (49.6%)	7.42 ± 3.01	
Attitude score (36.04 ± 6.51)	Male	127 (50.4%)	35.95 ± 6.57	0.587
	Female	125 (49.6%)	36.13 ± 6.48	

Table 4: Distribution of knowledge and attitude score across academic year

Variable	Academic year	Frequency	Mean score	p-value
Knowledge score (7.57 ± 3.10)	4th year	42 (16.67%)	6.64 ± 3.14	0.127
	5th year	54 (21.43%)	7.88 ± 3.37	
	6th year	91 (36.11)	7.49 ± 2.94	
	Intern	65 (25.79%)	8.01 ± 2.99	
Attitude score (36.04 ± 6.51)	4th year	42 (16.67%)	35.57 ± 7.24	0.198
	5th year	54 (21.43%)	35.79 ± 6.67	
	6th year	91 (36.11)	35.35 ± 5.88	
	Intern	65 (25.79%)	37.52 ± 6.64	

conducted predominantly among the dental students of Jazan University, we can never extrapolate its findings to the study samples from other countries.

However, the outcome of this study warrants the importance of promoting awareness and information about stem cells to create a more informed dental community. Dental clinicians ought to acknowledge the growth of this sector and bear in mind the potential of obtaining stem cells that can be preserved for future autologous therapies while performing dental treatments (extracting deciduous teeth, third molars, and gingiva).

To equip dental students for their future practice, they must be well-versed and enthusiastic about the fundamental concepts of stem cells. It is of utmost importance for academic institutions to give due attention to the topic of stem cells. Dental students must receive a comprehensive education on stem cells, along with instilling a positive outlook on the subject. Such an approach will empower them to educate, support and advance care, which is vital for the healthcare industry.

It's highly recommendable to organize numerous educational programs to present the value held by stem cells only after accounting for social, ethical, cultural, moral, and religious factors. The Ministry of Health can play a pivotal role in promoting stem cell research and treatment by hosting frequent informative talks that are geared towards motivating positive attitudes towards the use of stem cells. Attending such programs and gaining insight helps students acquire valuable knowledge which in turn helps them to elevate attitude levels towards implication and use of stem cells in the field of dentistry. Such visions help the dental students to dissipate knowledge for a better understanding regarding stem cells in the general population and patients which in turn enhances the ability of patients to make informed decisions regarding the same.

CONCLUSION

From an overall perspective, the level of knowledge and attitude of dental students and interns at Jazan University towards stem cells

can be interpreted as adequate. Conducting advanced training courses and public awareness programs about stem cells and their applications in dentistry would enhance their knowledge and attitude toward the utilization of stem cells.

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