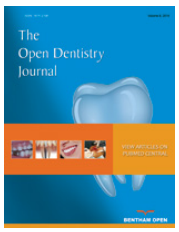

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RESEARCH ARTICLE

Knowledge, Awareness and Perception of Dental Stem Cell and Their Applications in Regenerative Medicine Among Professional Groups

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Abstract:

Introduction:

Dental stem cell research has become an important field in regenerative medicine. Nevertheless, the depth of knowledge and awareness of dental stem cells remain vague among the professional groups in Malaysia. The objective of this study is to assess the level of knowledge and awareness of professional groups in Malaysia on dental stem cells and their applications in regenerative medicine.

Methods:

A descriptive cross-sectional survey was implemented using online and hard-copy questionnaires that was distributed among medical doctors, scientists, and dentists to assess the level of knowledge and awareness (n=157). The questionnaire consists of 3 sections consisting of demographics, knowledge assessment and perception among the professional groups. The data were analysed using SPSS analysis.

Results:

Results showed that professional groups in Malaysia were knowledgeable and aware of dental stem cells and their application. Majority of the respondents were dentists (41.91%), followed by medical doctors (35.29%) and scientists (22.79%). 50.74% of respondents were unsure about the similar characteristics between dental stem cells (DSCs) and bone marrow mesenchymal stem cells (BMMSCs). Most respondents were aware of the derivation of DSCs from pulp and periodontal ligament (PDL) tissues (77.21%) and that DSCs are considered an adult stem cell source (51.11%). Most respondents were familiar with the characteristics of DSCs. They were aware that DSCs have the unique ability to self-renew and differentiate into trilineage differentiation (69.12%). They agreed that DSCs are an excellent cell resource for therapeutic approaches to neural repair and regeneration (63.24%). 63.24% of the respondents demonstrated a positive outcome for dental stem cell research. 59.56% of them would be willing to donate their extracted teeth for research. About 56.62% of respondents would conserve their teeth in stem cell banks and 52.94% are interested in investing in the stem cell industry.

Conclusion:

A high level of perception and awareness about dental stem cells and its application was noted among professional groups in Malaysia. They are supportive and willing to invest for dental stem cell research.

Keywords: Dental stem cell, Knowledge, Perception, Dentist, Scientists, Medicine.

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1. INTRODUCTION

Stem cell research has attracted the attention of society, including medical practitioners, due to the potential for multiple differentiation and self-renewal abilities to differentiate into all cell types of the human body. To date, using various approaches, researchers have tested the ability of different stem cells to differentiate into more specialized cell types. Among the various types of stem cells, embryonic stem cells (ESCs) retain the highest plasticity and possess the potential to differentiate into all of the cell lineages of the body [1].This, coupled with their unlimited capacity for self-renewal, bring obvious safety and ethical concerns. Moreover, cell differentiation may cause changes in the secretome and phenotype that could induce an immune response by the host, thereby requiring immunosuppressive therapy [2].

Mesenchymal stem cells (MSCs) are more acceptable in Malaysia due to the cost and ethical issues [3]. Furthermore,

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mesenchymal stem cells (MSCs) can be obtained from various tissues, such as bone marrow, the umbilical cord, and adipose tissues [4]. They are able to substantially expand *in vitro* and generate multiple cell lineages, although their exact nature and functions remain enigmatic. However, mesenchymal stem cell research and therapy have raised many debatable issues among researchers and the public. This also raises the question of whether sufficient information regarding the concept and uses of mesenchymal stem cells is available to the healthcare provider and the public to increase their awareness and understanding of the topic.

In conjunction, dental stem cell, a type of adult stem cell, exhibits multipotent differentiation capacity and has attracted worldwide attention because of its various applications [5]. The advances in applications of dental stem cells seem to be unsurpassed in the near future, for which specialized skills and knowledge in this arena are of prime significance. Hence, acquiring more knowledge about dental stem cells is necessary to obtain maximum benefits from them in the coming years.

Stem cell research is fairly new in Malaysia. The majority of the work until now has involved hematopoietic stem cells from bone marrow, peripheral blood, and cord blood [6]. Thus, the research in Malaysia showed that most participants were aware of embryonic stem cells, while the least awareness was observed concerning mesenchymal stem cells (MSCs) and induced pluripotent stem cells [7].

Limited information is available regarding the awareness and perception of dental stem cells and their applications in regenerative medicine among professional groups in Malaysia (*i.e.*, medical doctors, dentists, and scientists). To the best of our knowledge, no previous studies have been conducted to determine the amount of exposure given to the professional groups on this very specialized topic in Malaysia. Therefore, the awareness and perception of these targeted groups on stem cells remain uncertain. This study aims to gather information from the professional groups regarding their knowledge and awareness of dental stem cells and their perception of stem cell research in Malaysia. The outcome of this study is important for the advancement of stem cell research as its applications are currently highly experimented for the treatment of many diseases in Malaysia.

2. MATERIALS AND METHODS

2.1. Design

This descriptive cross-sectional study investigated the knowledge, awareness and perception of dental stem cells and their applications in regenerative medicine among professional groups.

2.2. Sampling and Participants

The sample size for this research was 157 participants (n=157). The targeted groups for this survey were dentists, medical doctors, and scientists in the Klang Valley. Those who were able to understand English from the targeted group were included.

2.3. Instrument Development

The self-administered instrumentation tool used in this research was a self-developed questionnaire. The questionnaire was formulated based on the literature review regarding stem cells and their application in regenerative medicine. The questions were developed by referring to a few sources [1 - 6].

2.4. Data Collection

In this study, online and hard-copy questionnaires were distributed to the respondents. The respondents were given approximately 10-15 minutes to complete the questionnaire.

The questionnaire comprised of three sections as follows:

- Part 1 was about demographic data (respondent's age, gender, nationality, race, religion, occupation, the highest level of education).
- Part 2 mainly focused on the awareness and knowledge regarding dental stem cells of the respondents.
- Part 3 dealt with the perception of dental stem cells and their applications in regenerative medicine. For each correct answer, a score '1' was given, and a score '0' was given for each wrong answer. As for part 3, each respondent was required to select his/her view of the statement to either strongly disagree, disagree, unsure, agree, or strongly agree.

2.5. Data Analysis and Scoring Measurement

Data were entered and analyzed using SPSS software. Demographic data were analyzed and reported with descriptive statistics using numbers and percentages. The numbers of correct answers for each question were qualified in percentages. The perception regarding the applications of dental stem cells in regenerative medicine was measured using a Likert 5-point scale. Respondents were given statements representing a range of views on a subject related to stem cells. Thus, each respondent was asked to select his/her view, such as strongly disagree, disagree, unsure, agree, or strongly agree. Scores ranged from 1 point, which was 'strongly disagree', to 5 points, which was 'strongly agree'. The Pearson's Chi-square test and percentages of the total were used for analysis to gain insight into the knowledge and attitude regarding DSCs among professional groups.

3. RESULTS

A total of 157 respondents from various professional groups (dentists, medical doctors, scientists, and others) participated in this survey. The majority of respondents (42%) were dentists (Fig. **1a**), while 31% were medical doctors, 18% were scientists, and 9% were from other categories (Fig. **1a**). In terms of ethnicity, the majority were Malays (46%), followed by Indians (24%) and Chinese (18%) (Fig. **1b**). Age-wise, most of the respondents (57%) were within 30-39 years of age, 20% were in their 20s, and 17% were in their 40s (Fig. **1c**).

Of the respondents, 98.41% were aware of stem cells, while the rest (1.59%) were not (Fig. **2**). There was a significant difference in the association of various professional groups with knowledge and perception of stem cells, as shown

in Table **4**. The results also showed that 69.12% of respondents were aware of the ability of DSCs to self-renew and undergo trilineage differentiation (Table **1**). The majority of respondents were well aware of the characteristics of DSCs, with 63.24% stating that dental pulp stem cells (DPSCs) have beneficial effects on neural regeneration and repair. About half of the respondents (50.79%) indicated that it is possible to replace missing teeth with dental implants derived from dental stem cells (Fig. **3**). In general, most of the respondents are very knowledgeable about the basic characteristics of dental stem cells and cell biology of dental stems based on their capability to answer correctly in our questionnaire (*i.e.*, DSCs have a unique ability to self-renew and differentiate into trilineage differentiation, dental implants derived from dental stem cells are possible to replace missing teeth, dental stem cells can proliferate through cell division, and dental pulp stem cells (DPSCs) have beneficial effects on neural regeneration and repair).

However, only 5.15% of them were aware that DSCs are capable of proliferating through cell division. Further evaluation of respondents was done through additional questions and statements. A minority (36.03%) were aware that stem cells give rise to certain cancers, while 50.74% were unsure if DSCs have similar characteristics to bone-marrow mesenchymal stem cells (BMMSCs) (Table **1**).

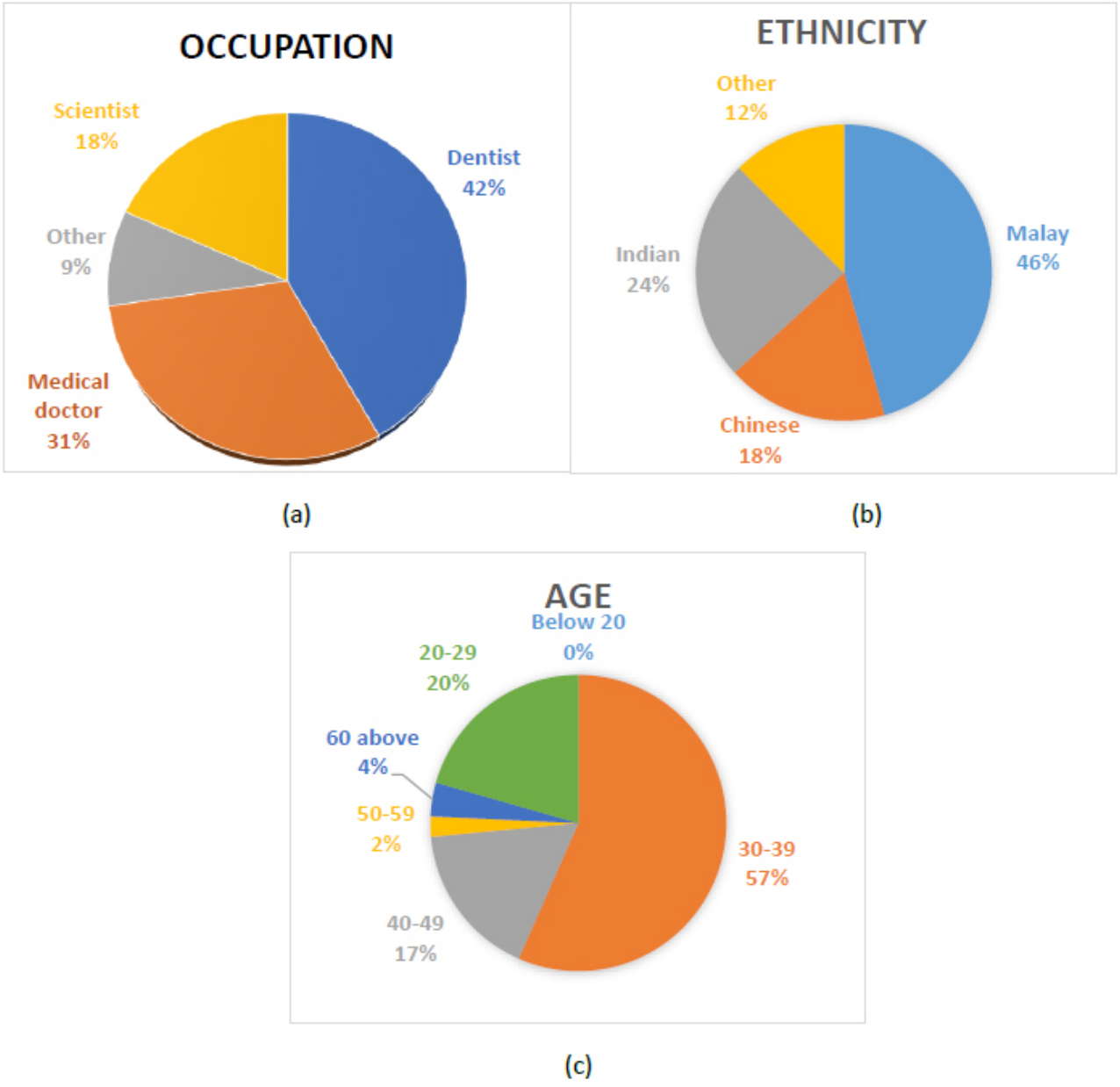

Fig. (1). (**a**) shows the types of professional groups involved in the survey. **b**) shows the different ethnicity that participated in the survey. (**c**) shows the percentage of different age group that participated in the survey.

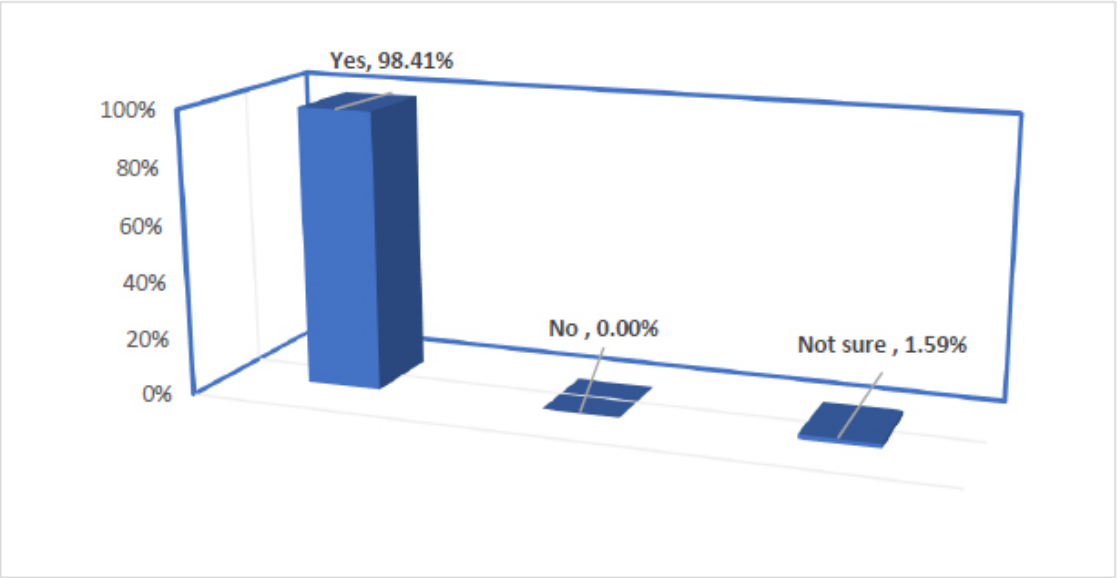

Fig. (2). Have you heard about stem cells?

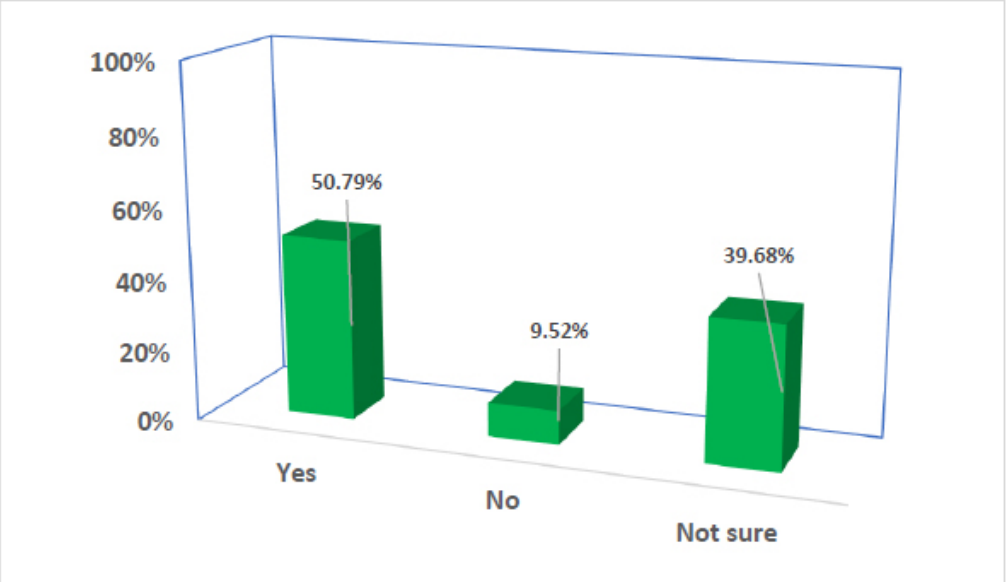

Fig. (3). Dental implants derived from dental stem cells are possible to replace missing teeth.

Table 1. The table shows five varying statements that assesses the respondents' level of knowledge regarding the characteristics of dental stem cells.

Statement: Dental stem cells have the unique ability to self-renew and differentiate into trilineage differentiation (*i.e.* osteoblasts, chondrocytes, adipocytes).	
Yes	**69.12% Expected answer**
No	4.41%
Not sure	26.47%
Statement: Dental stem cells can proliferate through cell division.	
Yes	73.53%
No	**5.15% Expected answer**

(Table 1) contd.....

Not sure	22.32%
Statement: Dental pulp stem cells (DPSCs) have beneficial effects on neural regeneration and repair.	
Yes	**63.24% Expected answer**
No	1.47%
Not sure	35.29%
Statement: Stem cells give rise to certain cancer.	
Yes	**36.03% Expected answer**
No	36.76%
Not sure	27.21%
Statement: Dental stem cells do not have similar characteristics as bone marrow mesenchymal stem cells (BMMSCs).	
Yes	24.26%
No	**25.00% Expected answer**
Not sure	50.74%

Table 2. The above shows several statements in the questionnaire pertaining to different sites of stem cell derivation to assess the level of knowledge of respondents.

Statement: Stem cells obtained from dental tissues are considered adult stem cells.	
Yes	**51.11% Expected answer**
No	7.41%
Not sure	41.48%
Statement: Adult stem cells can be obtained from sperm and eggs.	
Yes	19.12%
No	**47.79% Expected answer**
Not sure	33.09%
Statement: Mesenchymal stem cells (MSCs) are derived from various tissues such as bone marrow, umbilical cord, placenta, adipose tissue and dental tissues.	
Yes	**84.56% Expected answer**
No	2.21%
Not sure	13.24%
Statement: Dental stem cells can be derived from dental pulp and periodontal ligament tissues.	
Yes	**77.21% Expected answer**
No	0.00%
Not sure	22.79%

Table 3. The above shows several statements regarding the future and the willingness of the respondent to contribute to the dental stem cell industry.

Statement: Dental stem cell research has a positive future.	
Strong disagree	0.00%
Disagree	0.74%
Unsure	8.82%
Agree	63.24%
Strongly agree	27.21%
Statement: I would like to donate my extracted teeth for therapeutic and research purposes.	
Strong disagree	2.21%
Disagree	6.62%
Unsure	16.91%
Agree	59.56%
Strongly agree	14.71%
Statement: I would like to conserve my dental stem cells for personal and therapeutic purpose.	
Strong disagree	1.47%
Disagree	4.41%
Unsure	24.26%

(Table 3) contd.....

Agree	56.62%
Strongly agree	13.24%
Statement: Dental stem cell industry *i.e* stem cell banking and stem cell products is a good investment.	
Strong disagree	0.74%
Disagree	1.47%
Unsure	35.29%
Agree	52.94%
Strongly agree	9.56%

Table 4. Data association of various professional groups with knowledge and perception of stem cells.

-	-	-	-			Pearson Chi-Square
			No	Not sure	Yes	p-values
-	Stem cells obtained from dental tissues are considered adult stem cells.	Dentist	11	17	38	0.015
-			78.60%	27.00%	47.50%	
-			-	-	-	
-			-	-	-	
-			-	-	-	
-			-	-	-	
-		Medical doctor	2	28	18	
-			14.30%	44.40%	22.50%	
-		Other	0	7	7	
-			0.00%	11.10%	8.80%	
-		Scientist	1	11	17	
-			7.10%	17.50%	21.30%	
-	Dental stem cells can be derived from dental pulp and periodontal ligament tissues.	Dentist	1	6	59	0.003
-			50.00%	16.20%	50.00%	
-		Medical doctor	1	19	29	
-			50.00%	51.40%	24.60%	
-		Other	0	7	7	
-			0.00%	18.90%	5.90%	
-		Scientist	0	5	23	
-			0.00%	13.50%	19.50%	
-	Dental stem cells have the unique ability to self-renew and differentiate into trilineage differentiation (*i.e* osteoblasts, chondrocytes, adipocytes).	Dentist	2	9	55	0.002
-			28.60%	20.50%	51.40%	
-		Medical doctor	2	22	25	
occupation			28.60%	50.00%	23.40%	
-		Other	0	7	7	
-			0.00%	15.90%	6.50%	
-		Scientist	3	6	20	
-	-		42.90%	13.60%	18.70%	
-	-	-	Agree	Disagree	Strongly Agree	Unsure
-	-	Dentist	37	1	23	5
-	-		41.10%	33.30%	40.40%	62.50%
-	Government should do more campaign to make people aware of dental stem cell research.	Medical doctor	35	0	13	1
-	-		38.90%	0.00%	22.80%	12.50%
-	-	Other	4	0	10	0
-	-		4.40%	0.00%	17.50%	0.00%
-	-	Scientist	14	2	11	2
	-		15.60%	66.70%	19.30%	25.00%

Their knowledge of dental stem cells was further evaluated, and they were given a few questions and statements to answer. Most respondents (51.11%) were aware that mesenchymal stem cells (MSCs) are derived from various

sources, such as bone marrow and dental tissues. The results from respondents are shown in Table **2**.

To assess their level of perception and awareness of dental stem cells, the respondents' opinion on the future of such cells and their willingness to donate or invest in the industry were sought. The results, as tabulated in Table **3**, suggest strong support for the potential use and investment in DSCs in the future.

4. DISCUSSION

This study assesses the level of knowledge, awareness, and perception of DSCs and their applications in regenerative medicine among professional groups (dentists, medical doctors, scientists, and others) in Malaysia. The respondents comprised rather a diverse ethnicity (with the majority (46%) being Malays, followed by Indians (24%) and Chinese (18%)). About 57% of the respondents were young (30-39 years) and in the early stages of their professions. A possible explanation is that younger professionals show greater interest in the subject since they are more exposed to stem cells than those in older groups. From our observations, the majority of respondents claimed to have heard of stem cells regardless of their specialties. Most of them were practitioners and academicians. The findings suggest that respondents are well informed about stem cells, most probably due to their academic and research background, making them extremely familiar with stem cell research.

Based on our study, the majority of respondents have basic knowledge of dental stem cells (DSCs). The majority (69.12%) who participated in the survey were aware that dental stem cells (DSCs) were characterized by their ability to promote self-renewal and undergo trilineage differentiation. More than half of the respondents (69.12%) were aware that dental tissues are considered a source of mesenchymal stem cells (MSCs). The respondents (63.24%) were also aware that dental pulp stem cells (DPSCs) have beneficial effects on neural regeneration and repair. About half of the respondents (50.79%) noted that dental implants derived from dental stem cells could replace missing teeth. A few studies have indicated the possibilities of dental stem cells used for tooth repair and regeneration [16-17]. The results suggested that most of the respondents had regularly sought further information on the origins of stem cells from the literature. In addition, sources of information on dental stem cells are easily assessable from the internet and journals as well as social media, commercial companies, and professional societies. A similar study conducted among dentists in India found that most of the participants have specific knowledge of stem cells. [(19)]

However, most respondents in our study did not possess further detailed knowledge of dental stem cells. A minority (5.15%) had knowledge of the capability of dental stem cells to proliferate through cell division. Only 25% were aware that DSCs do have similar characteristics as bone-marrow mesenchymal stem cells (BMMSCs). A possible explanation is the insufficient in-depth formal education on stem cells among such professional groups because the dental stem cell industry in Malaysia is still new and also due to the lack of exposure and further research in the field by the health and education sectors.

In terms of perception among these professional groups, the idea of dental stem cells is seen to be generally well-received by them. There were positive results (63.24% agreed, 27.21% strongly agreed) among respondents regarding the good prospects for dental stem cell research in the future. This study showed that more than 60% of the respondents demonstrated a willingness to invest further in dental stem cells, which might be indicative of the acceptance of the newer treatment modalities in regenerative dentistry. This was further emphasized by the fact that most of the professional groups (above 70%) were willing to save their teeth for future use with stem cell banking, thus recognizing the potential of such regenerative procedures. *Chitroda et al.* showed that more than half (66.7%) of dental professionals were willing to recommend or advise their patients to store or preserve dental stem cells [15] and about 61.9% were ready to collect dental stem cells in their clinical practice [15]. This may be attributed to the fact that these professional groups realize that this is an upcoming and fast-growing field with advantages, such as ease of obtaining dental stem cells and their potential to differentiate into multiple cell lineages.

Our study also showed that the majority of respondents (84.56%) were aware that MSCs are derived from various tissues, such as bone marrow, umbilical cords, placenta, adipose tissues, and dental tissues. Meanwhile, 51.11% of respondents noted that stem cells derived from dental sources are considered ASCs. Meanwhile, the other study reported that awareness and knowledge of the sources, applications, uses, and clinical research guidelines regarding DSCs were lacking among dentists that participated in their survey. [(19)] Possible explanation could be that stem cells were only taught superficially in the education curriculum due to the high specialty of the subject and the lack of continuous reading and updating due to the busy lives of these professional groups.

CONCLUSION

This study showed that professional groups (scientists, dentists, and medical doctors) have a sound basic understanding of MSCs, particularly DSCs. However, a greater appreciation and in-depth knowledge of this subject are still lacking among professional groups in Malaysia, which needs to be addressed. Prioritizing and advancing knowledge about DSCs can be achieved by deeper incorporation of the subject in the academic curriculum for individuals in the health science fields, as well as by organizing seminars and conferences related to the subject.

LIST OF ABBREVIATION

DSCs = Dental Stem Cells

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by SEGi University Ethics Committe.

HUMAN AND ANIMAL RIGHTS

No animals were used for studies that are the basis of this research. All the humans used were in accordance with the

ethical standards of the committee responsible for human experimentation (institutional and national) and with the Helsinki Declaration of 1975.

CONSENT FOR PUBLICATION

Informed consent was obtained from the participants involved.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

ACKNOWLEDGEMENTS

Declared none.

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