



Original Article/Research

Awareness and Attitude towards Dental Pulp Stem Cell Banking among Malaysians



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ABSTRACT

Purpose: Like bone marrow and cord blood mesenchymal stem cells (MSCs), the regenerative potential of dental pulp stem cells (DPSCs) has been reported by several researchers. However, a lack of information on the knowledge and awareness of the Malaysians about DPSCs and their banking has been observed. Hence, this study aimed to assess the level of awareness and attitude among Malaysians about DPSCs and their banking.

Methods: A cross-sectional study was carried out among 983 Malaysians using face-to-face interviews ($n = 458$) and electronic surveys ($n = 525$) through social media. Significant differences between the two groups were analyzed using the student *t*-test. Analysis of variance (ANOVA) and Hochberg's GT2 Post-hoc analysis were used to determine the differences among ≥ 2 groups. The level of significance was set at $p < 0.05$.

Results: Knowledge of the participants on the DPSCs was fair (without scientific information) while knowledge on the regenerative potential of DPSCs was poor regardless of their race, gender and level of education. However, people with tertiary education have significantly ($p < 0.001$) higher knowledge compared to people with secondary education. Similarly, medical doctors, dentists, nurses and life science researchers presented significantly ($p < 0.05$) higher knowledge than the people from all other occupations. Although 91% of people were not aware of the presence of stem cell banks in Malaysia, 84% supported the establishment of DPSCs banking, 66% agreed to donate their children's DPSCs, 73% agreed to donate own DPSCs, and 83% interested to know more about DPSCs and their regenerative potentials.

Conclusion: Supporting of DPSCs banking and willingness of donating DPSCs by the vast majority of people indicate that taking an initiative by policymakers and establishment of DPSCs bank in Malaysia would be fruitful. This would enhance the advanced medical care systems through regenerative medical therapy in Malaysia.

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Introduction

For more than a decade, researches are being conducted on the regenerative potential of dental pulp derived stem cells and stem cells from other dental origins, such as periodontal ligament and

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apical papilla [2–5]). Stem cells isolated from the pulp of permanent teeth is known as dental pulp stem cells (DPSCs), while stem cells isolated from deciduous teeth known as stem cells from human exfoliated or extracted deciduous teeth (SHED). In this study, we have used the term DPSCs to denote both DPSCs and SHED. DPSCs share the characteristics of MSCs. Hence, MSCs like properties of DPSCs are confirmed by evaluating their plastic adhering capability, tri-lineage differentiation potential and expression of particular cell surface markers [6]. For instance, DPSCs should express CD44, CD73, CD90, CD105, CD271 and STRO-1, while they are expected lack of expression of CD34, CD45, and HLA-DR [5,6]. Studies have also revealed the immunomodulatory properties of DPSCs and their survival in the presence of immune components [1,7,8]. In recent years, the differentiation potential of DPSCs into cardiomyocytes, pancreatic beta-cells, hepatocytes, neuronal cells and myogenic lineages have been acknowledged by several researchers [9–15]).

It usually needs 4–5 weeks from isolation to yield enough cells (300–500 million) for transplantation in cell-based regenerative therapy and this time interval could affect the regenerative outcomes [16]. Banking of DPSCs could facilitate an instant supply of both autologous and allogenic stem cells to be used in regenerative therapy to treat non-communicable and degenerative diseases.

Despite having the regenerative potential, there is inadequate information on the knowledge and awareness of the Malaysians about DPSCs and their banking. The number of stem cell researches conducted in Malaysia were found rare as well. Moreover, studies on the awareness of the regenerative potential of MSCs from different sources among Malaysians are very scarce. The scenario is similar for other nations in the world as well. As the DPSCs have a large donor pool and require a less invasive technique to isolate [16], in this research we aimed to assess the awareness and attitude of Malaysians on the DPSCs and their banking.

Materials and methods

Study design, population and sample size

A cross-sectional study was carried out among 983 Malaysians in all 13 states in Malaysia. A non-probability sampling method was adopted in this study. Face-to-face data was collected from 458 students of MAHSA University, patients who were visiting MAHSA University dental clinic, people of the adjacent area to the MAHSA University, friends and family members and the neighbors. Hence, almost all the face-to-face data were collected from the inhabitants of Selangor and Kuala Lumpur states only. Whereas, Google form was shared with the students and employees of different public and private universities, and people of Facebook and WhatsApp communities. Receivers of the form were also requested to share this form with others in their reach. We received 525 filled-in google form through an electronic survey. For a 30 million population (as per Department of Statistics Malaysia official portal) with a 95% confidence interval and 5% margin of error, the minimum number of estimated samples was 385.

Participants who were aged below 15 years and who were intellectually disabled or mentally retarded were excluded from this survey.

Methods of data collection

A questionnaire was developed, and data was collected from October 2019 to January 2020. The survey was conducted in two ways which are: i) face-to-face interview and ii) online platform

Table 1
Categorizing the level of knowledge of the participants.

Score	Level of knowledge
0–8	No information
9–16	Poor
17–24	Fair
25–32	Very good
33–40	Excellent

using Google Forms. Participants were informed about the survey with a participation information sheet. The questionnaire and participation information sheet were available in both Bahasa Malayu (Supplementary 1) and English (Supplementary 2) to accommodate different races of participants.

Questionnaire design

This questionnaire-based survey included open-ended, multiple-choice, multiple response and rating scales type questions (Supplementary 1). This questionnaire was divided into five parts. The first part was on the socio-demographic details of the participants that encompassed age, gender, the highest level of education, the field of occupation and monthly family income. Questions on age and monthly family income were open-ended type, while others were multiple-choice type. The second part was on the family history of diseases that included a multiple response type question only. The third and fourth parts were on the knowledge about the DPSCs and the regenerative potential of DPSCs, respectively. There were eight rating scale type questions in both sections. Participants were allowed to rate their knowledge from the lowest to the highest (1–4) based on their level of knowledge. The scores of each section were summed-up and interpreted as shown in Table 1. Lastly, in the fifth part, there were eight individual multiple-choice type questions on the attitude of participants towards DPSCs banking in Malaysia.

Data analysis

Data were analyzed using IBM SPSS statistics software (version 20). Significant differences between the two groups were analyzed using the student *t*-test. While significant differences among ≥ 2 groups were analyzed using analysis of variance (ANOVA) and Hochberg's GT2 Post-hoc analysis. The level of significance was set at $p < 0.05$.

Ethics statement

As we did not collect any personal identification information, participants' written consent was not needed in this study.

Results

Age, gender and the awareness and knowledge of the regenerative potential of DPSC

For this questionnaire-based study, data was collected from a total of 983 participants, of which 458 responses were collected using face-to-face interaction and 525 responses using Google form. Among all the respondents, 299 (30.4%) were males and 684 (69.6%) were females. The average age of the participants was approximately 27 years. Further analysis showed that age and gender have no effects on the level of awareness and knowledge on the regenerative potential of DPSCs (Fig. 1).

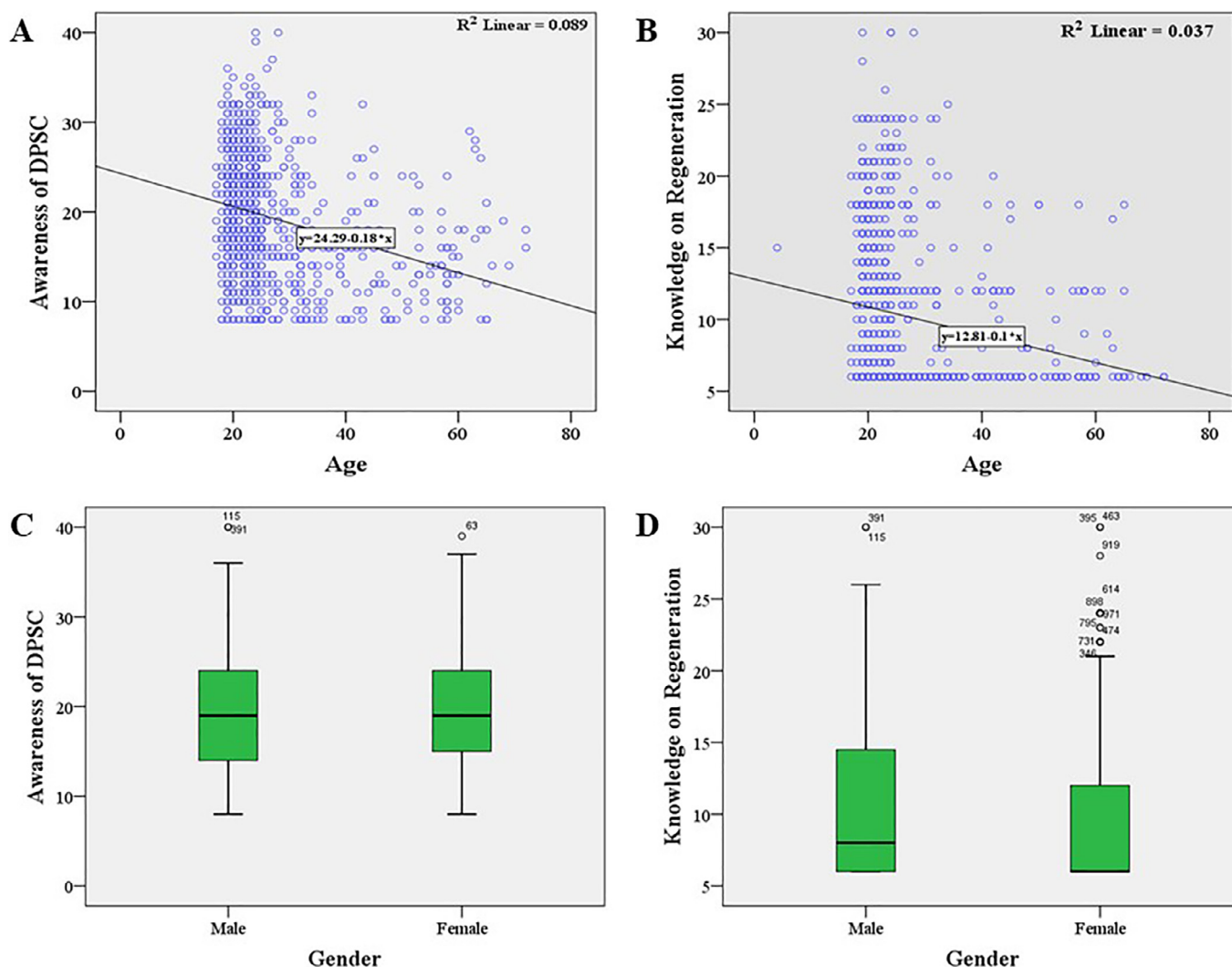


Fig. 1. (A) Influences of age on the awareness and B) the knowledge of the regenerative potential of DPSCs. C) Influences of gender on the awareness and D) the knowledge on the regenerative potential of DPSCs.

Race and awareness about DPSCs

From the race distribution, Chinese (64.8%) participants were the highest, followed by Malay (22%), Indian (7.9%) and the other races (4.1%). Among the participants from different races, Indians found to have the highest level of awareness about the presence of DPSCs and it was significantly higher ($p = 0.012$) compared to the participants of the Chinese race. However, the mean level of knowledge of all the groups were fair (score: between 17 and 24). Furthermore, no influence of race on the knowledge of the regenerative potential of DPSCs was observed (Fig. 2).

Association between the level of education and awareness of DPSC

Among all the respondents, 61.1% completed secondary education followed by 37.4% with tertiary education and 1.2% with primary education. Further data analysis has shown that the tertiary group of participants had the highest level of knowledge (21.2 ± 6.2) on DPSCs while it was significantly ($p < 0.001$) higher compared to the participant having the secondary level of education (18.3 ± 6.5). However, no significant effect of the level of education on the knowledge of the regenerative potential of DPSCs was observed (Fig. 3).

Economic status and the awareness and knowledge on the regenerative potential of DPSCs

This study has also revealed that the family monthly income of the participants had no effects on the knowledge of DPSCs and their regenerative potential (Fig. 4).

Family history of diseases and the awareness and knowledge of the regenerative potential of DPSCs

Unlike economic status, familial history of diseases was found to have effects on the awareness about DPSCs and their regenerative potential. More specifically, participants with a family history of cardiovascular diseases (CVD), organ failure and thalassemia were found to have a significantly higher level of awareness about the presence of DPSCs. While the family history of cancer and thalassemia has influences on the knowledge of the regenerative potential of DPSCs (Table 2).

Occupation and the awareness and the regenerative potential of DPSCs

The occupation has shown a significant effect on the level of knowledge about DPSCs and the regenerative potential of DPSCs.

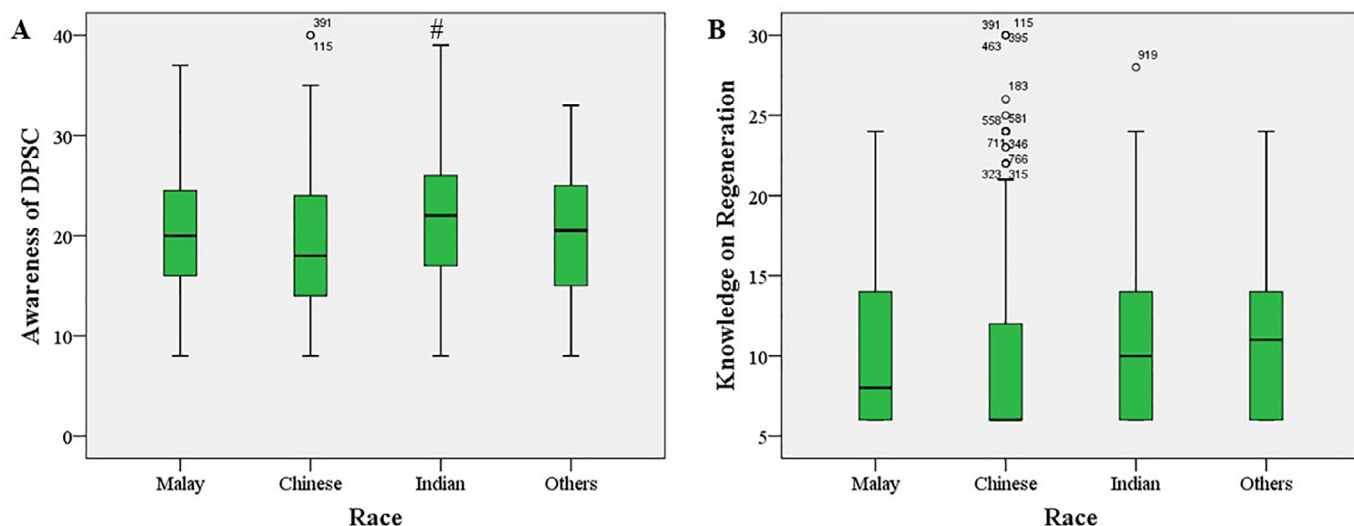


Fig. 2. (A) Race and awareness of DPSC B) Races and knowledge on the regeneration of DPSCs.

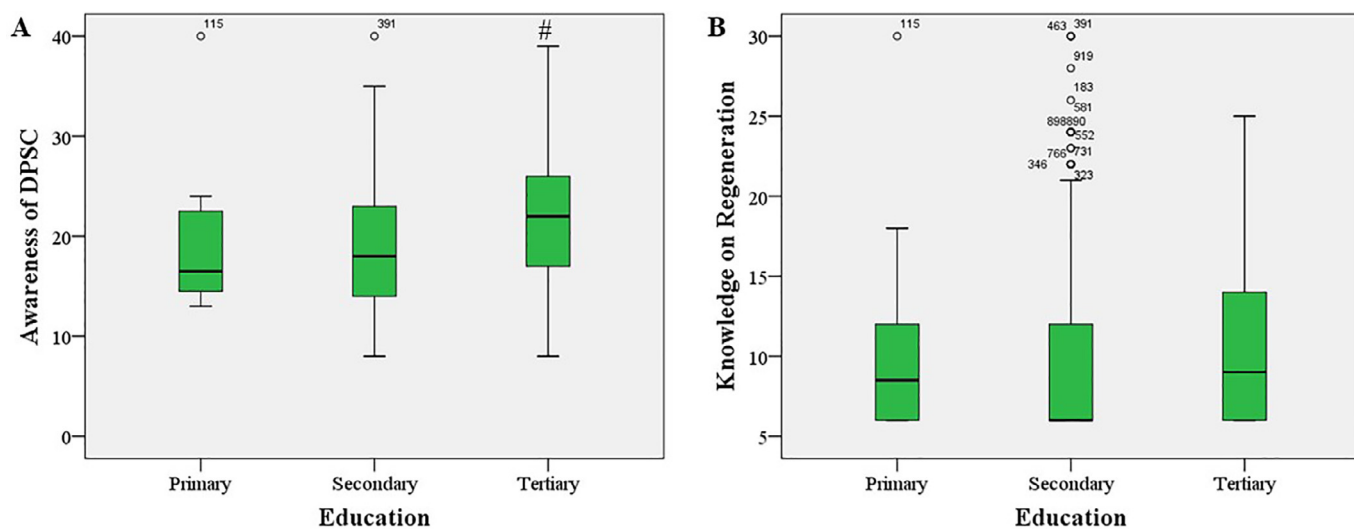


Fig. 3. (A) Education and awareness of DPSCs B) Education and knowledge of regeneration of DPSCs.

Participants from the health-related field (Doctors, Dentists, Nurses or Researchers) have had significantly ($p < 0.05$) higher knowledge on DPSCs and their regenerative potential compared to the participants from other occupations (Table 3).

It is noteworthy to mention that most of the participants came to know about DPSCs from their family doctors or researchers (Table 4).

Participants' attitude towards banking of DPSCs

Based on the analysis of participants' attitude towards DPSCs banking, 91% of the people were found to be unaware of the presence of private or public stem cells banks available in Malaysia regardless of their level of education, races and occupational fields. However, 84% of the participants supported DPSCs banking. Moreover, 73% of the participants agreed to donate their own DPSCs and 66% of the participants agreed to donate their children's DPSCs for banking in Malaysia regardless of private or public nature of the stem cells banks. It is noteworthy to mention that 83% (816 out of 983) of the participants showed to be interested to know further information about dental pulp stem cells banking in Malaysia.

Discussion

Researches on the regenerative potential of stem cells have been conducted for the last few decades. However, researches on the regenerative potential of the DPSCs is still very new in the field of regenerative medicine. This has been reflected in the result of this study. From the responses received from the participants of this study, we found that the knowledge of the participants on the DPSCs was fair while the knowledge on the regenerative potential of DPSCs was poor regardless of their race, gender and level of education. A similar result was observed in a study conducted on the knowledge of stem cells and its use in dentistry in Saudi Arabia among dental graduates [17]. A study conducted among Nigerian dentists also reported that 60.3% of respondents had poor knowledge on the use of stem cells in regenerative dentistry [18]. Hence, the lack of awareness about the regenerative potential of DPSCs among Malaysians did not deviate from our expectations.

Several scientific studies have proven the regenerative potential of DPSCs that makes them a promising tool for regenerative therapy in the fields of both medicine and dentistry. However, most studies are still in the experimental stages and long-term clinical studies and procedures are yet to be performed to ensure its stan-

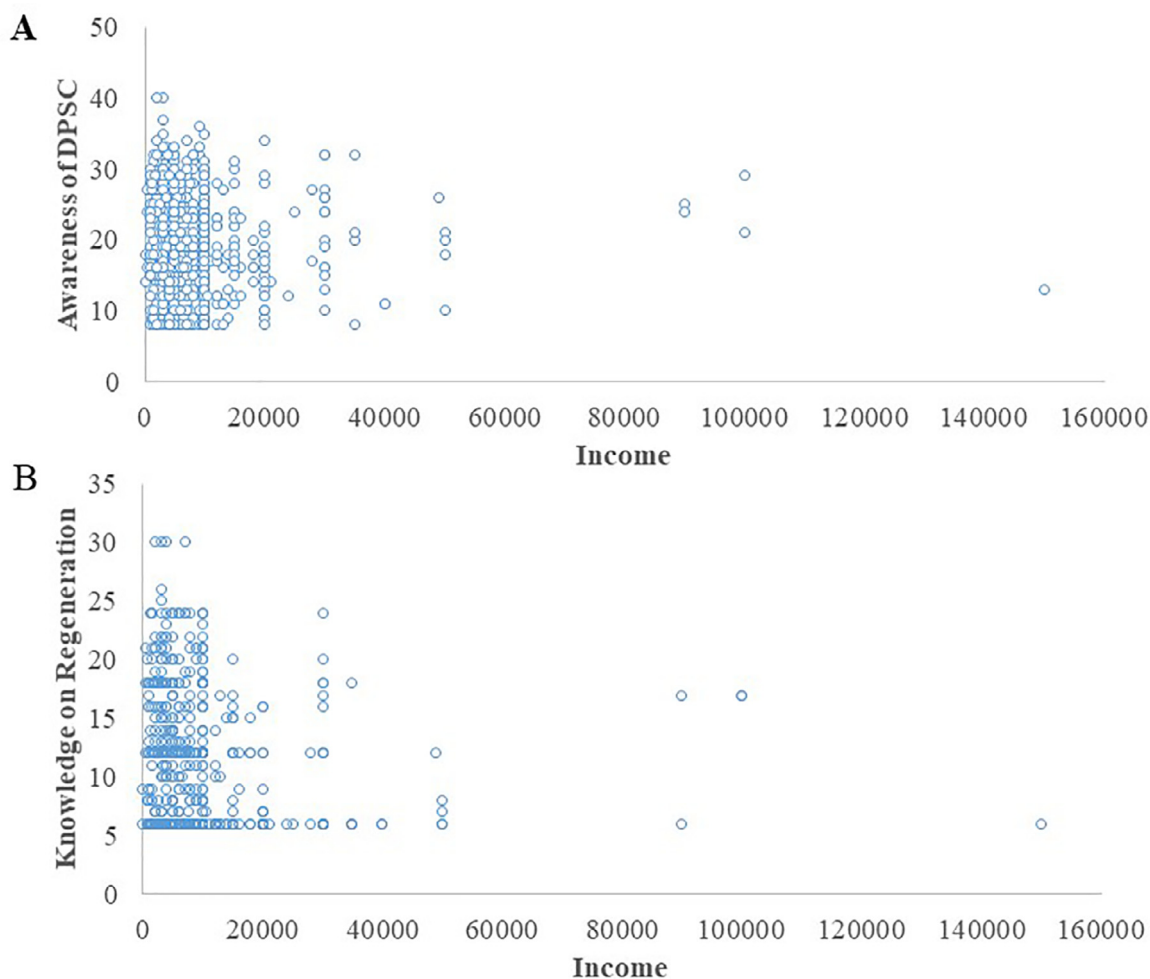


Fig. 4. Association of the family monthly income and the knowledge of DPSCs and their regenerative potential.

Table 2
Relationship of family history of diseases with the knowledge of DPSCs and their regenerative potential.

Disease	History	N	Knowledge of DPSC		Knowledge of regeneration	
			Mean ± SD	Sig.	Mean ± SD	Sig.
Diabetes	No	614	19.10 ± 6.45	0.088	10.48 ± 5.44	0.087
	Yes	362	19.84 ± 6.64		9.87 ± 5.21	
Cancer	No	799	19.53 ± 6.45	0.215	10.48 ± 5.41	0.005
	Yes	181	18.86 ± 6.82		9.24 ± 4.97	
CVD	No	625	18.89 ± 6.50	0.003	10.33 ± 5.47	0.527
	Yes	355	20.19 ± 6.41		10.10 ± 5.12	
Organ Failure	No	928	19.25 ± 6.55	0.008	10.26 ± 5.38	0.952
	Yes	53	21.68 ± 5.51		10.30 ± 4.85	
Neuro degeneration	No	908	19.29 ± 6.46	0.125	10.24 ± 5.37	0.856
	Yes	72	20.51 ± 7.23		10.36 ± 5.23	
Osteoporosis/ Arthritis	No	924	19.31 ± 6.49	0.256	10.29 ± 5.32	0.272
	Yes	57	20.32 ± 6.94		9.49 ± 5.76	
Thalassemia	No	889	19.38 ± 6.52	0.028	10.24 ± 5.39	0.022
	Yes	92	19.35 ± 6.54		10.22 ± 4.90	

Table 3
Relationship between occupation and the knowledge on DPSCs and their regenerative potential.

(I) Occupation	(J) Occupation	Mean Difference (I-J)	Std. Error	Sig.
Doctor/ Dentist/ Nurse/ Res	Agri/ Forest/ Fish/Business	5.687*	.981	.000
	Acc/Fin/Sales/Mark/Adm/HR	6.405*	.564	.000
	Teacher/Lecturer	3.514*	1.054	.025
	Engi/IT/Comp	5.008*	.761	.000
	Art/Media/Commu	8.520*	1.233	.000
	Manuf/Build/Constr	6.518*	1.310	.000
	others	3.031*	.503	.000

Table 4
Source of information on DPSCs.

	Frequency	Per cent	Valid Percent	Cumulative Percent
Internet	196	19.9	19.9	19.9
Newspaper	21	2.1	2.1	22.1
FnF	118	12.0	12.0	34.1
Doctors/researcher	553	56.3	56.3	90.3
Articles in journals	63	6.4	6.4	96.7
First time	29	3.0	3.0	99.7
By profession	3	.3	.3	100.0
Total	983	100.0	100.0	

dardization and validation [19]. Therefore, DPSCs are not commercially available in the market, which could be the possible reason behind public unawareness regarding its existence and regenerative potential. In contrast, a study on the knowledge, awareness and perception of stem cells research amongst Malaysian medical students showed that umbilical cord stem cells had the greatest awareness (81.5%) if compared to other types of stem cells [20]. This indicates that peoples' awareness about the presence and regenerative potential of umbilical cord stem cell could be because of their commercialized banking industries over the last decade.

Although the overall awareness of the existence of DPSCs and its regenerative potential is fair and poor among Malaysians, tertiary education has shown the highest level of awareness compared to others. This means that people with a tertiary level of education are more aware of the presence of dental pulp stem cells. It could be due to the inclusion of this topic in their syllabus or they could have access to this knowledge through their studies or by profession. However, no significant differences between education level and the knowledge on the regenerative potential of DPSCs were observed.

Like other factors, family income has also shown no effect on both the knowledge of DPSCs and its regenerative potential. However, people who work in the health-related field i.e. doctors, dentists, nurses and life-science related researchers have significantly higher knowledge on DPSCs and its regenerative potential compared to others who work in other fields. This reflects that those who come from a health-related background are more likely to be exposed to the new and latest clinical advancement that could help to improve health. The result of this study is aligned with a study conducted among dental professionals in India which showed that almost 95.2% of participants were aware of the DPSCs [21].

Besides accessing the public awareness on DPSCs, this survey also helped to access their attitude towards DPSCs banking. By analyzing data, 91% of the respondents were found unaware of the presence of either public or private stem cell banks in Malaysia. This result reflects that stem cell therapy is still not a common practice in Malaysia. Similar findings were recorded in a study conducted among recent dental graduates in Saudi Arabia in which more than two-thirds of respondents were reportedly unaware of the availability of stem cell banks [17]. Likewise, more than 50% of participants were reportedly unaware of the presence of dental stem cell banks in India [22].

It is interesting that despite being unaware 84% of respondents supported banking regardless of nature (private or public). Moreover, 73% agreed to donate their own DPSCs and 66% of them agreed to donate their children's DPSCs. In addition, 83% showed interested to know more about DPSCs and their regenerative potentials. Similarly, a study conducted among dentists in South Africa also showed that the majority (73%) has a positive interest to attend additional training courses and lecture programs on stem cells [23]. A study conducted in University Sains Malaysia, Malaysia also showed that the majority of nursing students (76.1%)

had a positive attitude towards the therapeutic potential of stem cell [24]. This suggests that DPSCs banking and its clinical application could be a leading modality to treat degenerative, acute and chronic noncommunicable diseases in the near future. Meanwhile, there could be a dramatic increase in the demand for stem cell-based therapy in Malaysia. It is noteworthy to mention that like banking of other MSCs, banking of DPSCs following minimal processing of the pulp tissues samples could provide advantages for not to isolate and use DPSCs immediately, hence could help to minimize the risk of contamination [25].

The success of biobanking depends directly on the availability and willingness of the donors to donate their tissues or organs (i.e., DPSCs). At the same time, public decision-making is influenced by many factors including returning research results, privacy, freedom of choice, uncertainties about research, monetary and health considerations, and personal belief [26]. Therefore, public awareness regarding DPSCs banking and its regenerative potential in stem cell therapy should be highly promoted. As studies have shown that DPSCs exert their therapeutic effect to cure diseases, such as type 1 diabetes, neurological diseases, immunodeficiency diseases and diseases of bone and cartilages [27]. The various measure should be drawn out at the national level to help Malaysian to be more aware of DPSCs and its benefits. The campaigns that could involve both government organizations (GOs) and non-government organizations (NGOs) should be carried out nationwide. Examples of campaign activities can be documentaries or programs that introduce DPSCs and can be shown across various platforms such as TV, radio, social media, and the internet. Other examples include events, posters, advertisements, news and articles that involve innovative ways of sharing information with the community can increase the success of raising public awareness.

Besides that, our survey also reveals that most of the respondents obtain information about stem cells through their family doctors or researchers. Based on this, we can see that family doctors or dentists play a major role in promoting DPSCs and their benefits when their patients visit them. Thus, a good rapport between doctors or dentists with their patients is very crucial so that their patients trust in them. In addition, researchers can also continue to study DPSCs to a greater extent and publish their work so that more people could be aware of DPSCs and the great benefits that it can bring to humans. On the other hand, a survey done among dentists in India showed that the internet and journals were the main sources for obtaining information about DPSCs [22]. This could be due to the surging popularity of stem cells that increased the related scientific publication available online.

The therapeutic effects are not just applicable in the medical but also in the dental field. Studies have shown that pulp regeneration is possible using DPSCs. In one clinical trial, patients with pulp necrosis after a dental trauma showed regeneration of three-dimensional pulp tissue equipped with blood vessels and sensory nerves following the implantation of DPSCs. On top of that, no adverse events were observed [28]. These outcomes provide evidence suggesting that it might be feasible to revascularize pulp and re-

store vitality in the necrotic tooth. Even though further studies are still needed to understand the mechanisms better, it is a promising treatment option that can be applied in the clinic in the coming days. The proven regenerative potential also suggesting that it can be an option given to the patient in addition to the conventional method of treating teeth. Therefore, dentists play a key role here in educating patients about the latest clinical advancement and giving them treatment options. In addition, considering to mention isolating DPSCs is a non-invasive procedure for patients where it can be obtained from exfoliated deciduous teeth, and extracted teeth from impacted third molar, orthodontic purposes or supernumerary teeth in the cases the teeth have no function anymore. Therefore it might as well put into good use by extracting the DPSCs and add value to the unwanted teeth [29]. Hence, it is crucial for dentist to explain the regenerative potential of DPSCs and encourage them to bank their DPSCs. This corresponds to a survey conducted among dentists in South Africa showed that almost all (95%) agreed to recommend regenerative therapies to their patients while the majority (80%) of them agreed to save teeth in cell banks for future therapeutic purposes [23]. Similarly, a study that was done among dental professionals in India also shows that more than half (66.7%) agreed to recommend or advise their patients to store or preserve the DPSCs [21]. However, this observation is contradicted in a study conducted among Nigerian dental students showing that less than one-third of the participants had a positive attitude towards stem cell application in dentistry [30].

There are limitations in this study. Firstly, the data collected did not reflect the ideal population ratio of Malaysia where the majority are Malays which are inconsistent with our data collected where our respondents are mostly Chinese. Besides that, the gender proportion was unequal as well (69.9% were females which overrides the 30.4% of males). These are the considerations that would have to opt for a better understanding of the studies in the future.

Conclusion

This survey has made a ground to have a better understanding of the awareness level and attitude towards DPSCs banking among Malaysians. Most of the respondents supported DPSCs banking despite their awareness level on DPSCs is far from average, indicating that their attitude on DPSCs is encouraging. Therefore, various initiatives should be carried out to improve their awareness and attitudes towards DPSCs as DPSCs undoubtedly has promising therapeutic effects in clinical applications because of their regenerative potential and easy isolation with the non-invasion procedure without any controversial ethical concerns.

Author contributions

MSH, NSMH, HEN and NH conceptualized and designed the work; KC, WMX, MSH, NSMH, HEN, MZI, IAA and NH developed the questionnaire; KC, WMX, MSH, and NH carried out the survey; KC, WMX, NSMH, and NH conducted the formal analysis; KC, WMX, and NH prepared the original draft; MSH, NSMH, HEN, MZI, IAA and NH reviewed and edited the drafts. All authors read and approved the final manuscript.

Data and materials availability

The basic data used to support the findings of this study are included in the article. If someone needs access to the raw data could be obtained upon acceptance of the request by the Principal Investigator or Corresponding author of this study.

Ethical approval

The data collection procedure of this study was approved by the Research Ethics Committee of MAHSA University (Ref: RMC/EC11/2019).

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Declaration of Competing Interests

None declared.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.hlpt.2021.100502](https://doi.org/10.1016/j.hlpt.2021.100502).

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