

# Knowledge and practices of Dental stem cell Dentistry amongst Dental graduates of Karachi: A multicenter cross-sectional survey

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## ABSTRACT

**Objectives:** The primary purpose of this questionnaire study was to assess the knowledge and attitude of Dental health professionals and students concerning dental stem cells.

**Materials & Methods:** The data collected was via an electronically generated questionnaire which was circulated amongst the house officers and postgraduate residents of all private and public dental universities and hospitals set up in Karachi, Sindh. The questionnaire was used to assess dental professionals' knowledge and attitude toward dental stem cells.

**Statistical analysis:** Descriptive statistics of socio-demographic variables were presented as mean  $\pm$  standard deviation or frequency percentages. The outcome variable was assessed in proportion according to knowledge and attitudes. Factor variables were compared using the Chi-square test for categorical variables and the independent t-test for quantitative variables. A p-value of  $\leq 0.05$  was considered significant.

**Results:** Female respondents knew more about stem cells and had more positive attitudes toward stem cell research than male respondents ( $P \leq 0.010$  and  $P \leq 0.035$ , respectively). There was a significant association between knowledge and attitude about dental stem cells and the age of participants, their area of practice (clinical/academic), and work experience in years ( $p$ -value  $< 0.05$ ).

**Conclusion:** Most participants had adequate knowledge about stem cells and positive attitudes towards both stem cell research scores in female respondents. A significant association of age, type of practice, and work experience with knowledge of dental stem cells and their use in developing non-dental tissues were observed.

**Conclusion:** A positive attitude towards recommending dental stem cell banking was seen. However, more supervisory oversight and professional action are essential to protect society from unproven stem cell therapies without sufficient clinical trials.

**Index Terms:** Dental stem cells, dental graduates, knowledge and practices, regenerative dentistry.

## I. INTRODUCTION

The Discovery of stem cells dates back as far as the 19th century when the renowned biologist of German origin Ernst Haeckel talks of it in the scientific literature as an "ancestor unicellular organism" from which all the multicellular organisms evolved (1). Stem cells are defined as clonogenic cells which are capable of both self-renewal and multilineage differentiation (2,3). The detection of these cells proved to be a breakthrough for the field of medicine as it opened a new arena with its use as a powerful tool for stem cell-based therapeutics (3), for example in the treatment of several types of cancers, heart disorders, and aplastic anemia (4).

Stem cells are of two types; embryonic and non-embryonic. Non-embryonic stem cells are further subdivided into adult stem cells and induced pluripotent stem cells. Adult stem cells can be of hematopoietic or mesenchymal origin (2). Based on their differentiation potential, they are classified as totipotent, pluripotent, and multipotent stem cells (3, 5). Back in 1985, the discovery of stem cells in dental pulp was embarked on by Yamam,ura and later in 2000, Gronthos identified dental pulp stem cells in adult human dental pulp (6). Stem cells of dental origin are categorized under adult

stem cells and are derived and isolated from dental tissues and associated structures (7). The development of teeth results from the interactions between the oral epithelium and underlying ectomesenchyme. From this, two types of dental stem cells are postulated; epithelial stem cells and mesenchymal stem cells (2). Till date, however, five types of stem cells dental in origin have been isolated; dental pulp stem cells (DPSCs), stem cells from exfoliated deciduous teeth (SHED), periodontal ligament stem cells (PDLSCs), stem cells from the apical papilla (SCAP), and dental follicle progenitor cells (DFPCs) (3,8).

Dental stem cells (DSCs) available have the potential to differentiate into a wide variety of cells including adipocytes, neural cells, myocytes, osteocytes, and chondrocytes. In addition to that, DSCs have also been used to regenerate various tooth tissues, namely dentine, PDL, cementum, and pulp tissue (5). After obtaining DSCs mostly through extracted teeth, they are stored in one of two ways; either they are cryopreserved, or are stored through magnetic freezing techniques (3). As mentioned in the literature, DSCs have, till date, been used for various procedures and treatments in dentistry, namely alveolar bone augmentation for insertion of dental implants (7), impact in regenerative dentistry strategies by regenerating whole tooth and associated structures tissues including salivary glands, craniofacial muscles, and structures of the temporo-mandibular joint (5).

Previous studies have revealed variable levels of stem cell knowledge and attitude and their potential applications by health professionals, dental graduates and students of health science schools across various countries. For example, in India, there was a positive attitude towards use of stem cells in dentistry; and a significant association of age and type of practice with awareness of dental stem cells and knowledge regarding their use in developing non dental tissues was observed. (5) Findings of a study from Kerman suggested the acceptable attitude of dentists about dental stem cells. A positive attitude toward stem cell application can lead to more use of it and an improvement in the clinical application (9). A recent study performed in various dental schools in Saudi Arabia showed that there was an overall moderately positive attitude of recent dental graduates towards stem cells and their therapeutic applications in dentistry; however, knowledge was inadequate. (7) In general, it can be concluded that a positive attitude toward the application of stem cells can lead to greater use of it and an improvement in its clinical application.

The awareness, knowledge, and attitude of dental graduates regarding dental stem cells is a relatively unsearched arena and should be assessed to obtain a baseline information. Such assessment if performed among recent graduates may reflect the amount of exposure of dental students to the topic during their dental education and thus help in making any necessary recommendations. The dental professionals must acquire a complete knowledge about their nature, applications, and the procedure to procure as well as store them, so that the masses are benefitted at large.

The current study was conducted with the aim to assess the awareness about the existence of dental stem cells among dental graduates and to further assess their knowledge and attitude regarding dental stem cells.

## II. MATERIALS & METHODS

This study was online questionnaire-based study conducted at dental institutes of Karachi among dental graduates, house officers and postgraduate residents. The study lasts from December 2021 to April 2022. Approval to conduct this study was obtained from the institutional review board (IRB application # IRB/D000010/21) at the Liaquat College of Medicine & Dentistry, Karachi, Pakistan.

The sample size was calculated at a confidence level of 95% and bound on error of 5%, and a previous knowledge, awareness, and attitude taken to be 72% (5), yielded 310 participants. Keeping the factor of non-response, the sample size of this study was increased up to 350 participants.

There were 8 dental colleges included in this study; 3 government and 5 private. The email IDs of dental graduates and house officers were obtained through college management and the online questionnaire was emailed to them. Informed consent was attached along with the questionnaire.

The questionnaire was designed in English language and developed on the basis of available literature and similar studies concerning knowledge of dental stem cells and their application in dentistry. (5) The questionnaire started with informed consent from the participant also mentioning objective and benefits of the study. Information regarding demographic variables such as age, gender, qualification, and years of experience was obtained using the online questionnaire. The questions were structured mainly to assess the knowledge of dental graduates and postgraduates regarding existence, types and potential sources of dental

stem cells; their isolation method and attitude of participants towards recommending their storage to the patients.

Data obtained from participants were entered and analyzed using the Statistical Package for the Social Sciences (Version 22.0, SPSS, Chicago, IL, USA). Descriptive statistics (frequencies, means and percentages) were calculated for the participants' demographic characteristics.

## RESULTS & FINDING

In this study, 97 males (26.5%) and 269 females (73.5%) among the 366 people were interviewed. The mean age was  $26.9 \pm 4.8$  with minimum age 18 and maximum 48 years. A total of 295 (80.6%) of the participants had fewer than 5 years of work experience, 51 (13.9%) had 5-10 years, and 20 (5.5%) had more than 10 years. (Table 1)

Overall, 136 (57.9%) of the 235 participants were aware of the various types of dental stem cells. A total of 103 (75.7%) responses were selected for all of the above answers for knowledge regarding types of dental stem cells; 67 (49.5%) primary teeth and 66 (48.5%) primary and permanent teeth were both selected for answering the question "dental stem cells can be derived from." When it came to the types of teeth utilized for dental stem cell banking, 71 (52.2%) of the affirmative responders said tooth extraction owing to non-pathologic conditions was the primary source, while 55 (40.4%) said exfoliated tooth was the primary source. The

## DISCUSSION

There is a huge increase in research activities with the advent of stem cells in dental pulps in the field of regenerative medicine as well as dentistry. (10) The application of stem cell therapy has been growing and will make a significant contribution to future dentistry.

The present study aimed to assess the awareness, knowledge and attitude about dental stem cells among dental graduates and practicing dental professionals. This is an essential step to measure the current exposure of dental graduates about stem cells during their dental education. The rising level in procurement of dental stem cells from vital teeth, their application in medical and dental domains indicates the need of thorough knowledge about the various aspects of DSCs for the dental professionals. Due to scarcity of locally published studies about knowledge and attitudes of dental professionals toward DSCs, there is a need of more studies are which will emphasize on these parameters.

Scores were reported in proportions according to knowledge and attitudes. The Pearson's chi-square test was used and significance for all statistical tests was predetermined at a probability value of 0.05 or less.

## RESULTS & FINDINGS

process for obtaining dental stem cells was also evaluated in this study. Only 29% of affirmative respondents were aware of the technique for obtaining dental stem cells (Table 2).

Females had significantly better knowledge of dental stem cells 89 (65.4%) than males 47 (34.6%), while people with less than 5 years of work experience had significantly better knowledge of dental stem cells 99 (72.8%) than those with 5-10 years of work experience 22(16.2%) and more than 10 years of work experience 15(11.0%). A significant difference was found between gender, work experience and knowledge of dental stem cells  $p=0.011$  and  $p=0.001$  respectively. (Figure 1).

Among participants in this study, women knew more about Dental stem cells, had more positive attitudes towards stem cell research, than men ( $P \leq 0.010$  and  $P \leq 0.035$ , respectively) (Table 3). There was a significant association between knowledge and attitude about dental stem cells and age of participants, their area of practice (clinical/academic) and work experience in years ( $p < 0.05$ ) (Table 3).

In the present study, about 64.2% of the participants having awareness about the existence of DSCs. A study from Karachi also reported similar level knowledge about the application of stem cells in dentistry i.e., 61%. (11) This shows that more than half of the dentists had knowledge but still most of dentists didn't know much regarding stem cells. Similar greater levels were reported in studies conducted by Goswami (5), Chitroda (12), and Katge (8). The awareness among dental professionals with age less than 25 years and up to 5 years of work experience, was reported to be higher ( $P\text{-value} < 0.001$ ). Comparable findings have been reported by Goswami (5) and Chitroda (12) whereas contrasting results have been observed by Katge. (8)

The participants in the present study, were reported dental books according to curriculum as an important source of information of DSCs (50.2%) followed by internet and scientific journals. The studies conducted by Sede et al (13) and Goyal et al (14) showed that conference/symposium/seminar were the primary source of the information whereas a study by Chitroda (12) declared

that internet-based material followed by books are the main sources of information. This could be due to the rising awareness regarding the topic through different forums like scientific publications and also because of its novelty in the world of medicine and dentistry. (15,16) In the present study, majority of dental graduates (35%) considered the books as main source of DSCs information while about 52% of postgraduate residents and faculty members marked the scientific journals and internet as their source of information. As observed in the present study, greater level of awareness about scientific literature among postgraduate students could be due to advanced knowledge obtained during postgraduate courses as well as exposure to indexed journals, and dental conferences during their postgraduate training. Since the topic is not taught through the curriculum, this may be the outcome of the, which are attended when compared with undergraduates. More postgraduate students attend CDE programs and seminars as compared to undergraduates, so this could also be a reason of their better awareness.

The DSCs can be isolated from pulpal tissue of both primary and permanent teeth. Other main sources of DSCs include the periodontal ligament cells, cells from apical papilla of young permanent teeth and developing dental follicle.<sup>14,19</sup> Nearly, 58% of participants were aware about the different types of DSCs which is similar as reported by Goyal et al (60.3%)<sup>16</sup> but in contrast with 81% and 69.6% as reported by Goswami and Chitroda.<sup>12 13</sup> There was a significant association found between awareness of types of DSCs and participants with age less than 25 years, practicing academic faculty, and with working experience up to 5 years. Regarding the type of teeth used, 49.5% of the positive respondents reported both primary and secondary teeth as the main source while almost 48.2% participants listed primary teeth only. Similar level of awareness regarding origin of DSCs is reported in other studies.<sup>11,12</sup> A total of 52.2% of positive responders listed that teeth extracted due to non-pathologic conditions could be used for dental stem cell isolation (stem cell banking) whereas 40.4% reported exfoliated teeth to be the main source. A study conducted by Goswami<sup>5</sup> reported that 70.8% dental professionals listed exfoliated teeth as the primary source, with 67.7% reporting teeth extracted due to non-pathologic conditions as the source of DSCs.

The steps included in DSCs banking involve the extraction, processing and storage of DSCs for practical implications. The techniques used for identification of DPSC's involve

fluorescent antibody cell sorting (FACS), magnetic activated cell sorting (MACS), and immuno-histochemical staining.<sup>8</sup> Storage of isolated cells can be done by either cryopreservation or magnetic freezing<sup>20</sup>

Among positive responders for DSCs types and origin, only 29.4% were aware about the procedure to procure DSCs. The knowledge of procurement of DSCs was much higher among postgraduate faculty members and those in specialty practice as compared to graduates, a result similar to previous studies.<sup>8,12</sup> This disharmony in knowledge might be attributed to the lack of information provided by curriculum books at the undergraduate level.

DSCs have potential to differentiate into chondrogenic, osteogenic and adipogenic cell lines as well as cells from neural crest-derived lineages such as melanocytes and endothelial cells.<sup>11,21</sup> The vast potential of DSCs make them prominent contributor in cure of various neurological disorders such as ischemic brain injury, Parkinson's and Alzheimer's disease; for vasculogenesis in treatment of ischemic heart disease; as cell-based therapy for patients with liver dysfunction such as cirrhosis, diabetes mellitus, and for regenerative ocular therapies<sup>21</sup>. In this study, 33.1% of positive responders were aware of the use of DSCs in the development of non-dental tissues, this lower proportion of knowledge about use of DSCs in treatment of diseases is also reported by a local survey in Karachi<sup>11</sup> Previous literature also revealed that knowledge regarding non-dental applications of DSC's was highest among senior residents followed by postgraduate students and interns.<sup>12 14</sup> Also provided knowledge was higher among those above 29 years of age and with more than 5 years of experience. Similar findings reported in this study that participants with age above 25 years, with post-graduation in basic or clinical sciences, in clinical practice and with experience up to 5 years displayed awareness regarding non-dental applications of DSCs. This can be explained on the basis of greater exposure of professionals with respect to age and clinical experience in treatment of intractable diseases in comparison to those still specializing in their respective fields.

This study also assessed the attitude of dental professionals towards recommending dental stem cell banking to patients. About 45% of positive responders showed a positive attitude and were willing to recommend DSCs banking in their practice. Much higher figures were reported in studies (55-75%) where participants exhibited a positive attitude

towards dental stem cell use and gave affirmative response towards aspect that regenerative dental treatment will be a better treatment option than tooth implant placement.<sup>7,11-13,15</sup>

Dental stem cells have become a popular research arena in not only dentistry but also in the medical field. Their easy-to-procure nature, relative non-immunogenicity and their vast potential for treatment of various intractable diseases make them superior to other types of stem cells. There is an utmost need to upgrade the knowledge of dental professionals and undergraduates regarding various aspects of dental stem cells with different methods. The first step in this regard is to incorporate in-depth and contemporary information about this topic in curriculum books at the undergraduate level. Next, organizing symposiums, seminars, and conferences regarding the same with discussions pertaining to the nature, types, isolation, preservation, and potential applications of these cells should be taken up. Educational programs and workshops providing professional training must be organized in order to create awareness and acquire clear understanding about these cells. It becomes necessary for every dental professional to be aware about dental stem cells in order to provide the correct guidance to general public at the right time.

#### **LIMITATIONS**

This study has few limitations. This was an online survey and all data collected was self-reported by the participants. Self-reported responses are usually unable to be verified and may be prone to bias. The knowledge and attitude towards DSCs assessed in this study are mostly confined to fresh dental graduates with less work experience in Pakistan and cannot be generalized to represent dentists and dental graduates in other geographic regions.

#### **CONCLUSION**

Overall, the level of knowledge and attitude of dental graduates in Karachi toward dental stem cells and their potential therapeutic applications in dentistry can be interpreted from this study as moderately adequate. Showed that there was moderate to positive attitude toward stem cells and their therapeutic applications in dentistry; however, knowledge was inadequate.

It is recommended that dental students should be more exposed and motivated about the principles of regenerative dentistry during their dental education in order to be prepared for future practice utilizing stem cells. The results

warrant a need of promoting stem cells knowledge and application to create awareness through professional training, lectures, academic courses and visits to the major research centers to realize its importance. Adequate knowledge will make an impact in the quality of treatment of patients.

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## TABLES

Table 1: Characteristics of Study Participants (n=366)

	<b>Variables</b>	<b>n</b>	<b>%</b>
1.	Gender of Participants		
	Male	97	26.5
	Female	269	73.5
2.	Age of Respondents		
	Less than 25 years	162	44.3
	Equal and more than 25 years	204	55.7
3.	Qualification of Participants		
	BDS	306	83.6
	MDS/MS/MPhil	44	12.0
	FCPS	16	4.4
4.	Area of Work		
	Clinical Practice	222	60.7
	Academic Faculty	144	39.3
5.	Work Experience		
	Less than 5 years	295	80.6
	5 -10 years	51	13.9
	More than 10 years	20	5.5



Table 2: Knowledge Responses of Dental Professionals Regarding Dental Stem Cells

Questions	n	%
Are you aware about Dental Stem Cells? (n=366)		
Yes	235	64.2
No	131	35.8
What is your source of information about Dental Stem Cells? (n=235)		
Dental curriculum books	118	50.2
Internet	67	28.5
Journals	42	17.9
Others	8	3.4
Are you aware about the different types of Dental Stem Cells? (n=235)		
Yes	136	57.9
No	99	42.1
What are the different types of Dental Stem Cells? (n=136)		
Dental pulp stem cells (DPSCs)	25	18.4
Periodontal ligament stem cells (PDLSCs)	4	2.9
Stem cells from human exfoliated teeth (SHED)	3	2.2
Stem cells from gingiva (GMSCs)	1	0.7
All of the above	103	75.7
Dental Stem Cells can be derived from? (n=136)		
Primary teeth	67	49.3
Permanent teeth	3	2.2
Primary teeth Permanent teeth Both	66	48.5
Which tooth can be used for stem cell banking? (n=136)		

Tooth extracted due to non-pathologic condition	71	52.2
Exfoliated tooth	55	40.4
Tooth extracted due to pathologic condition	6	4.4
Carious tooth	4	2.9
Do you know the procedure to procure Dental Stem Cells? (n=136)		
Yes	40	29.4
No	96	70.6
Can Dental Stem Cells be used to develop non-dental tissues? (n=136)		
Yes	45	33.1
No	24	17.6
Don't Know	67	49.3
Will you recommend a patient to store Dental Stem Cells? (n=136)		
Yes	61	44.9
No	6	4.4
Can't Say	69	50.7

Table 3: Association of Socio-demographic variables with knowledge and practices regarding Dental stem cells

	<b>Variables</b>	<b>Association with Knowledge (P-value)*</b>	<b>Association with Practices (P-value)*</b>
1.	Age	0.001	0.001
2.	Gender	0.010	0.035
3.	Level of Education	0.2440	0.234
4.	Area of Practice	0.021	0.062
5.	Work Experience	0.001	0.011

\*Pearson Chi-square test

P-value &lt;0.05–significant

## FIGURES:

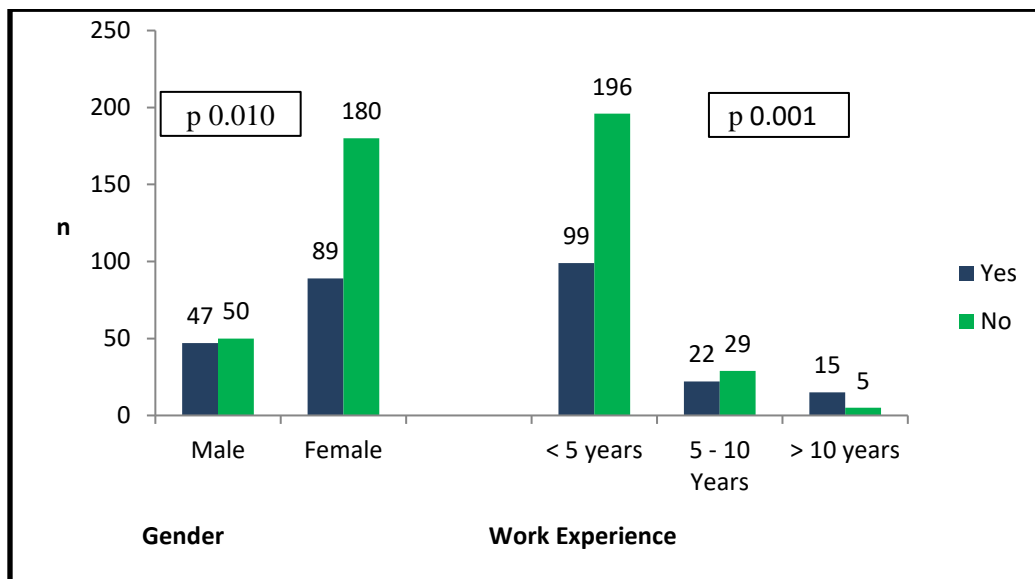


Figure 1: Association of Gender and Work Experience with knowledge regarding dental stem cells