

# **SURVEY ON THE INCIDENCE OF COVID19 AMONG DENTISTS WORKING IN DENTAL HOSPITAL ATTACHED WITH DENTAL COLLEGE**

## **ABSTRACT:**

## **INTRODUCTION:**

Covid 19 is primarily a pneumonia associated viral infection that originated from Wuhan city in December 2019. The spread of novel coronavirus occurs through direct close contact with COVID-19 patients within one Metre of the infected person and the rate of spread is enhanced especially if they do not cover their face when coughing or sneezing. The novel virus also spreads by the droplets surviving on surfaces and clothes for many days. The current study focuses on analysing the vulnerability of the dental population to covid19, and the study also deals with analysis of the knowledge among the dentists regarding the diagnosis, prevention and treatment protocols of Covid19.

## **MATERIALS AND METHOD:**

An manual survey was conducted with the self structured questionnaire prepared using google docs. An total of 1000 responses were received. The responses recorded were analysed and statistical analysis was performed

## **RESULTS:**

The current survey results depict that around 97.14% of the participants were exposed to the pandemic outbreak covid19 and among them around 74.23% of the population did not get admitted in hospital and self quarantined themselves and took nutrition rich diet to recover from covid19 infection.

## **CONCLUSION:**

The study results within the limitation depicted that there is adequate awareness, knowledge on all aspects with regards to the pandemic outbreak novel corona virus. study also shows the vulnerability of dentists in any community outbreak of any size. it also shows the disease management strategy handled by the local community.

**KEYWORDS:** COVID19; SARS-COV2; Awareness; Knowledge.

**RUNNING TITLE:** awareness about the incidence of covid19 among the dental population.

## INTRODUCTION:

The most infectious pneumonia associated viral outbreak SARS-COV-2 originated from Wuhan city in China in December 2019. The novel coronavirus was first described in 1966 by Tyrell and Bynoe, by cultivating the viruses from patients with common colds(1)The virus is named 2019- Ncov by the WHO, the international committee on taxonomy of viruses terms it to be SARS-COV-2.The pandemic global outbreak covid19 is a new human infecting betacoronavirus is likely to be originated from the chrysanthemum bats(2).The novel virus SARS- CoV- 2 is found to cause a type of pneumonia associated problem termed Severe Acute Respiratory Syndrome. The virus appears to be spherical and have proteins called spikes protruding from their surface(3). The pandemic outbreak COVID-19 spreads mainly by droplets produced as a result of coughing or sneezing of a COVID-19 infected person. The spread of novel coronavirus occurs through direct close contact with COVID-19 patients within one Metre of the infected person and the rate of spread is enhanced especially if they do not cover their face when coughing or sneezing. The novel virus also spreads by the droplets surviving on surfaces and clothes for many days. Therefore, touching any such infected surface or cloth and then touching one's mouth, nose or eyes can transmit the disease.The Hydroxychloroquine, an old drug used for the treatment of malaria, had demonstrated marked efficacy and it is acceptable globally in treating COVID-19 associated pneumonia (4).

Innate immunity is the inborn capacity of the body to offer resistance to pathogens and toxin products.Innate immunity was first described in 1906 by nobel prize winner ILYA MECHNIKOV(5).Innate immunity is produced by cells of hematopoietic and non-hematopoietic origin.Hematopoietic cells include natural killer cells,macrophage ,neutrophils.Innate immunity is further subdivided into 2 components such as humoral immunity and cell mediated immunity.(6)Humoral immunity is mediated by antibodies where the antibody provides the first line of defence against infections,long-term humoural immunity is mediated by continuous differentiation of B cells.(7)

Immunity is an essential factor to protect ourselves from the infections such as covid19,influenza etc. so in the recent times various studies regarding covid19 origin, prevention methods,correlation of associated topics with coronavirus were conducted and one among them is the research carried out to understand the connect between cancer and the global alarming covid19 condition and the recent studies carried out discovered that people suffering with cancer are more vulnerable to covid19 infection(8,9).However the recent studies also discovered that the aerosol generated in dental procedures reveals that dental profession are at a high risk of developing the viral infection due to enhanced transmission through these large droplets.(10–14), but potentially oral biopsy procedure done in dentistry is effective in detecting covid19 among smokers by the procedure GS17913 and ACE which are found to be receptor for the viral outbreak.(15),also the teledentistry mainly the dental photographs have proved to be a trusted source to

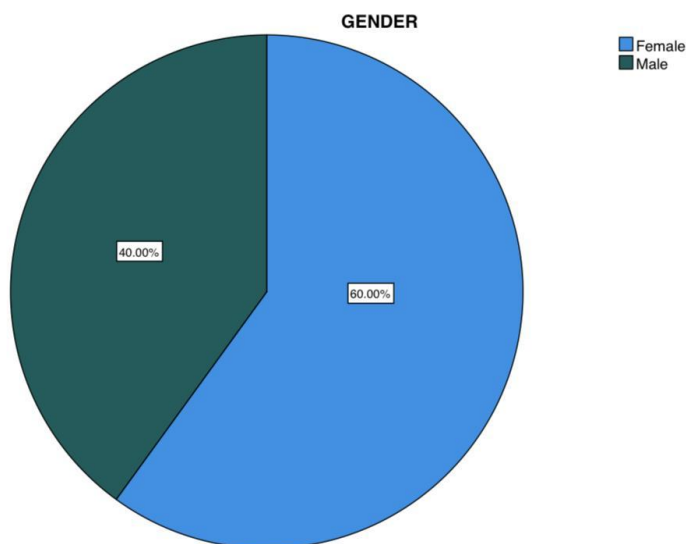
improve the oral health of people to fight against the infection covid19.(16,17). It is also found that the presence of the covid19 infection can be identified from the gingival crevicular fluid.(18–20)(21,22)

In recent times various studies regarding covid19 origin, prevention methods,correlation of associated topics with coronavirus were conducted and one among them is the research carried out to understand the connection between cancer and the global alarming covid19 condition(23–34),(35–39). . The recent studies carried out discovered that people suffering with cancer are more vulnerable to covid19 infection(40).The current study focuses on analysing the vulnerability of the dental population to covid19,and the study also deals with analysis of the knowledge among the dentists regarding the diagnosis,prevention and treatment protocols of Covid19.

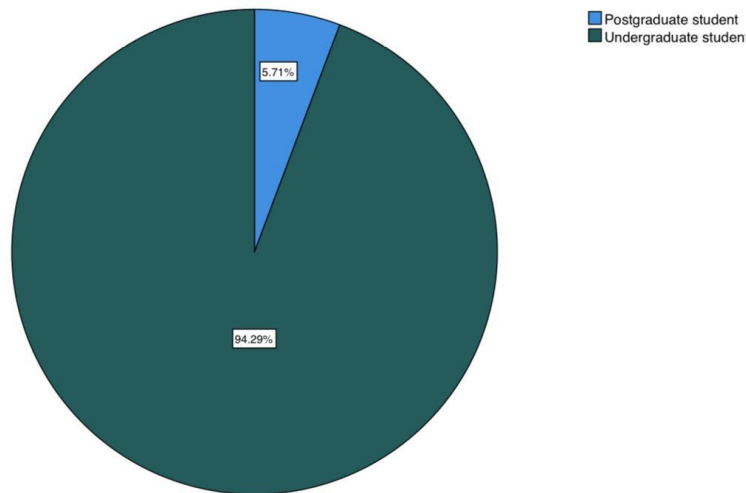
## MATERIALS AND METHOD:

A manual survey was conducted with a self structured questionnaire among dentists with a sample size of 1000 . The questionnaire was designed using the online platform “google docs” and the questionnaire was circulated and responses were collected. The questionnaire consists of 2 parts,first part contains questions related to socioeconomic data, questions related to the COVID19 and about the available treatment modalities and the second part of the questionnaire comprise questions related to recovery rate and consequences of COVID19 infection. The questionnaire was validated in the usual manner. Measures such as the selection of participants randomly, steps to prevent asking irrelevant questions to the participants, placing restrictions over participant population and age groups are taken to minimise the bias occurring in sampling,with the collected data a descriptive analysis test was performed using the software “SPSS VERSION 20” and the findings of the present study was displayed in the form of pie charts.

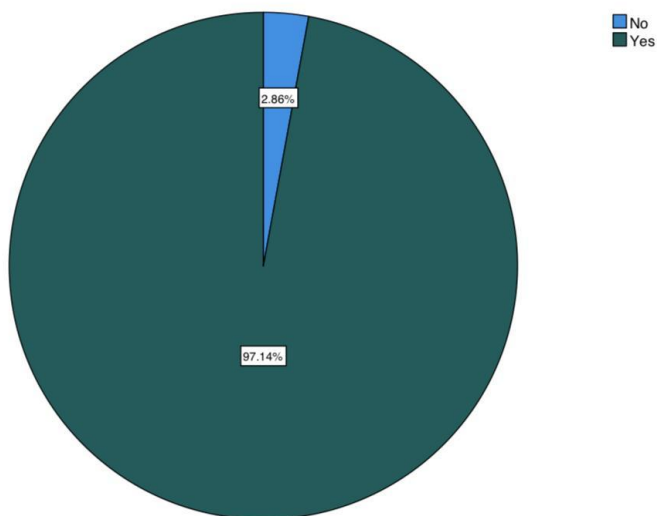
## RESULTS:



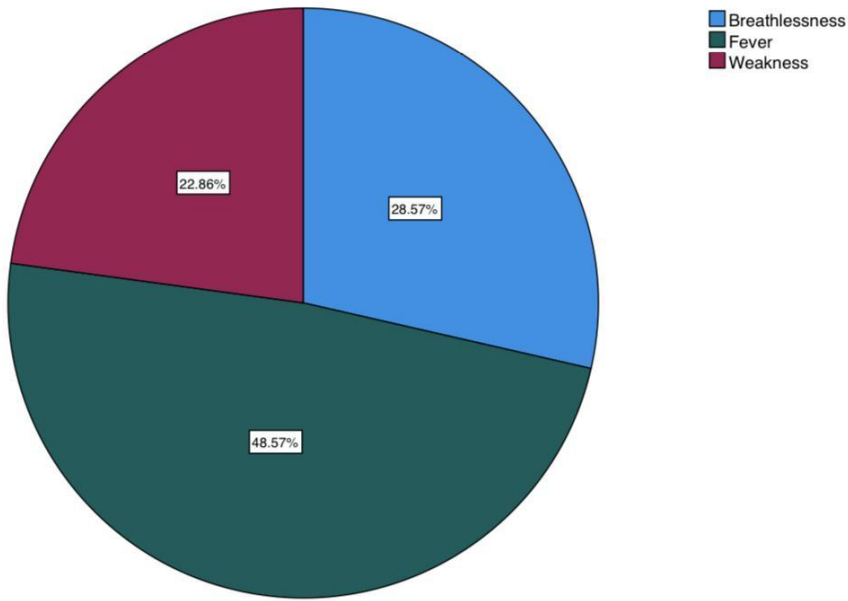
**Figure 1:**This pie chart depicts the ratio of male and female population in the total survey population,60% of the participants were female(blue) and around 40% were male(green).



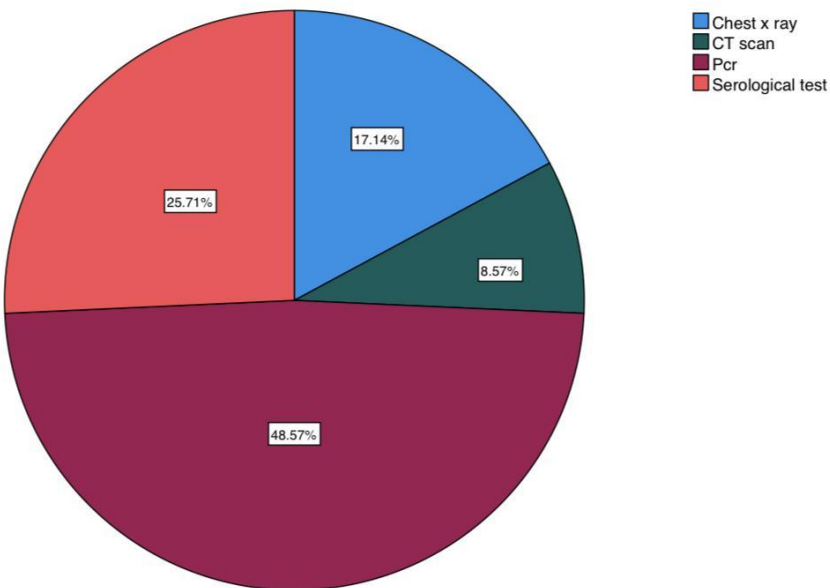
**Figure 2:** The pie chart depicts the ratio of undergraduate and postgraduate participants in the overall population, 94.29% of the participants were from undergraduate students (green), 5.71% of the participants were from post graduate (blue).



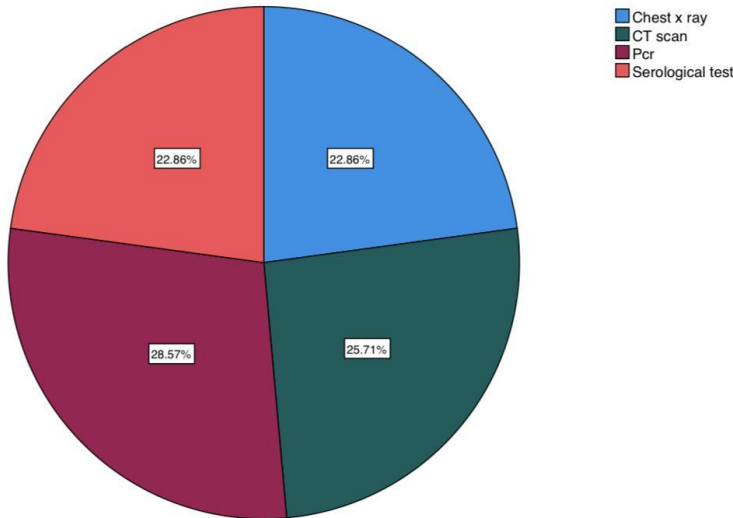
**Figure 3:** pie chart shows the ratio of participants affected/exposed with covid19 in the overall population, 97.14% responded that they are exposed to the pandemic outbreak covid19 (green), 2.86% are not exposed to covid19 (blue).



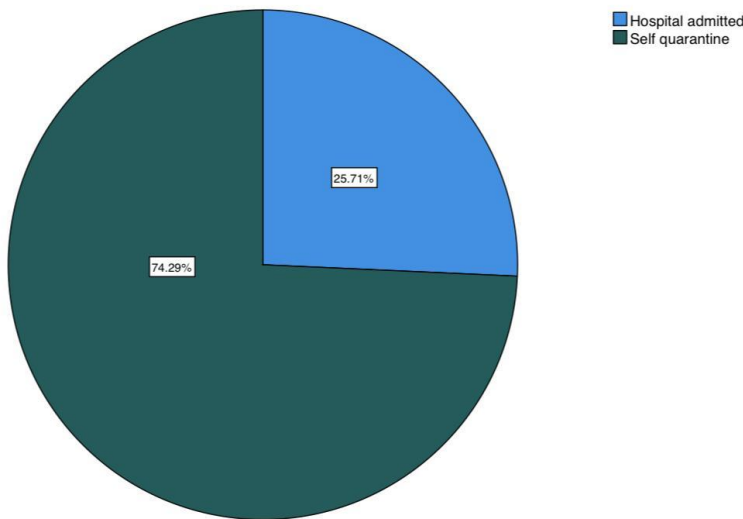
**Figure 4:** The pie chart depicts the various symptoms associated with COVID-19. 48.57% of the participants had fever as a symptom at the initial stage (green), around 28.57% of the respondents had breathlessness (blue) and the remaining 22.86% had weakness (pink).



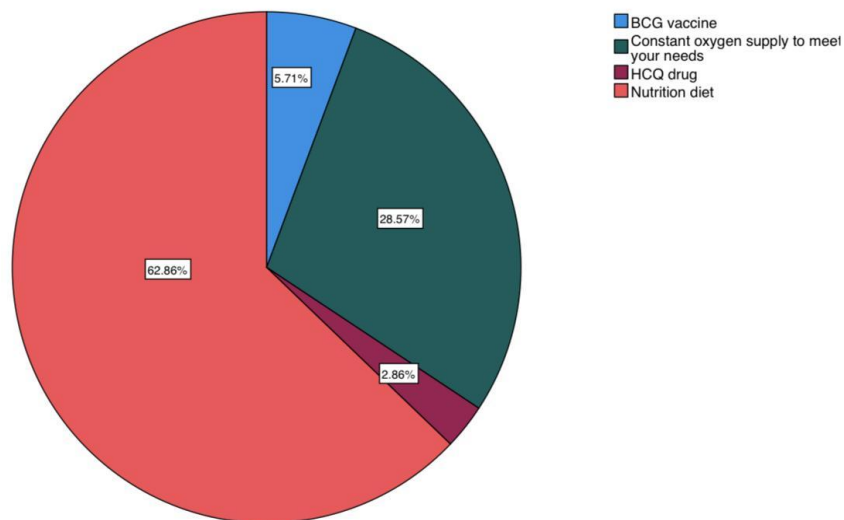
**Figure 5:** The pie chart shows the various diagnostic method of covid19,48.57% of the participants were diagnosed using PCR(pink),25.71% were diagnosed with serological test(orange),around 17.14% were diagnosed with the help of chest X ray(blue) and the remaining with CT scan(green).



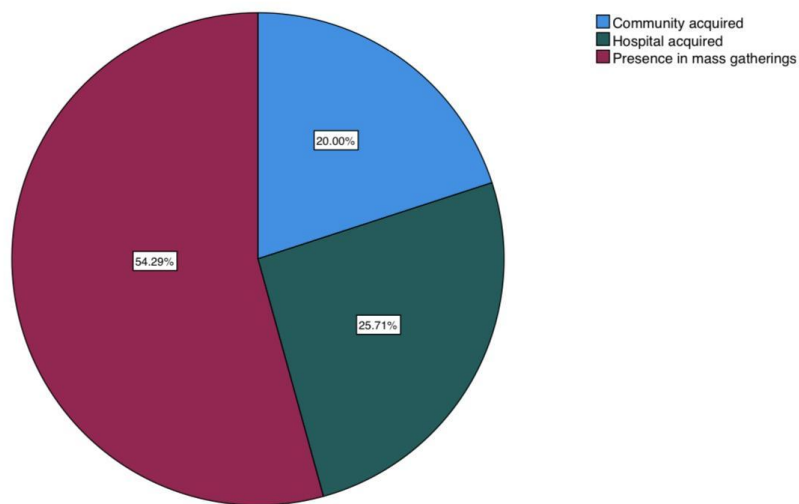
**FIGURE 6:** The pie chart depicts the reliability of various diagnostic methods of covid19, 28.57% of the people answered PCR to be the reliable method(blue),25.71 of the participants believe CT scan to be the reliable method(green),and the remaining people believe other methods like chest x ray, serological test to be reliable(orange,blue).



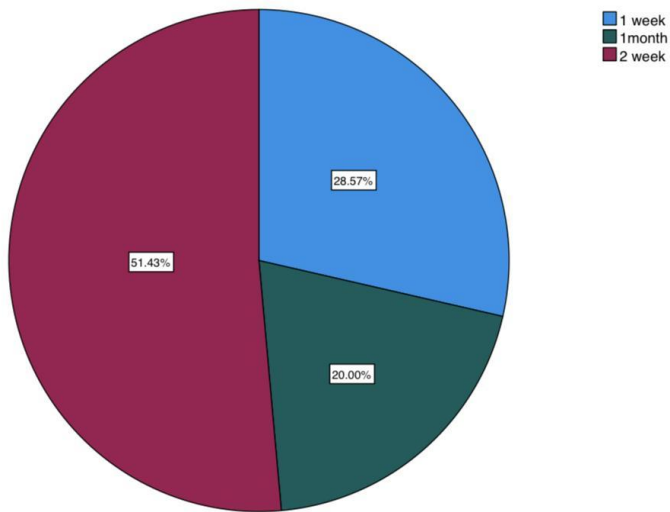
**FIGURE 7:** The pie chart depicts the ratio of incidence of hospital admitted participants in the population,74.23% of the population did not get admitted in hospital(green) and around 25.71% got admitted in the hospital(blue).



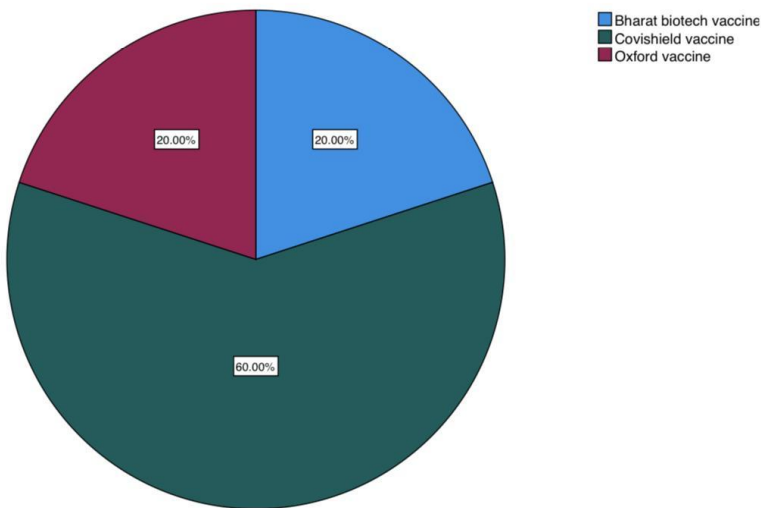
**FIGURE 8:** The pie chart shows the Various treatment modalities available for covid19, 62.8% were given only proper nutritional diet (orange) and 5.71% of BCG vaccine (blue), 28.7% of constant oxygen (green) and around 2.88% were given HCQ drug (pink).



**FIGURE 9:** The pie chart depicts the various sources of COVID-19 infection, 54.28% of the participants got affected because of attending a mass gathering (pink), 25.71% of the participants got exposed through their contact with hospital (green).

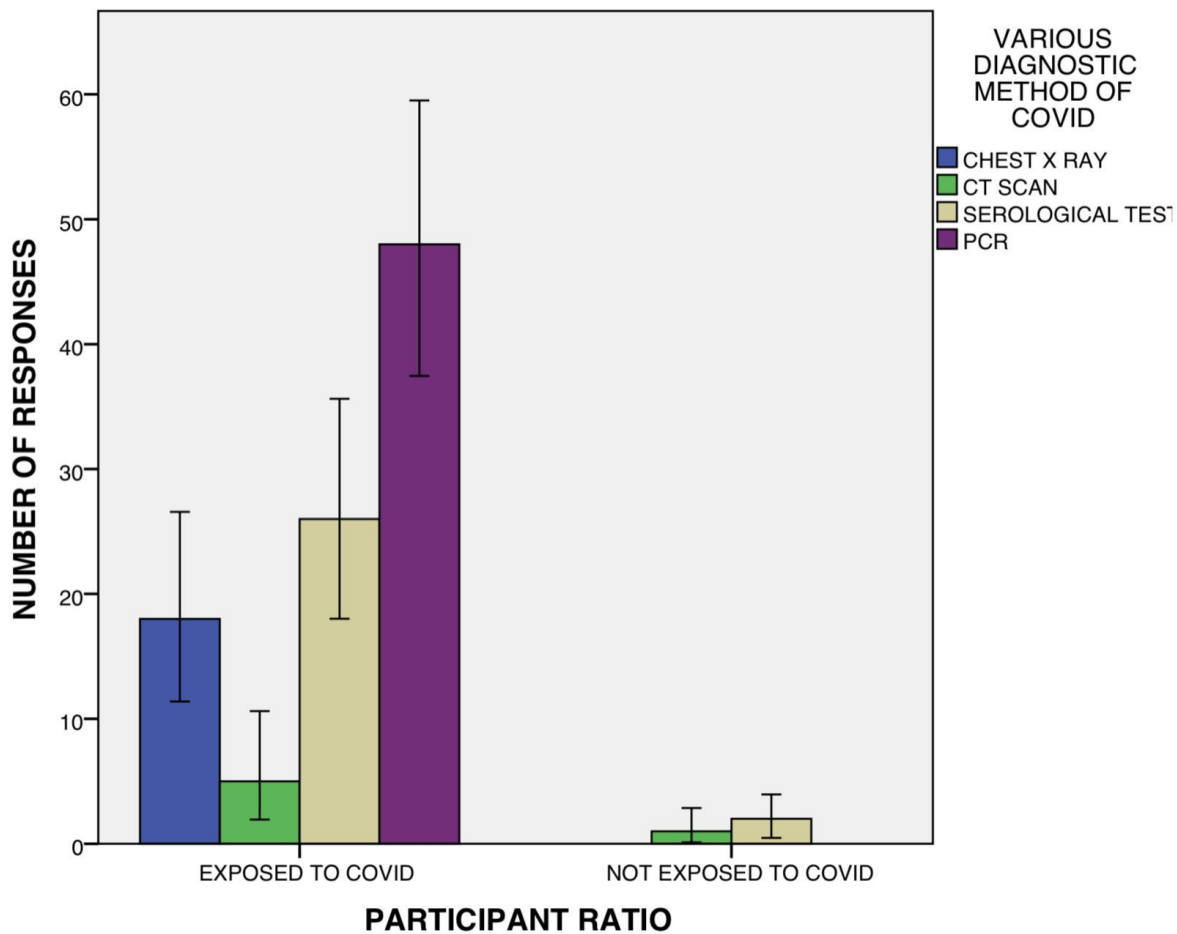


**FIGURE 10:** The pie chart depicts the recovery rate from covid19,51.43% of the participants answered that they recovered within 2weeks(pink),28.57% of the people answered that they think the recovery rate from covid19 is 1 week(blue).



**FIGURE 11 :**The pie chart shows the various available vaccine for preventing covid19.60% of the participants prefer COVISHIELD(green),20% of the participants prefer BHARAT BIOTECH VACCINE(blue)and 20% of the participants prefer OXFORD VACCINE(pink)





Error Bars: 95% CI

**FIGURE 12:** Bar graph representing the association by chi square test between participant ratio and the various diagnostic methods of covid. X axis represents the participant ratio and Y axis represents the frequency of responses. Blue colour denotes the people who think chest X ray as a diagnostic tool and green colour denotes the people preferring CT scan as a diagnostic tool, yellow determine ratio of people preferring serological tests and purple denotes people who believe PCR to be a diagnostic tool. P value=0.012, p value>0.05 hence statistically significant.

In the current study the Figure 1 depicts that the number of male and female population ratio in the overall survey population was in the percentage 40% males and 60% females. Figure 2 depicts that the number of undergraduate students and postgraduate students population ratio in the overall survey population was in the percentage 94.29% undergraduate students and remaining were post graduate students. The Figure 3 in the current study depicts about the ratio of participants affected/exposed with covid19 in the overall population, 97.14% responded that they are exposed to the pandemic outbreak covid19, 2.86% are not exposed to covid19. Figure 4 depict the various symptoms associated with covid19, 48.57% of the participants had fever as a symptom at the initial stage, around 28.57% of the respondents had breathlessness and the remaining 22.86% had weakness. Figure 5 shows the various

diagnostic method of covid19,48.57% of the participants were diagnosed using PCR,25.71% were diagnosed with serological test,around 17.14% were diagnosed with the help of chest X ray and the remaining with CT scan.The Figure 6 denotes the reliability of various diagnostic methods of covid19, 28.57% of the people answered PCR to be the reliable method,25.71 of the participants believe CT scan to be the reliable method,and the remaining people believe other methods like chest x ray, serological test to be reliable.The results recorded for Figure 7 in the study depicts the ratio of incidence of hospital admitted participants in the population,74.23% of the population did not get admitted in hospital and around 25.71% got admitted in the hospital.Figure 8 of the study shows the Various treatment modalities available for covid19,62.8% were given only proper nutritional diet and 5.71% of BCG vaccine,28.7% of constant oxygen.Figure 9 depicts various source of Covid19 infection,54.28% of the participants got affected because of attending a mass gathering,25.71% of the participants got exposed through their contact with hospital.Figure 10 depicts the depicts the recovery rate from covid19,51.43% of the participants answered that they recovered within 2weeks,28.57% of the people answered that they think the recovery rate from covid19 is 1 week.Figure 11 shows the various available vaccine for preventing covid19.60% of the participants prefer COVISHIELD,20% of the participants prefer BHARAT BIOTECH VACCINE and 20% of the participants prefer OXFORD VACCINE.Figure 12 representing the association by chi square test between participant ratio and the various diagnostic methods of covid.

## **DISCUSSION:**

In the previous study performed to analyse the inhibition properties of plants and proved that plants possess inhibition property to a certain extent based on the affinity of turmeric, neem, ashwagandha and ginger to be potential inhibitors for covid19(41)(42). The findings of the previous study match with the findings of fig 8 in the present study.

The results of figure 6 depicts the CT scan has a high degree of reliability among the various available diagnostic methods of covid19,when compared with the study conducted on analysing the efficiency of CT scan and PCR found that they were patients Typical CT findings was associated with negative rRT-PCR results, the study concluded that CT SCAN possesses 97.2% reliability than rRT-PCR, the finding of both the study are similar(43,44).

The findings of fig8 depict that around 5.71% of the people believe BCG vaccine has role in preventing Covid19 infections,when compared with previous study findings it revealed that BCG vaccination also acted as one of the trusted prevention methods to prevent healthcare workers against COVID19 infection in the initial period of pandemic situations(45,46).

So, the possible factors for the high incidence rate of Covid19 Pandemic outbreak on dental populations is specifically demonstrated in the current study.The present study possesses limitations such as the small sample size, homogeneous population and the study deals only with one particular parameter. Further studies with a large sample size, focus on detail concerned with many parameters should be done to significantly demonstrate the merits,demerits and benefits of sterilization procedure against Covid19.

## **CONCLUSION:**

The study results within the limitation depicted that there is adequate awareness, knowledge on all aspects with regards to the pandemic outbreak novel corona virus. Study also shows the vulnerability of dentists in any community outbreak of any size. It also shows the disease management strategy handled by the local community. The impact of the pandemic in a community depends on the overall strategy and the management by the government agencies at all levels. The impact is said to be an indication of the poor political decision and delay in the initiation of the control measures. It had a significant penetration in the community before the lockdown

#### **COMPETING INTERESTS DISCLAIMER:**

**Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.**

#### **REFERENCE:**

1. Tyrrell DA, Bynoe ML. Cultivation of viruses from a high proportion of patients with colds. *Lancet*. 1966 Jan 8;1(7428):76–7.
2. Rio C del, del Rio C, Malani PN. COVID-19—New Insights on a Rapidly Changing Epidemic [Internet]. Vol. 323, *JAMA*. 2020. p. 1339. Available from: <http://dx.doi.org/10.1001/jama.2020.3072>
3. Novel coronavirus structure reveals targets for vaccines and treatments [Internet]. National Institutes of Health (NIH). 2020 [cited 2020 Jun 4]. Available from: <https://www.nih.gov/news-events/nih-research-matters/novel-coronavirus-structure-reveals-targets-vaccines-treatments>
4. Gao J, Tian Z, Yang X. Breakthrough: Chloroquine phosphate has shown apparent efficacy in treatment of COVID-19 associated pneumonia in clinical studies. *Biosci Trends*. 2020 Mar 16;14(1):72–3.
5. Turvey SE, Broide DH. Innate immunity. *J Allergy Clin Immunol*. 2010 Feb;125(2 Suppl 2):S24–32.
6. Beutler B. Innate immunity: an overview. *Mol Immunol*. 2004 Feb;40(12):845–59.
7. Slifka MK, Antia R, Whitmire JK, Ahmed R. Humoral immunity due to long-lived plasma cells. *Immunity*. 1998 Mar;8(3):363–72.
8. Shree KH, Ramani P, Sherlin H, Sukumaran G, Jeyaraj G, Don KR, et al. Saliva as a diagnostic tool in oral squamous cell carcinoma—a systematic review with Meta analysis. *Pathol Oncol Res*. 2019;25(2):447–53.
9. Palati S, Ramani P, Herald. J. Sherlin, Gheena S, Don KR, Jayaraj G, et al. Age Estimation of an Individual Using Olze’s Method in Indian Population—A Cross-Sectional Study [Internet]. Vol. 13,

Indian Journal of Forensic Medicine & Toxicology. 2019. p. 121. Available from: <http://dx.doi.org/10.5958/0973-9130.2019.00179.8>

10. Ahad M, Gheena S. Awareness, attitude and knowledge about evidence based dentistry among the dental practitioner in Chennai city. *Research Journal of Pharmacy and Technology*. 2016;9(11):1863–6.
11. Padavala S, Sukumaran G. Molar Incisor Hypomineralization and Its Prevalence. *Contemp Clin Dent*. 2018 Sep;9(Suppl 2):S246–50.
12. Harrita S, Santhanam A. Determination of Physical Height Using Clinical Crown Height of Deciduous Teeth. *Indian J Forensic Med Toxicol*. 2019;13(4):23–7.
13. Gunasekaran G, Abilasha R. TOOTH SENSITIVITY AMONG RESIDENTIAL UNIVERSITY STUDENTS IN CHENNAI [Internet]. *Asian Journal of Pharmaceutical and Clinical Research*. 2016. p. 63. Available from: <http://dx.doi.org/10.22159/ajpcr.2016.v9s2.13228>
14. Uma PK, Ramani P, Sherlin HJ, Others. Knowledge about Legal Aspects of Medical Negligence in India among Dentists--A Questionnaire Survey. *Medico Legal Update*. 2020;20(1):111–5.
15. Sheriff K, Santhanam A. Knowledge and Awareness towards Oral Biopsy among Students of Saveetha Dental College. *Research Journal of Pharmacy and Technology*. 2018;11(2):543–6.
16. Hannah R, Ramani P, Sherlin HJ, Ranjith G, Ramasubramanian A, Jayaraj G, et al. Awareness about the use, ethics and scope of dental photography among undergraduate dental students dentist behind the lens. *Research Journal of Pharmacy and Technology*. 2018;11(3):1012–6.
17. Palati S, Ramani P, Shrelin HJ, Sukumaran G, Ramasubramanian A, Don KR, et al. Knowledge, Attitude and practice survey on the perspective of oral lesions and dental health in geriatric patients residing in old age homes. *Indian J Dent Res*. 2020 Jan;31(1):22–5.
18. Manohar J, Abilasha R. A Study on the Knowledge of Causes and Prevalance of Pigmentation of Gingiva among Dental Students. *Indian Journal of Public Health Research & Development*. 2019;10(8):95–100.
19. Abitha T, Santhanam A. Correlation between bizygomatic and maxillary central incisor width for gender identification [Internet]. Vol. 22, *Brazilian Dental Science*. 2019. p. 458–66. Available from: <http://dx.doi.org/10.14295/bds.2019.v22i4.1775>
20. Krishnan RP, Ramani P, Sherlin HJ, Sukumaran G, Ramasubramanian A, Jayaraj G, et al. Surgical Specimen Handover from Operation Theater to Laboratory: A Survey. *Ann Maxillofac Surg*. 2018 Jul;8(2):234–8.
21. Prasanna GE, Gheena S. A study of empathy across students from 4 health disciplines among 1st years and Final years [Internet]. Vol. 9, *Research Journal of Pharmacy and Technology*. 2016. p. 1472. Available from: <http://dx.doi.org/10.5958/0974-360x.2016.00286.9>
22. Sarbeen JI, Insira Sarbeen J, Gheena S. Microbial variation in climatic change and its effect on human health [Internet]. Vol. 9, *Research Journal of Pharmacy and Technology*. 2016. p. 1777. Available from: <http://dx.doi.org/10.5958/0974-360x.2016.00359.0>
23. Priyadharsini JV, Vijayashree Priyadharsini J, Smiline Girija AS, Paramasivam A. In silico analysis of virulence genes in an emerging dental pathogen *A. baumannii* and related species [Internet]. Vol.

94, Archives of Oral Biology. 2018. p. 93–8. Available from:  
<http://dx.doi.org/10.1016/j.archoralbio.2018.07.001>

24. Vijayashree Priyadharsini J. In silico validation of the non-antibiotic drugs acetaminophen and ibuprofen as antibacterial agents against red complex pathogens. *J Periodontol.* 2019 Dec;90(12):1441–8.
25. Paramasivam A, Vijayashree Priyadharsini J, Raghunandhakumar S. N6-adenosine methylation (m6A): a promising new molecular target in hypertension and cardiovascular diseases. *Hypertens Res.* 2020 Feb;43(2):153–4.
26. Vijayashree Priyadharsini J, Smiline Girija AS, Paramasivam A. An insight into the emergence of *Acinetobacter baumannii* as an oro-dental pathogen and its drug resistance gene profile - An in silico approach. *Heliyon.* 2018 Dec;4(12):e01051.
27. Paramasivam A, Vijayashree Priyadharsini J. Novel insights into m6A modification in circular RNA and implications for immunity. *Cell Mol Immunol.* 2020 Jun;17(6):668–9.
28. Paramasivam A, Priyadharsini JV, Raghunandhakumar S. Implications of m6A modification in autoimmune disorders. *Cell Mol Immunol.* 2020 May;17(5):550–1.
29. Girija ASS, Shankar EM, Larsson M. Could SARS-CoV-2-Induced Hyperinflammation Magnify the Severity of Coronavirus Disease (CoViD-19) Leading to Acute Respiratory Distress Syndrome? *Front Immunol.* 2020 May 27;11:1206.
30. Jayaseelan VP, Arumugam P. Exosomal microRNAs as a promising theragnostic tool for essential hypertension. *Hypertens Res.* 2020 Jan;43(1):74–5.
31. Ushanthika T, Smiline Girija AS, Paramasivam A, Priyadharsini JV. An in silico approach towards identification of virulence factors in red complex pathogens targeted by reserpine. *Nat Prod Res.* 2021 Jun;35(11):1893–8.
32. Ramalingam AK, Selvi SGA, Jayaseelan VP. Targeting prolyl tripeptidyl peptidase from *Porphyromonas gingivalis* with the bioactive compounds from *Rosmarinus officinalis*. *Asian Biomed.* 2019 Oct 1;13(5):197–203.
33. Kumar SP, Girija ASS, Priyadharsini JV. Targeting NM23-H1-mediated inhibition of tumour metastasis in viral hepatitis with bioactive compounds from *Ganoderma lucidum*: A computational study. *pharmaceutical-sciences [Internet].* 2020;82(2). Available from: <https://www.ijpsonline.com/articles/targeting-nm23h1-mediated-inhibition-of-tumour-metastasis-in-viral-hepatitis-with-bioactive-compounds-from-ganoderma-lucidum-a-comp-3883.html>
34. Mathivadani V, Smiline AS, Priyadharsini JV. Targeting Epstein-Barr virus nuclear antigen 1 (EBNA-1) with *Murraya koengii* bio-compounds: An in-silico approach. *Acta Virol.* 2020;64(1):93–9.
35. Samuel SR, Kuduruthullah S, Khair AMB, Shayeb MA, Elkaseh A, Varma SR. Dental pain, parental SARS-CoV-2 fear and distress on quality of life of 2 to 6 year-old children during COVID-19. *Int J Paediatr Dent.* 2021 May;31(3):436–41.
36. Samuel SR. Can 5-year-olds sensibly self-report the impact of developmental enamel defects on their quality of life? *Int J Paediatr Dent.* 2021 Mar;31(2):285–6.

37. Barma MD, Muthupandiyan I, Samuel SR, Amaechi BT. Inhibition of *Streptococcus mutans*, antioxidant property and cytotoxicity of novel nano-zinc oxide varnish. *Arch Oral Biol.* 2021 Jun;126:105132.
38. Teja KV, Ramesh S. Is a filled lateral canal - A sign of superiority? *J Dent Sci.* 2020 Dec;15(4):562–3.
39. Reddy P, Krithikadatta J, Srinivasan V, Raghu S, Velumurugan N. Dental Caries Profile and Associated Risk Factors Among Adolescent School Children in an Urban South-Indian City. *Oral Health Prev Dent.* 2020 Apr 1;18(1):379–86.
40. Addeo A, Friedlaender A. Cancer and COVID-19: Unmasking their ties [Internet]. Vol. 88, *Cancer Treatment Reviews.* 2020. p. 102041. Available from: <http://dx.doi.org/10.1016/j.ctrv.2020.102041>
41. Srivastava AK, Kumar A, Misra N. On the Inhibition of COVID-19 Protease by Indian Herbal Plants: An In Silico Investigation [Internet]. arXiv [q-bio.OT]. 2020. Available from: <http://arxiv.org/abs/2004.03411>
42. N MA, Gheena S. Awareness on the possible role of ayurveda as an immunity booster in the covid19 pandemic [Internet]. Vol. 11, *International Journal of Research in Pharmaceutical Sciences.* 2020. p. 567–74. Available from: <http://dx.doi.org/10.26452/ijrps.v11ispl1.2855>
43. Long C, Xu H, Shen Q, Zhang X, Fan B, Wang C, et al. Diagnosis of the Coronavirus disease (COVID-19): rRT-PCR or CT? *Eur J Radiol.* 2020 May;126:108961.
44. Teng Y, Dai H, Shang Y, Xia J, Chen Y, Tian W, et al. Diagnosis of Coronavirus Disease 2019 (COVID-19): Neither Chest CT nor RT-PCR Fits All [Internet]. Available from: <http://dx.doi.org/10.21203/rs.3.rs-27336/v1>
45. Meena J, Yadav A, Kumar J. BCG Vaccination Policy and Protection Against COVID-19 [Internet]. Vol. 87, *The Indian Journal of Pediatrics.* 2020. p. 749–749. Available from: <http://dx.doi.org/10.1007/s12098-020-03371-3>
46. Mohapatra PR, Mishra B. BCG Vaccination Policy and Protection Against COVID-19: Correspondence [Internet]. Vol. 87, *The Indian Journal of Pediatrics.* 2020. p. 772–3. Available from: <http://dx.doi.org/10.1007/s12098-020-03462-1>