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KNOWLEDGE AND AWARENESS ABOUT NANOTECHNOLOGY AND ITS APPLICATIONS IN DENTISTRY- A SURVEY

SAMYUKTHA P S[1], BALAJI GANESH S[2*] AND SOMASUNDARAM J[3]

1: Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India

2: Scientist, White Lab Material Research Centre, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India

3: Chief scientist, White Lab- Material research centre, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India

***Corresponding Author: E Mail: Dr. Balaji Ganesh S: balajiganeshs.sdc@saveetha.com**

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ABSTRACT

Nanotechnology refers to the development of an applied science at the molecular or atomic level. The basic idea involved in nanotechnology is to employ individual molecules or atoms to construct functional structures. Nano materials are materials which have components of nano size. The properties of nano materials vary due to increased surface area and quantum properties, which are more dominant at the nanoscale level. All properties, including electrical, optical and magnetic are changed. Nanotechnology has many applications in the medical field and also in dentistry. The survey assesses the knowledge and awareness levels about nanotechnology among dental students. In 2020, an online survey containing 15 questions was sent out to 100 dental students. Results were tabulated and analysed. Overall, there was a positive response from the students about nanotechnology. 95% believe that nano technology is essential to dentistry. Knowledge about advanced materials is not as worldwide as we are led to believe. The current study shows the lack of specific knowledge in the population that participated. Through the survey, it was evaluated that the students had moderate awareness and knowledge about nanotechnology which can be improved.

Keywords: Dental Nanotechnology, Nanobots, Nanocomposite, Nanomaterials, Nanotechnology

INTRODUCTION

Nanotechnology refers to the development of an applied science at the molecular or atomic level. The basic idea involved in nanotechnology is to employ individual molecules or atoms to construct functional structures **[1]**. Nano materials are materials which have components of nano size. The properties of nano materials vary due to increased surface area and quantum properties, which are more dominant at the nanoscale level. All properties, including electrical, optical and magnetic are changed **[2]**. Nanotechnology has many applications in the medical field. Nanotechnology has various scopes that are currently being used **[3]**. Some of the common research scopes studied include Nanorobotics, Nanotherapeutics, Nano-diagnostics, Nanocomposites, Nano Adhesives etc.

Nano robotics is used in local Nano-anesthesia. A colloid and suspension with millions of dental nanorobots are used to induce local anaesthesia. The robots move from the gingiva to the dentine and to the pulp through dentinal tubules **[4]**. Nanobots are also used in tooth repositioning. All periodontal tissues, namely the gingiva periodontal ligament, cementum and alveolar bone may be directed by orthodontic treatment using nanorobots **[5]**. Nanotechnology is also used as drug delivery mechanisms in Nanotherapeutics. Nano technology eliminates solubility problems, leading to reduction of drug dosage and adverse effects **[6]**. Nanotechnology is also used in the diagnosis of oral cancer. Carbon nanotubes can detect affected genes and localise their locations **[7]**. One of the more clinically prominent uses of Nanotechnology is the incorporation of Nanofillers in nanocomposite. Very minute filler particles result in higher proportions, leading to in distinctive physical, mechanical and optical properties **[8]**. Bonding agents use Nano adhesives which constitute disposable nanoparticles. These are used as a component in bonding agents **[9]**. Challenges faced in nanotechnology: Precise positioning and manufacture, Cost-effective methods, Biocompatibility, Financing, Inadequate clinical research, Social issues etc.

As nanotechnology is an emerging field, its implications in dentistry increases. Thus, knowledge and awareness about nanotechnology is essential to the students. Previously, our team had conducted numerous clinical trials **[10–14]** , in-vitro studies **[15–17]**, reviews **[18–23]** and population studies **[24]** over the past 5 years. Now, we are focusing on epidemiological surveys. The idea for this survey stemmed from the current interest in our community. Hence, the aim of the study was to evaluate the knowledge and

awareness of dental students in Nanotechnology and its applications in dentistry.

MATERIALS AND METHODS

The study is an online based cross-sectional survey. Data was collected by circulating a Self structured questionnaire consisting of 16 questions. 100 students were selected based on simple random sampling. This is done to minimise bias.

The results were tabulated and analysed using Windows version SPSS version 20. Frequency and Chi-Square test was done for the data obtained. Pie charts and bar graphs were used to depict the results.

RESULTS AND DISCUSSION

Analysing the responses, the following results were obtained.

61% were aware of the general principles of nanotechnology **(Fig. 1)**. Applications of nano technology contained very results for each application. 90% of the population were aware about nano robots; 60% were aware about drug delivery systems; 56% knew about tooth renaturalisation. The Use of nano materials yielded confused responses. 80% answered incorrectly regarding use of carbon nanotubes **(Fig. 6)**, 54% **(Fig. 5)** answered incorrectly regarding which nanoparticles were safest to use in dentistry, 57% have not dealt with nano materials **(Fig. 2)**, 95% were aware of nano adhesive properties, 60% aware of nano composite bonded teeth, 77% aware about titanium coated implants. 83% believe nano materials are biocompatible. 77% believe that nanotechnology can revolutionise dentistry **(Fig. 7)**, 65% believe that nanotechnology is essential to dentistry **(Fig. 8)**. The cross tabulations and the p values of the Chi- Square test for the responses were done and the results turned out to be insignificant (p value less than 0.05) **(Fig. 9 and 10)**.

Nanotechnology is a very popular and emerging science. It has a promising future. Knowledge and awareness about now technology is thus essential. The first and foremost fact about the technology is that its small size opens are big avenues for the materials **[25]**. Previous research by Sakr *et al* in 2018, conducted an extensive survey in Saudi Arabia **[26]**. It concluded that there is a lack of attention to nanotechnology applications in dentistry among students and students of Saudi Arabia. While a total of 50% participants had no prior knowledge about our technology, the current study had 68% correct response **(Fig. 1)**.

The current study is also similar to the previous study. About 26% of the participants use nano materials clinically. In current study about 45% had used nano materials clinically **(Fig. 2)**. There are various factors that affect the disparity and similarity, a few which include availability

of nano materials, knowledge about Nanomaterials et cetera.

The next past research we will be comparing with that of Sara Ali *et al* in 2017 **[27]**. The study was conducted in Pakistan and had very simple basic questions in its questionnaire. The study also concluded that there is a lack of awareness on nanotechnology applications. They further concluded that the participants showed enthusiasm in learning about nanotechnology. This is similar to the present study, when 90% are willing to learn about clinical techniques revolving around nano technology **(Fig. 3)**. There is another fact that binds the two researches. About 29% of the population had used nano composite prior to this research, in the present study about 45% had used nano materials. This makes us believe that nano materials, although have shown great properties and research studies, are yet to be incorporated into everyday clinical practice **[28]**. This brings us to the next point – nano materials are not cost-effective yet **(Fig. 4)**.

A study conducted by Daoutsali *et al* in 2014, also yielded a similar result **[29]**. As the technological development is not the same worldwide, there are bound to be discrepancies in management of technologically advanced substances worldwide **[30]**. The same way, knowledge about advanced materials is not as worldwide as we are led to believe **[31]**. A Study conducted by Xenaki *et al* in 2019, shows us that the school or the university curriculum plays a major role in what the individual will know and understand **[32]**. While the study showed the correct responses to nanotechnology related questions in a huge number - 88%, the current study shows the lack of knowledge in the population **(Fig. 5, 6)**. The study conducted by Ali *et al* 2017, concurs with our present study in the question of whether nanotechnology can revolutionise dentistry **[33] (Fig. 7)**.

In the end, what decides the impact on the field is whether its students can believe it is vital in it **[34]**. 95% of the population agree that nanotechnology is vital in the dental field **(Fig. 8)**. This is an acceptance to the study conducted by Retzbach *et al* in 2011 **[35]**.

Some of the limitations faced by the study include a small sample size, and the respondents unwillingness to answer. The cross tabulations of the survey was done between Gender and various responses of the questions. The p value for the Chi- Square Test done for the cross tabulation between Gender and "Do you think Nanotechnology can revolutionise dentistry?" was found to be 0.975, which is insignificant **(Fig. 9)**. The p value for the Chi- Square Test done for the cross tabulation between Gender and "Do you agree on the essentiality of nanotechnology?" was found to be 0.635, which is insignificant **(Fig. 10)**.

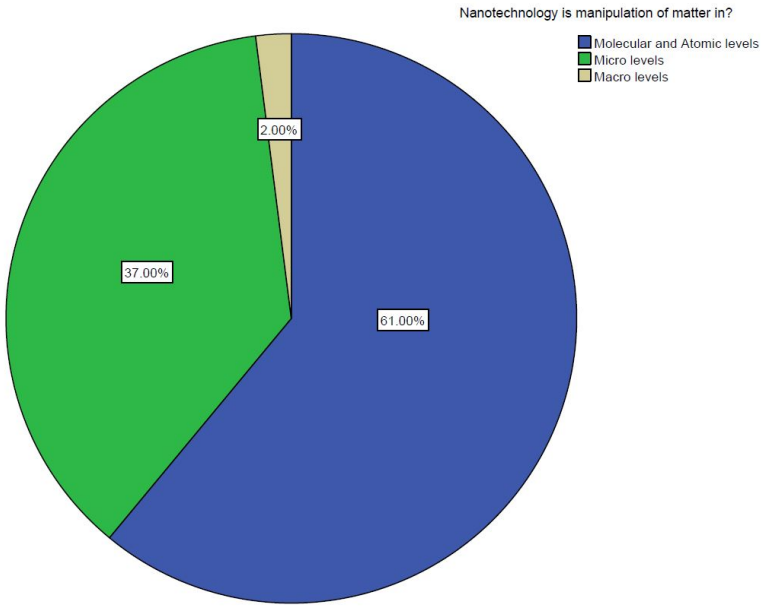

Fig. 1: Pie chart depicting the responses to questions related to the definition of Nanotechnology. 61% responded with "Molecular and atomic levels" (blue), 2% responded with "macro levels" (yellow) and 37% responded with micro levels (green).

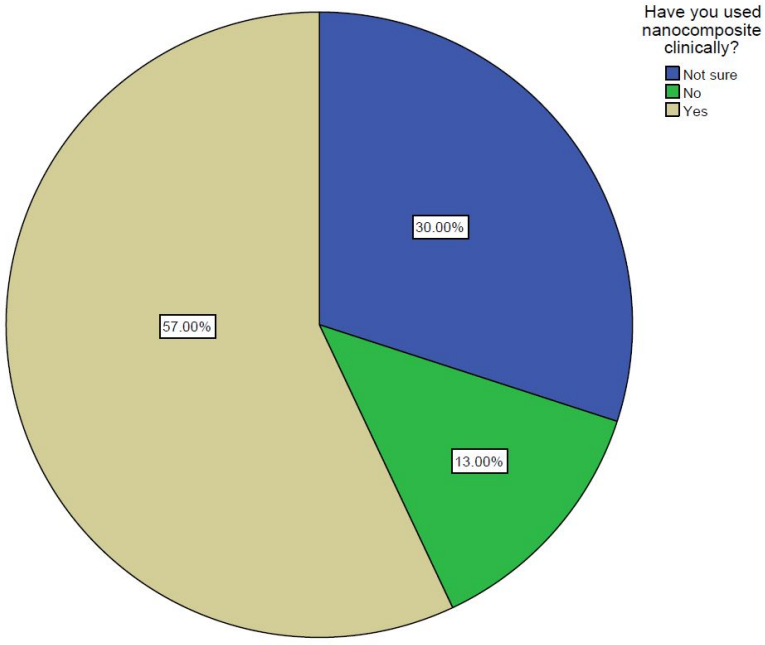

Fig 2: Pie chart depicting the responses related to clinical use of Nanocomposites. 57% responded positively (yellow) , 13% responded negatively (green) and 30% responded with "not sure" (blue).

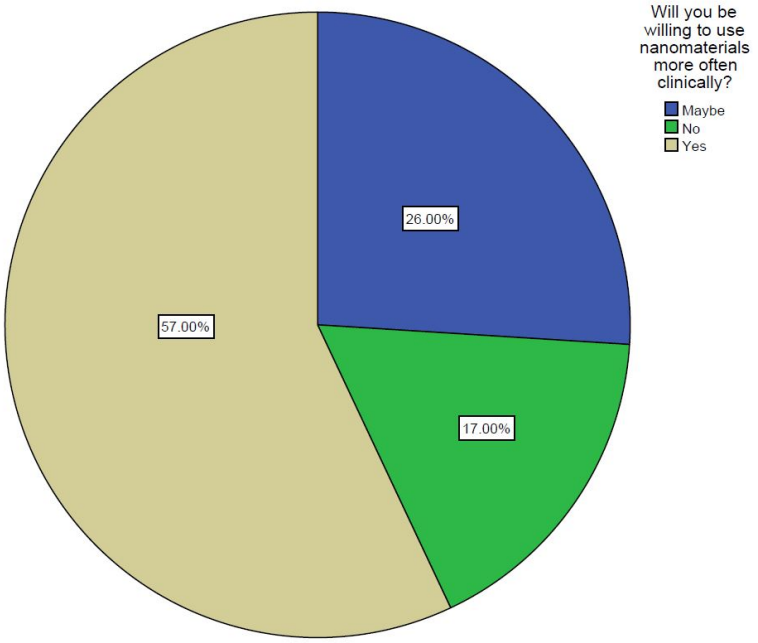

Fig 3: Pie chart depicting the response to the question "Are you willing to learn about Nanomaterials for clinical use?". 57% responded positively (yellow), 17% responded negatively (green) and 26% were not sure (blue).

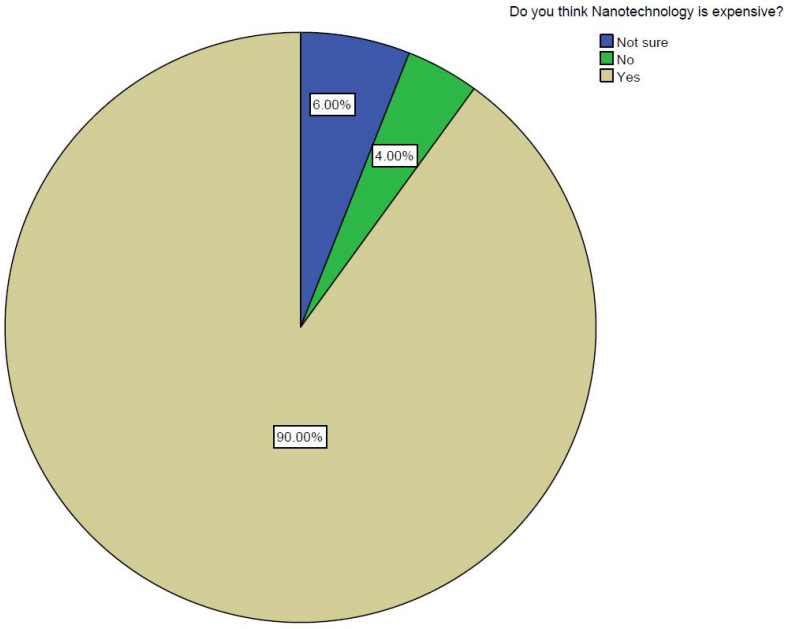

Fig. 4: Pie chart depicting the responses to the question "Do you think nanomaterials are expensive?". 90% agreed that nanomaterials are expensive (yellow), 4% disagreed (green) and 6% were not sure (blue).

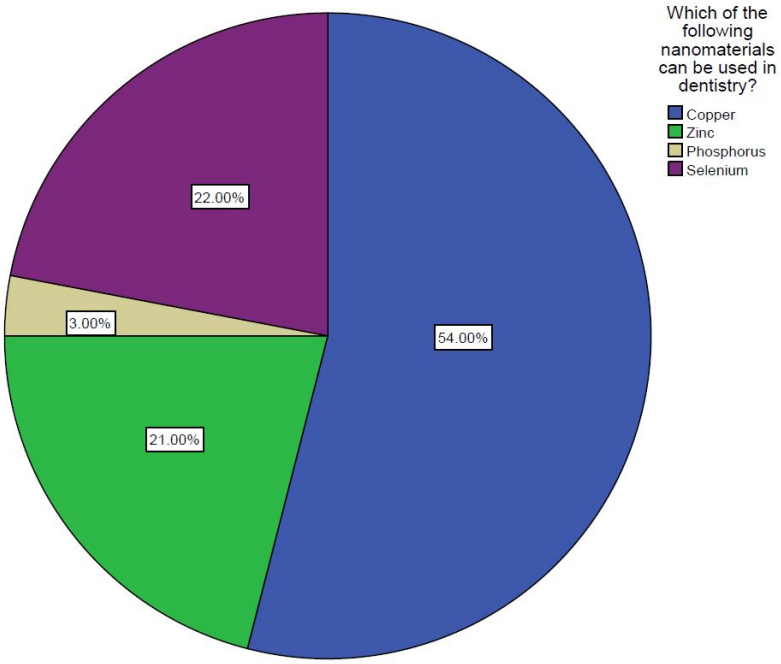

Fig. 5: Pie chart depicting the responses to the question "Which of the following nanoparticles is used clinically". Majority of the answers were incorrect. 54% responded with "Copper" (blue). The other three nanoparticles have been reported to be used clinically.

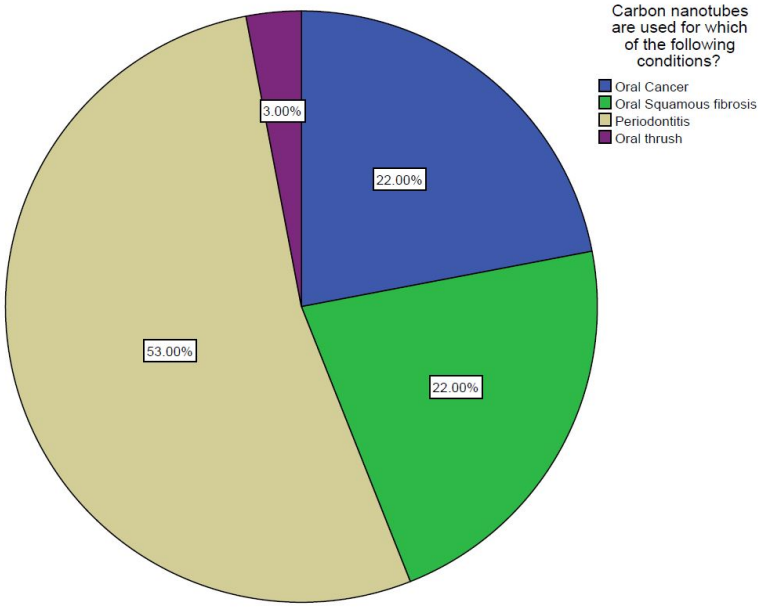

Fig. 6: Pie chart depicting the responses to "Carbon nanotubes are used in the diagnosis of?". The correct answer is Oral Cancer. Only 22% responded correctly (blue).

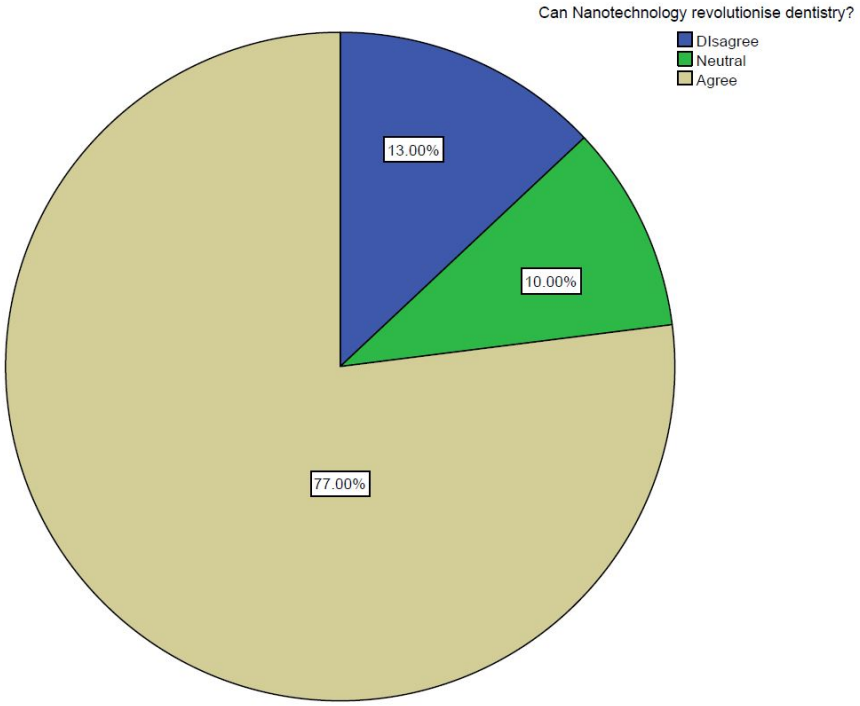

Fig 7: Pie chart depicting the responses to "Do you think Nanotechnology can revolutionise dentistry?" 77% agreed that nanotechnology will revolutionise dentistry (yellow), 13% disagreed (blue) and 10% remained neutral (green).

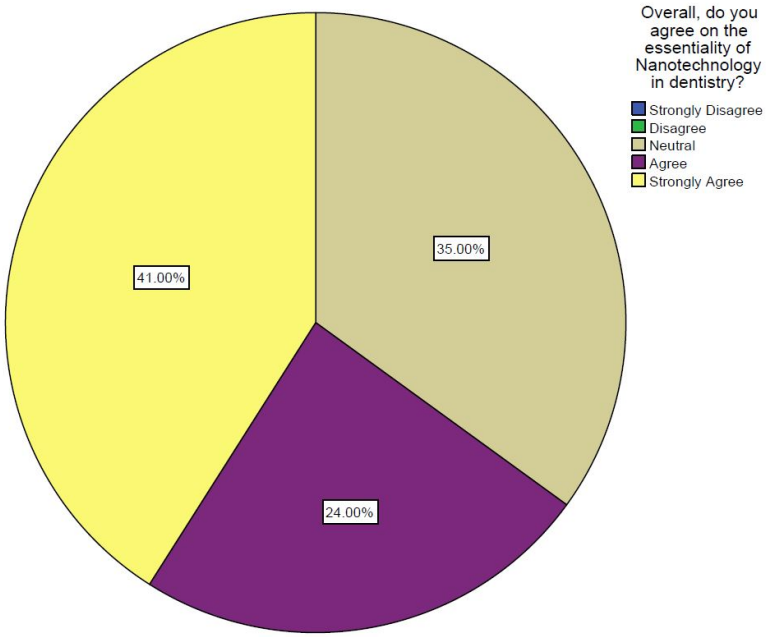

Fig. 8: Pie chart depicting the responses to "Nanotechnology is essential in dentistry". 35% remained neutral (beige), while 65% responded with Strongly Agree (yellow) and Agree (purple).

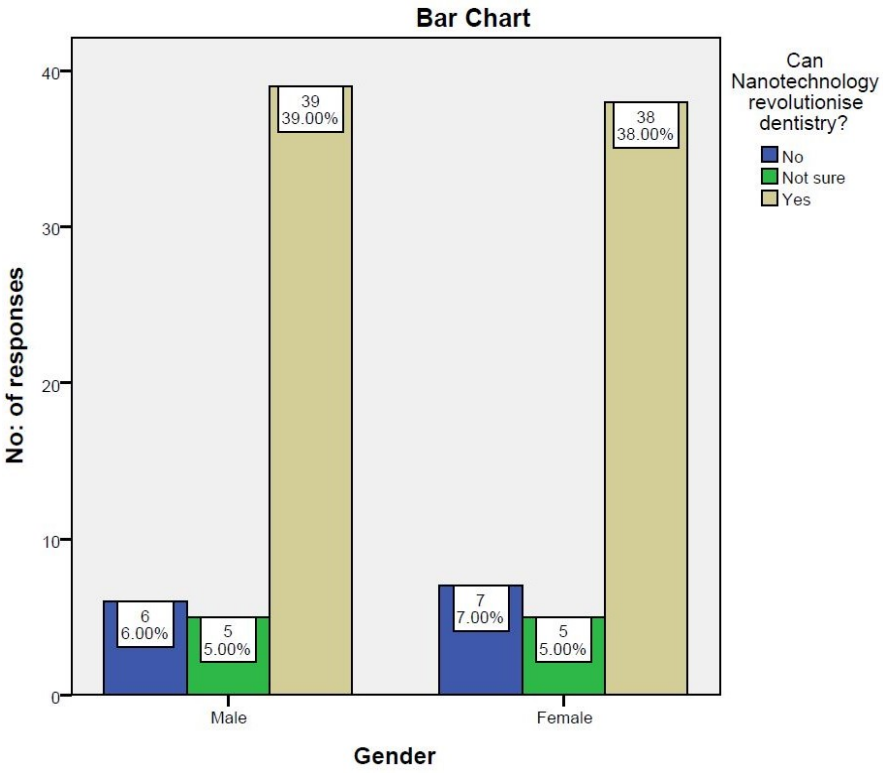

Fig. 9: Bar chart depicting the comparison of responses based on Gender to the question, "Do you think Nanotechnology can revolutionise Dentistry?". X axis represents Gender and Y axis represents the Participants' responses. Almost equal percentage of male and female participants agreed that nanotechnology can revolutionise dentistry. However, Chi-square analysis (Chi- square value= 0.050) did not show any statistical significance with p value- 0.975 (p> 0.05).

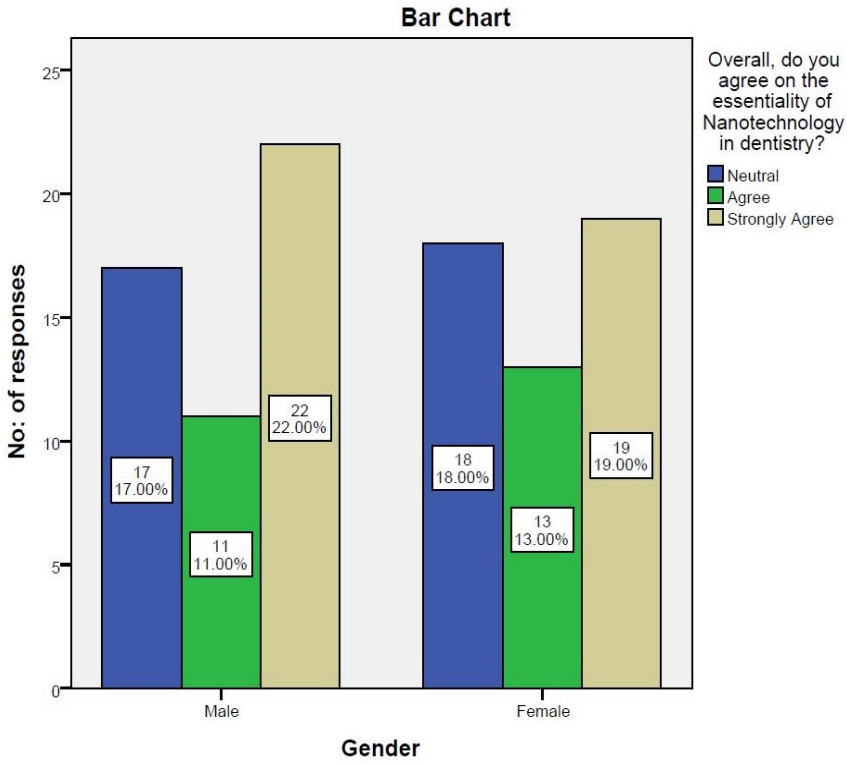

Fig. 10: Bar chart depicting the comparison of responses based on Gender to the question, "Do you agree on the essentiality of Nanotechnology?". X axis represents Gender and Y axis represents the Participants' responses. Almost

equal percentage of male and female participants agreed that nanotechnology is essential. Chi-square analysis (Chi-square value= 0.909) did not show any statistical significance with p value- 0.635 (p> 0.05).

FUTURE SCOPE

The study can further be expanded by extensive research to develop new nano materials and applications.

CONCLUSION

Within the limits of the study, the knowledge and awareness about nanotechnology and its applications in dentistry was evaluated. It was found that the dental students had a moderate level of knowledge about nanotechnology in dentistry, which can be improved by delivering information and exposure to the Nano materials used in dentistry.

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AUTHOR CONTRIBUTIONS

Samyuktha P S contributed to data collection, analysis and interpretation and drafting of the article. Balaji Ganesh and Jayalaksmi S contributed to the critical revision of the article.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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