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Assessment of Knowledge of DNA among Dental Students in Chennai, India

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Abstract

Although there have been several recent advances in genomic technology over the past two decades, little to no change has occurred in the incorporation of genetics in dental school curricula. Also, there are only a limited number of studies that have reported the knowledge and awareness of genetics in dental professionals. With the available information, the present study was conducted to analyze the knowledge of DNA among dental students. This cross-sectional study was conducted among 302 dental students from various Dental Colleges across Chennai to assess the knowledge of DNA among dental students. It was done using a questionnaire survey from May 2021 to June 2021comprising of 14 questions that were validated owing to the pandemic situation, the survey was conducted online using Google Forms Student T-test was planned to statistically analyze the result. The mean percentage of correct responses from students of various academic years was calculated and it was observed that interns had better knowledge and interest in genetics (81.39%), followed by final-year students (80.9%), first-year students 75%, third-year students (74.76%) and second-year students (73.07%). Considering gender, females (77.21%) had better knowledge of genetics than males (75.2%). The results were not statistically significant. The basic concepts of genetics and applications of genetics have to be incorporated into the dental curriculum. This can also be accomplished by conducting educational programs during the study and continuing dental educational programs after they complete their course.

Keywords: *Dental Curriculum, Forensic Dentistry, Genetic.*

Introduction

Deoxyribonucleic acid (DNA) is the most important molecule to maintain life. It has a double-helical structure and carries information to manufacture, assemble, and maintain all the components of a living

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organism [1]. A molecule of DNA has a basic chemical structure consisting of many DNA nucleotides linearly arranged into a polymer chain. Single-stranded DNA (ssDNA) has one such chain, and in double-stranded DNA, two ssDNA molecules are arranged into a DNA double helix by a non-covalent bond. DNA nucleotide is the basic unit of DNA structure, which has three major groups: backbone, sugar and base. Adenine (A), cytosine (C), guanine (G) and thymine (T) are the four types of DNA bases that carry genetic information [1,2,3,4].

In 2003, the completion of the Human Genome Project and subsequent genome-wide studies helped in a greater understanding of the human genome and its role in human genetic conditions. Evolving technology like Sequencing and genotyping has resulted in faster and cheaper genetic testing in daily clinical practice [5,6]. This has made a better understanding of the pathogenesis of inherited conditions and genetic diagnoses [5]. Genetic analyses have a major role in revolutionizing the practice of health care by improving prenatal and reproductive care, early diagnosis of disease or disorder and advancing the treatment for heritable as well as acquired disease [7].

Hereditary factors play a major role in caries, periodontal disease, oral cancer, absent or malformed teeth, orofacial anomalies and other common oral disorders have increased evidently in dentistry. [8,9,10,11,12,13] Systematic genetic diseases are having more implications on oral health care. Gene-environment interactions cause complex disorders like diabetes and hypertension, as well as caries and periodontal disease. Dentists should be knowledgeable of various genetic factors that affect oral health and the respective genetic tests that would aid in the diagnosis of diseases. Also, knowledge of genetic tests has various applications including forensic dentistry, and oral microbiology [14,15] Better understanding of genetic susceptibility, lifestyle, and oral health risk factors will aid in effective preventive and treatment strategies for oral diseases [16].

A clinician should be able to recognize, differentiate and diagnose developmental anomalies that are normal and dysmorphic physical characteristics, educate the patients about various preventive strategies and be in a position to answer patients' questions and provide them with a referral to a medical geneticist or genetic counsellor. Thus it is clear that a basic understanding of genetics, and knowledge of the types of genetic testing for human diseases should be known to dental practitioners [16].

Despite several recent advances in genomic technology over the past two decades, little to no change has occurred in the incorporation of genetics in dental school curricula. Therefore, it is crucial to determine the knowledge and awareness of DNA in students pursuing dental education to ascertain the importance of the current dental education system to provide adequate knowledge on genetics to these students to prepare them for personalized Dentistry. To date, only a limited number of studies have reported the knowledge and awareness of genetics in dental professionals. With the available information, the present study was conducted to analyse the knowledge of DNA among dental students.

Materials and Methods

Description of the Site The present study was approved by the Institutional Committee for Research Ethics, from Sri Venkateswara Dental College and Hospital, Chennai. This cross-sectional study to assess the knowledge of DNA among dental students was done using a questionnaire survey from May 21 to June 21 comprising 14 questions. After an intense review of the literature, a draft questionnaire of 20 questions was created. The face validity and content validity were assessed by a team of 6 experts and a prototype questionnaire was developed. This was pre-tested among 10 dental students for feasibility assessment and

modification. After the pre-testing, the questions were reduced to 14 questions. Owing to the pandemic situation, the survey was conducted online using Google Forms. First-year, second-year, third-year, Final year and Intern Undergraduate students pursuing of Bachelor of Dental Surgery (B.D.S) in Chennai who were willing to participate in the survey were included in the study. Incomplete responses and individuals who did not consent to participate in the survey were excluded from the study. The obtained responses were electronically recorded and subjected to statistical analysis. A student T-Test was performed to assess the variation in knowledge between male and female participants and ANOVA was used to compare the knowledge between the students of different academic years of the B.D.S course responses.

Results

The present study included 302 participants of which 72 were males (23.2%) and 232 were females (76.8 %) depicting unequal gender distribution. (Figure 1 B) Considering the academic year of study 68 students (22.5%) were in the first year, 79 students (26.3%) were in the second year, 43 studies (14.2%) were in the third year, 46% (15.2%) were in their final year and 66 students (21.9%) were interns (Figure 1A).

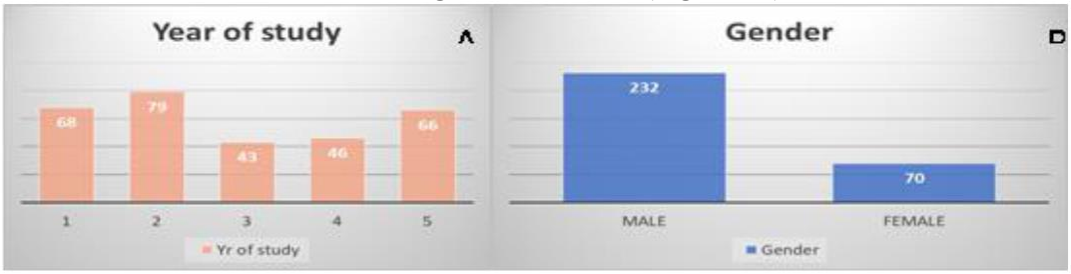

Figure 1. A. Number of Participants in Each Academic Year, B. Gender Distribution of Study Participants

Considering response to interest in genetics majority of the students (86.36%) (Figure 2 A) were interested in genetics irrespective of gender (87.5% females and 84.3% males) and year of study (88.2% first year, 83.5% second year, 83.7% third year, 93.4% final year and 86.36% intern whereas only a small proportion (13.24%) of the students were not interested (Figure 3A).

79.8% of the students correlated disease with genetics whereas 20.2% did not (Figure 2 B). 83.2% of females correlated disease with genetics whereas 68.6% of males correlated disease with genetics, hence females had a better knowledge of diseases with genetic etiopathogenesis (p=0.011*). Considering the year of the study 93.9% of interns correlated diseases with genetics followed by 84.8% in final years followed by 81.4% in third years by75.0% in first years and the least was from second years 68.4% the results were statistically significant (p= .003*) (Figure 3B).

65.69% of the students felt dentists should sometimes give importance to genetics whereas 30% responded that dentists should always give importance to genetics whereas 0.03% of students felt that genetics is not important for dentists. (Figure 2C) Considering variations in responses given by the students of different academic years of study there was a gradual increase in the percentage of students from first year to final year who felt that a dentist should always give importance to genetics however there was a slight decline in interns who selected always an option (39.4%) in comparison with the final year (43.5%). The results were statistically significant. Also, none of the third and final-year students felt that genetics is not necessary for dentists and only a small proportion (1.5%) of interns felt that genetics is not necessary for dentists. (Figure 3C) There was no statistical difference in response based on gender

although a higher proportion of males 31.4% had chosen the option always.

91.3% of the students asked for family history while recording a case sheet 8.6% of students did not ask for family history and none of the students responded that they would do so sometimes. (Figure 2D) Considering the academic year of study, there was a steady increase in the percentage of students who record family history ranging between 79.4 % (first year) to 100 % (final year and intern) and the results were statistically significant. (Figure 3D) Regarding gender variations, there was no significant difference in the responses given by males and females.

96.02% of the students responded that DNA is the main unit of inheritance while 3.9% of students felt proteins are the main unit of inheritance while all of them were sure that carbohydrates are not involved in inheritance. (Figure 2E). Although there were no statistically significant variations in the responses given by students of various academic years of study, there was a steady decrease in the number of students who responded that DNA is the major source of inheritance from the first year (97.1%) to interns (93.9%). (Figure 3E) and a higher percentage (97.1%) of males chose the option DNA in comparison with females (95.7%) $p<0.05$.

66.56% of students were aware of the three types of DNA A, B and Z 26.5% of the students were aware of A and B types of DNA and 6.95% of students were aware of A and Z types of DNA. (Figure 2 F) A similar trend was observed in male and female students ($p<0.05$). Although there was no statistical difference in the responses between the different academic years, 80.9% of first-year students knew about the three types of DNA whereas the awareness decreased as they progressed to the next academic year second year 64.6%, third year 60.5%, final year 63.0% and interns 60.6% (Figure 3F).

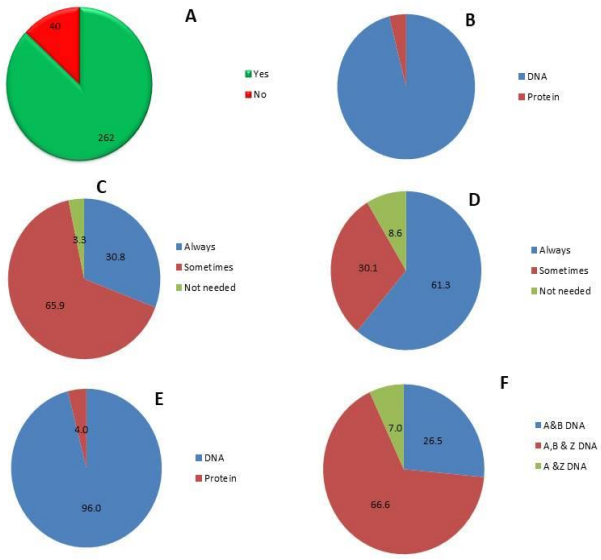

Figure 2. A. Response towards interest in genetics, B. Response towards correlation of disease with genetics, C. Response towards the importance of genetics for dental students, D. Response towards recording family history in case sheet, E. Response towards knowledge on the main unit of inheritance, F. Response towards types of DNA.

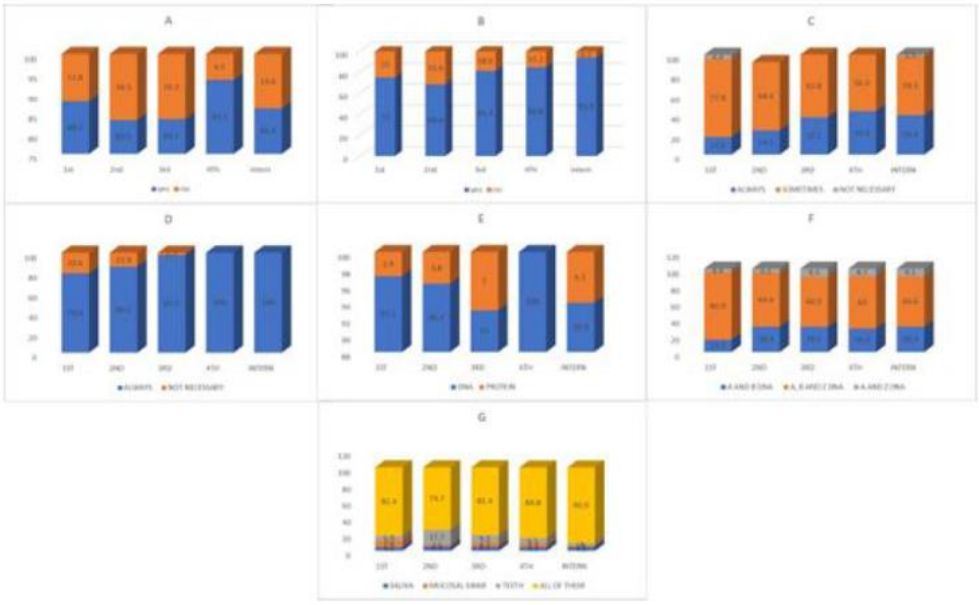

Figure 3. A Year-wise response of students towards interest in genetics. B Year-wise response of students towards the correlation of disease with genetics. C Year-wise response of students towards the importance of genetics for dental students. D Year-wise response of students towards recording family history in case sheet. E Year-wise response of students towards knowledge on the main unit of inheritance. F Year-wise response of students towards types of DNA. G Year-wise response of students towards sources of DNA in the oral cavity.

82.45% of students were aware that saliva, mucosal swabs and teeth were sources of DNA while, 4.6% felt that only saliva was the source of DNA, 3.97% felt only mucosal swabs were the source of DNA and 8.94% of students felt that teeth were the source of DNA. Figure 4A) 82.4% of the first year, 74.7% of the second year, 81.4% of the third year, 84.8% of the final year and 90.9% of interns were aware that saliva, mucosal swabs and teeth were sources of DNA. Although the results were not statistically significant there was second years had the least knowledge followed by third-year students on dental sources of DNA (Figure 3G).

82.11% of the students were aware of autosomal dominant and autosomal recessive; X-linked dominant and X-linked recessive; multifactorial and mitochondrial inheritance 13.6% knew only autosomal dominant and autosomal recessive, 3.97% knew X-linked dominant and X-linked recessive and 0.03% had chosen the option multifactorial and mitochondrial inheritance. (Figure 4B) Among the various academic year of study 83.8% first year, 86.1% second year, 72.1% third year, 87.0 final year and 78.8% of interns were aware of all three patterns of inheritance. (Figure 5A) 84.3% of males and 81.5% of females had complete knowledge of inheritance patterns.

86.75% of students were aware of Diagnostic testing, Prenatal testing and Newborn screening genetic tests while 4.63% chose the option of diagnostic testing, 6.62% chose prenatal screening and 1.99% chose newborn screening. (Figure 4C) Among the students 87.5% of females and 84.3% of males were aware of all three genetic tests $p<0.05$). 85.3% of first-year students, 91.1% of second-year students, 69.8% of third-year students, 87.0% of final-year students and 93.9% of interns were aware of all three genetic tests (Figure 5B).

57.2% of the students knew the correct difference between genetic screening and testing 26.49% felt that both were the same and 16.22 felt that Genetic testing is done for a

population at risk whereas genetic screening is done for an individual. (Figure 4D) The highest proportion of interns was 77.3% followed by final year students 63.0 > first-year students 60.3> third-year students 51.2%> second-year students 51.2% had understood the differences between genetic screening and genetic testing p=0.001 (Figure 5 C).

64.23% were aware of DNA fingerprinting and 35.76% were not aware of the same. (Figure 4E). 60.3% of first-year students, 67.1% of second-year students, 69.8% of third-year students, 63.0% of final-year students and 62.1% of interns were aware of DNA fingerprinting p>0.05. (Figure 5D) 64.7% of females and 62.9% of males knew about DNA fingerprinting p.0.05.

89.73% of students knew that genetic disease has a link with the oral cavity and 10.26% of students were unaware. (Figure 4F) 90.9% of females and 85.% males were aware of the same p>0.05. There was a steady increase in the percentage of students who were aware of the link between genetic disease and oral cavity 77.9% first-year students, 86.1% second-year students, 93% third-year students, 97.8% final-year students and 98.5% interns. p=0.000 (Figure 5E).

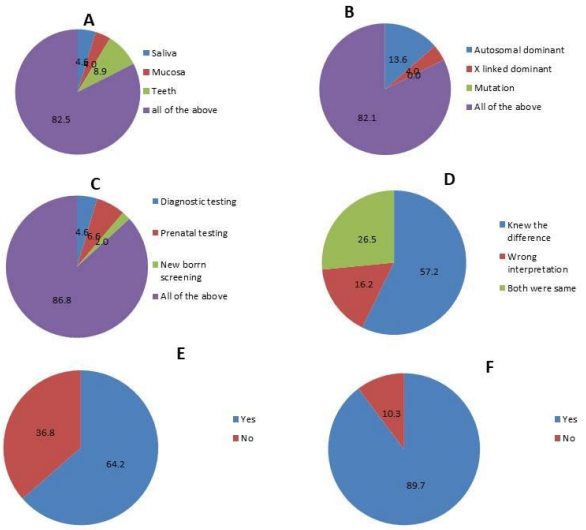

Figure 4. A. Response towards sources of DNA in the oral cavity, B. Response towards a pattern of inheritance, C. Response towards genetic tests, D. Response towards the difference between genetic screening and genetic testing, E. Response towards awareness of dental DNA fingerprinting, F. Response to knowledge in the influence of genetic disease in the oral cavity.

69.53% of the students were aware that genetic disorders can be prevented while 30.4% of students were unaware of the same. (Figure 6A) 69.1% of first-year students, 67.1% of second-year students, 72.1% of third-year students, 73.9% of final-year students and 68.2% of interns; 67.2% (Figure 5F) females and 77.1 males were aware of the prevention of genetics p.0.05.

91.05% of students were aware of gene therapy and 8.9% of students were unaware of the same (Figure 6B) among which 91.4% were females 90.0% were males, 92.6% were first-year students, 89.9% were second-year students, 83.7% were third-year students, 91.3% were final year students and 95.5% were interns p>0.05 (Figure 5G).

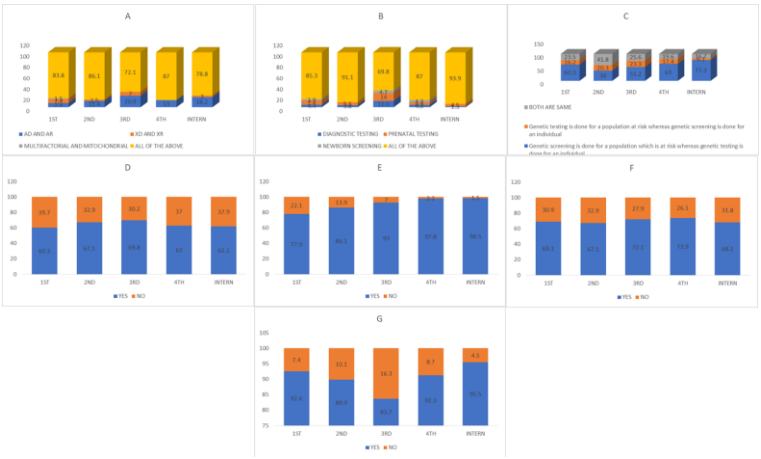

Figure 5. A Year wise response of students towards a pattern of inheritance, B Year wise response of students towards genetic tests, C Year wise response of students towards the difference between genetic screening and genetic testing, D Year wise response of students towards awareness of dental DNA fingerprinting, E Year wise response of students to knowledge in the influence of genetic disease in the oral cavity, F Year wise response of students to knowledge on prevention of genetic disease, G Year wise response of students to awareness on gene therapy

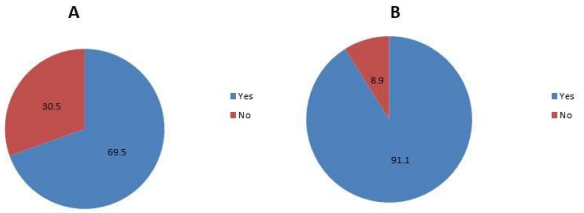

Figure 6. A. Response to Knowledge on Prevention of Genetic Disease. B. Response to Awareness of Gene Therapy

The mean percentage of correct responses from students of various academic years was calculated and it was observed that interns had better knowledge and interest in genetics at 81.39% followed by final-year students at 80.9% followed by first-year students at 75% followed by third-year students at 74.76% and second-year students had the least 73.07%. Considering gender females 77.21% had better knowledge of genetics than males 75.2% although the results were not statistically significant.

Discussion

It is a well-known fact that most of the diseases affecting mankind have a genetic etiology and hence the knowledge of genetics and DNA is essential for a healthcare professional. Among the various health care professionals, dentists also have a vital role in the diagnosis of not only diseases associated with the oral cavity but also systemic diseases as the mouth is the mirror of the body. Dental diseases such as dental caries congenital anomalies and malignancies have a genetic etiology. Similarly, most of the systemic diseases that manifest in the oral cavity also have a genetic aetiology. Hence a dentist needs to have a thorough knowledge of genetics and DNA for accurate diagnosis, treatment planning and appropriate referral. Jorgensen et al as early as 1980 depicted the role of dentists in genetic counselling and failure which should be considered malpractice [17].

With the available information, we conducted this study to assess the knowledge of DNA and the basics of genetics among

dental students in different academic years of study. In the present study interns had overall the highest knowledge and interest in genetics > final-year students> first-year students> second-year students. The results were not statistically significant which could be attributed to the low sample size. This could be attributed to the fact that interns and final-year students have a higher duration of exposure to clinics along with theoretical knowledge during their preparation for competitive exams. The first-year students had higher theoretical knowledge of DNA as genetics has been included in the school curriculum. The last response given by second-year students could be attributed to the fact that during the second year of the course, more importance is given to pre-clinical laboratory work to prepare the students for clinical courses in the third year. The majority of the students were interested in genetics as a subject and the highest percentage of final year students were interested in genetics but they felt that as dentists only sometimes importance to genetics has to be given. This shows that although the students were interested in genetics as a subject, they felt that the same was not essential in clinical dentistry. 91.3% and 79.8% of the students respectively recorded family history and correlated disease with genetics and there was a significant increase in the percentage of students from first year to interns who correlated disease with genetics. The results were statistically significant and depict the fact that as there is more exposure to clinical dentistry along with theoretical knowledge of genetics, the students were able to correlate diseases with genetics. However, since most of the students felt that dentists should give importance to genetics only sometimes, it would be questionable if they would apply their genetics knowledge to clinical practice after completing their course.

96.02% of the students were aware that DNA was the major unit of inheritance and there was a steady decrease in the percentage of students who responded to the correct option from the first year to the final year. 66.56% of the students were aware of the three types of DNA and the highest percentage (80.9%) of first-year students were aware of the types of DNA. This finding depicts the loss of theoretical knowledge on genetics as they progress towards clinical dentistry.

82.45% of the students were aware of all the sources of DNA 82.11% were aware of the pattern of inheritance, 86.75% were aware of the genetic tests, 89.73% of students knew that genetic disease has a link with the oral cavity and 91.05% of students were aware of gene therapy. However lesser proportion 57.2% of students knew the correct difference between genetic screening and testing and 69.53% of the students were aware that genetic disorders can be prevented. The findings are similar to the finding of Merdad et al who reported that although students had a good knowledge of genetics, they lacked fundamentals of genetics, and genetic testing [18],64.23% were aware of DNA fingerprinting which is concurrent with the findings of Keerthika et al [19] Considering gender, females had had better knowledge in genetics than males although the results were not statistically significant which are concurrent with the findings of Merdad et al. [18].

A systematic review by Gupta et al has reported the importance of dentists in genetic counselling [20]. Similarly, Johnson et al have reported that the principles of genetics that are learnt in the classroom have to be extrapolated into clinical practice and every patient file should carry information on genetics [21]. Several studies have reported the genetics knowledge imparted in dental education is not sufficient which is concurrent with the findings of the present study [22,23,24].

The limitations of the study include a lower sample size and unequal gender distribution. Hence basic concepts of genetics and applications of genetics have to be incorporated into the dental curriculum. This

can also be accomplished by conducting educational programs during the study and continuing dental educational programs after they complete their course. Workshops can also be conducted for students for students to gain practical knowledge in this field.

Conclusion

With the limitations of the study, we can conclude that although students know about genetics there is a lack of in-depth knowledge of the fundamentals of genetic testing, fundamental concepts of DNA and its clinical significance. It is recommended that the dental curriculum be incorporated with detailed basics of genetics and their applications. However future studies with a larger sample size could be conducted to obtain data on knowledge of dental students on genetics and thereby curriculum modifications could be done.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgements

None

References

[1]. Maffeo, C., Yoo, J., Comer, J., Wells, D. B., Luan, B., Aksimentiev, A., 2014, Close encounters with DNA. *J Phys Condens Matter*, 26(41), 413101. doi: 10.1088/0953-8984/26/41/413101.

[2]. Jaekel, A., Lill, P., Whitelam, S., & Saccà, B., 2020. Insights into the Structure and Energy of DNA Nanoassemblies. *Molecules (Basel, Switzerland)*, 25(23), 5466. https://doi.org/10.3390/molecules25235466.

[3]. . Watson, J.D., Crick, F.H.C., 1953, Molecular Structure of Nucleic Acids: A Structure for Deoxyribose Nucleic Acid. *Nature*, 171, 737–738. doi: 10.1038/171737a0.

[4]. Watson J.D., Crick, F.H.C, 1953, Genetical Implications of the Structure of Deoxyribonucleic Acid. *Nature*, 171,964–967. doi: 10.1038/171964b0.

[5]. Mc Gruder, Carla., Evaluation of current knowledge of genetics among dental students, residents and dental hygiene students 2015, The University of Texas MD Anderson Cancer Center uthealth graduate school of biomedical sciences dissertations and theses (Open Access). 579. https://digitalcommons.library.tmc.edu/utgsbs_dissertations/579.

[6]. Baars, M. J., Henneman, L., Ten, Kate, L. P., 2005, Deficiency of knowledge of genetics and genetic tests among general practitioners, gynaecologists, and pediatricians: a global problem. *Genet Med.*, 7(9), 605-10. doi: 10.1097/01.gim.0000182895.28432.c7. PMID: 16301861.

[7]. Slavkin, Harold, 2014, Revising the scope of practice for oral health professionals: Enter genomics. *Journal of the American Dental Association*, 1939 (145), 228-230. 10.14219/jada.2014.11.

[8]. Loos, B. G., & Van Dyke, T. E., 2020, The role of inflammation and genetics in periodontal disease. *Periodontology* 2000, 83(1), 26–39. https://doi.org/10.1111/prd.12297.

[9]. Shaffer, J.R., Xiaojing Wang, Daniel, W. M., Robert, J. W., Richard, C., and Mary L. M., 2015, Genetic susceptibility to dental caries differs between the Sexes: A family-based study. *Caries Research*, 49(2),133–140. doi:10.1159/000369103.

[10]. De Coster, P. J., Marks, L. A., Martens, L. C., & Huysseune, A. 2009, Dental agenesis: genetic and clinical perspectives. *Journal of oral pathology & medicine: official publication of the International Association of Oral Pathologists and the American Academy of Oral Pathology*, 38(1), 1–17. https://doi.org/10.1111/j.1600-0714.2008.00699.x.

[11]. Alade, A., Awotoye, W., & Butali, A.,2022, Genetic and epigenetic studies in non-syndromic oral clefts. *Oral diseases*, 28(5), 1339–1350. https://doi.org/10.1111/odi.14146.

[12]. Balachander, K., and Paramasivam. A.,2023, The implication of mitochondrial DNA mutation

and dysfunction in periodontal diseases. *J Indian Soc Periodontol*, 27(2), 126–130.

[13]. Abdul, N.S., Shenoy, M., Reddy, N.R. et al. 2024, Gene sequencing applications to combat oral-cavity related disorders: a systematic review with meta-analysis. *BMC Oral Health*, 24, 103, https://doi.org/10.1186/s12903-023-03541-7.

[14]. Rajasekar, A., Balu, P., Kumar, S. R., & Varghese, S. S., 2023, Comparison of Microbial Composition of Natural Teeth and Implants by 16S rRNA Gene Sequencing. *Journal of Long-Term Effects of Medical Implants*, 33(3), 1–8. https://doi.org/10.1615/JLongTermEffMedImplants.2022044519.

[15]. Sujatha, G., Priya, V. V., Varadarajan, S., et al., 2022, A Bibliometric Analysis of the Published Literature Related to Toothbrush as a Source of DNA. *World J Dentistry*, 13(S-1), S87–S95.

[16]. Johnson, L., Genco, R. J., Damsky, C., Haden, N. K., Hart, S., Hart, T. C., Shuler, C. F., Tabak, L. A., Tedesco, L. A., 2008, Genetics and its implications for clinical dental practice and education: Report of panel 3 of the Macy study. *J Dent Educ*, 72(2 Suppl):86-94. PMID: 18250384.

[17]. Jorgenson, R. J.,1980, The role of the dentist in genetic counseling. *Birth Defects Orig Artic Ser*, 16, 139–45.

[18]. D, Merdad L., Ramadan, E., 2016, Knowledge of Genetics and Attitudes toward Genetic Testing among College Students in Saudi Arabia. *Public Health Genomics*,19, 260-268. doi: 10.1159/000446511.

[19]. Keerthika, S., Vishnupriya, V., Gayathri, R., Selvaraj, J, 2019**,** Knowledge, attitude, and awareness of DNA fingerprinting among college students Drug Invention Today, 2378-2383.

[20]. Gupta, R., Chandra Shekar, B. R., Goel, P., Hongal, S., Ganavadiya, R., 2019, Role of dentist in genetic counseling: A critical appraisal of the current practices and future requirements in Indian scenario. *Dent Res J (Isfahan)*, 16(3), 131-138.

[21]. Johnson, L., Genco, R. J., Damsky, C., Haden, N. K., Hart, S., Hart, T. C., Shuler, C. F., Tabak, L. A., tedesco, L. A., Behnke, A. R., Hassell, T. M., 2004, Need for genetics education in U.S. Dental and dental hygiene programs. *J Dent Educ*, 68, 819–22.

[22]. Behnke, A. R., Hassell, T. M., 2004, Need for genetics education in U.S. Dental and dental hygiene programs. *J Dent Educ*, 68, 819–22.

[23]. Dudlicek, L. L., Gettig, E. A., Etzel, K.R., Hart, T. C., 2004, Status of genetics education in U.S. Dental schools. J Dent Educ, 68:809–18. Genetics and its implications for clinical dental practice and education: Report of panel 3 of the Macy study. *J Dent Educ*., 72(2 Suppl, 86-94.

[24]. Collins, F., Tabak, L., 2004, A call for increased education in genetics for dental health professionals. *J Dent Educ.*, 68, 807–8.