KNOWLEDGE AND AWARENESS ABOUT VIRTUAL REALITY AND AUGMENTED REALITY IN DENTISTRY - A SURVEY

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ABSTRACT

Virtual reality is the science of the creation of a virtual environment for the diagnosis, planning, and surgical training of different anatomical regions of the body. Increased reality is the superimposition on the surgical field of an individual patient-specific 3D real environment using semi-transparent glasses to increase the virtual scene. The main aim of this survey-based study is to provide an overview of the knowledge and awareness of dental practitioners on the application of virtual and augmented reality in dentistry. This study was done by conducting an online survey among 200 dental practitioners including interns, dentists, and postgraduates from

different locations. This survey has provided a clear view about the use of virtual reality and augmented reality in the clinical practice of dental practitioners and their knowledge and awareness about virtual reality come out to implement betterment in clinical procedures of dentists. The results were collected and then analyzed through SPSS software. Descriptive statistical analysis was carried out and the chi-square test was used and the p-value was calculated. This survey gives a better analysis about the knowledge and Awareness of Virtual reality and augmented reality in dentistry gives a clear view to all the dentists to get a clear view about the virtual environment which can be further implemented in a wide range in the dental field, which paves a better way for enhancing dental treatments in future.

Keywords: Virtual reality, Augmented reality, dentists, surgery, dental health

INTRODUCTION

With the rise of the elderly population and economic development, the idea of oral health is slowly growing, and issues of dental and dental health care are becoming increasingly important. The oral disease has become a major public health concern, and the global oral health market is continuing to expand [1].

Moreover, according to statistics from the World Health Organization, more than 60 percent of school-age children worldwide and nearly 100 percent of adults have dental caries status, and adult population, nearly 20 percent of those suffering from severe teeth disease, follow-up will lead to the possibility of missing teeth [2]. The overall tooth loss rate is as high as nearly 30 percent for the 65e74-year-old population. Despite the increase in the number of elderly people and a growing aging population, the care rate is relatively small, compared with the majority of elderly people. This would lead to a significant rise in oral medical needs in the long term [3].

Nowadays, the advances in computer-based technologies such as Augmented Reality (AR) and Virtual Reality (VR) are abundant [4]. AR is the first application in the two kinds of reality that began to be widely used [5]. AR, in which virtual 3D objects are integrated into a real-time 3D environment. AR is to "virtualize" the virtual image into the real space, creating a virtual space around the eyes of the user to replace the actual space **(Figure 1) [6]**. To make users see a world that has a real environment and is generated over a real scene by computer graphics. And the VR provided users with a real, virtual 3D model inside [7]. To create a three-dimensional, seemingly real virtual

world in the eyes of the user according to the monitor. To achieve the interaction situation, VR has also recently designed head mount displays with special glasses to cover the user's surrounding vision **(Figure 2) [8]**.

With the increasing demand for dental implants, professional skills, clinical training, and accumulation of experience is more important in the dentist-related faculties or postgraduate year (PGY), and these technologies are directly reflected in the education of the school **[9]**. In order to train a dentist, complete education and training with realistic exercises and evaluations. Therefore, whether on the educational or clinical side, the increasingly mature development of the technology developed by the auxiliary products will become increasingly important in the process of surgery and training **[10]**. An evolving trend for global dental education is without question the better way to learn. It will be a must-have for dental universities around the world to learn education equipment and methods built around such technology **[11]**.

With advanced information technology (IT) growth, computer-led dental solutions, and internet technologies have made considerable progress around the world **[12]**. The trend for the professional dental field in the future will be digital dental solutions. This pattern would slowly challenge both conventional clinical dental procedures and the learning methods of dental education **[13]**.

The increasingly mature medical image can help doctors identify the affected area of the patient, and make a different cure. The new technology that supported the doctor was being mature slowly **[14]**. Image-guided therapy (IGT) and image-guided interventions (IGI) technology creation, image recognition, and tracking device location combined with computer computing, computed tomography, position tracker, monitor, and PC to achieve immediate tracking location and surgical tools **[14]**. The nerve surgery also combined with the above technology to achieve a real-time surgical effects. And because good image clarity will affect the overall system of precision, medical imaging such as CT technology advances, with a good tracking system also reduces the risk of surgery and mistakes **[15]**. The main purpose of this study is to provide an overview of the knowledge and awareness of dental practitioners on the application of virtual reality and augmented reality in dentistry.
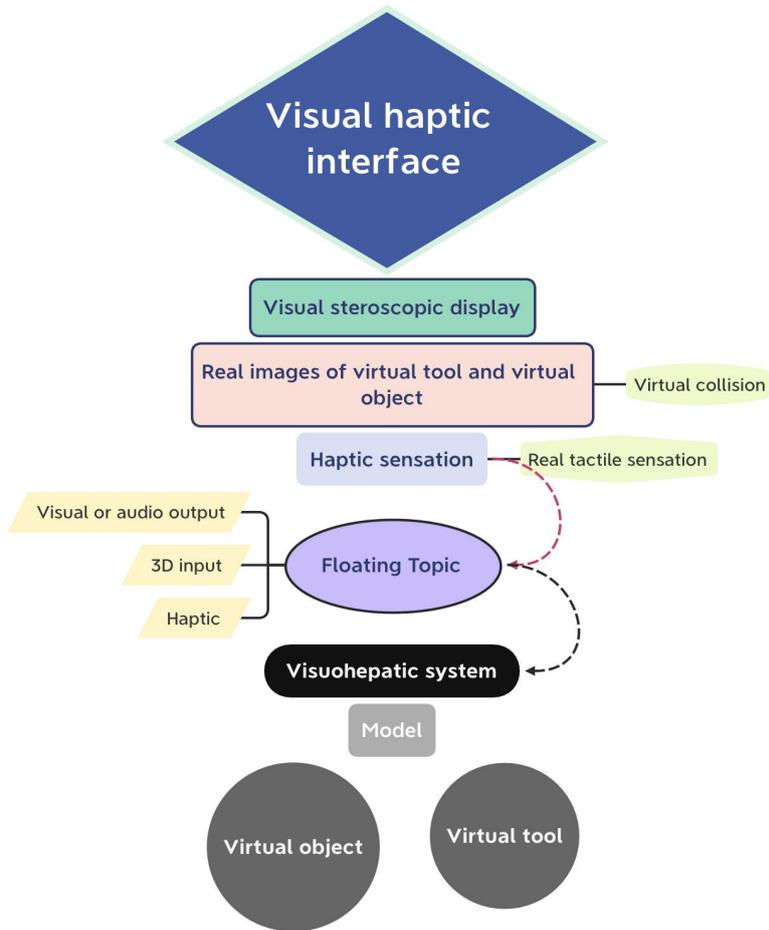
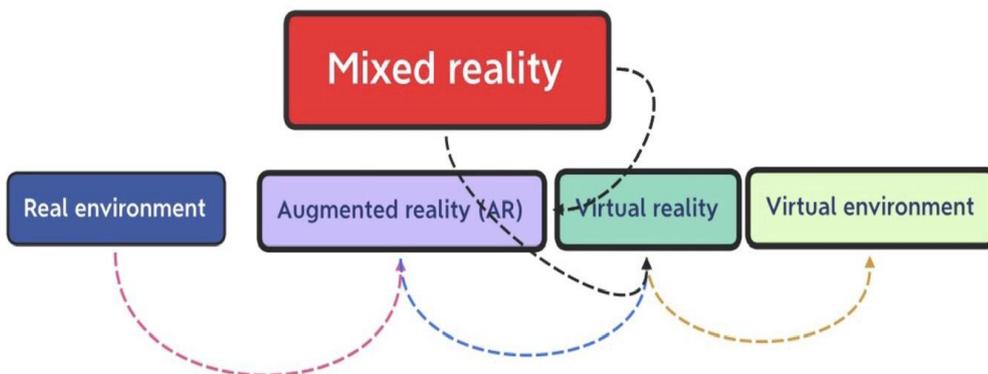**Figure 1: Representation of virtual haptic interface in virtual reality**

Figure 2: Representation of the Virtual Environment in VR And AR

MATERIALS AND METHODS

To analyze the knowledge and awareness about Virtual reality (VR) and augmented reality (AR) In dentistry, an online survey was conducted in a standard manner by simple random sampling method involving all age groups, by distributing 15 questionnaires(Given below) through an online portal called google forms, among 200 dental practitioners including Interns, dental postgraduates and dentists from different locations by acquiring approval from the ethical committee and proper consent from the individuals involved in filling the survey and then the stratified data was collected and then data manipulation was done by clean up in an excel spreadsheet and the results were collected and then analyzed through SPSS software. Descriptive statistical analysis and chi-square test for comparison of parameters were used and p-value was calculated.

QUESTIONNAIRES:

- Name
- Age
- Sex
    a. Male
    b. Female
- Qualification
- Are you aware of the term " virtual reality" and "augmented reality"?
    a. Yes
    b. No
- Have you experienced VR in any of these ways?
    a. Games
    b. Dentistry
    c. Education
    d. None
    e. All of the above
    f. Others
- Do you know that VR is used in dentistry?
    a. Yes
    b. No
- What do you think is the use of VR in dentistry?
    a. Help dentists to keep their skills up to date
    b. Reduce the anxiety of pediatric patients
    c. To avoid boredom of the patient
    d. To perform implants and tooth extraction
    e. Allow dentists to practice with VR before treating actual patients
    f. Others
- Which branch of dentistry do you think is VR mostly used?
    a. Pedodontics
    b. Implantology

c. Oral and maxillofacial surgery

d. Conservative dentistry and endodontics

e. All of the above

f. Others

- Are you currently using VR for any of your dental procedures?

  a. Yes

  b. No

- If not, What do you think is the reason for most of the dental practitioners not using VR?

  a. Deteriorates human corrections

  b. High cost

  c. Lack of flexibility

  d. Human sensory limitation

  e. Health effects

  f. Damage eyesight

- What kind of dental procedures do you think Virtual reality and Augmented reality is effective?

  a. Surgery training

  b. Dentofacial deformities

  c. Extraction

  d. Implants placements

  e. All of the above

  f. Others

- Do you think Virtual reality helps in reducing dental anxiety, fear, and boredom of pediatric dentistry in the dental chair?

1. Yes

2. No

- What is the use of augmented reality?

  a. Medical training

  b. Perform complex surgeries

  c. GPS compass map

  d. All of the above

  e. Others

- Are you currently using Augmented reality in your dental practices?

  a. Yes

  b. No

- What are the things needed for Implementing augmented reality?

  a. Mobile

  b. Tab

  c. AR app

  d. All of the above

  e. Others

- If yes, what do you think is the advantage of using Augmented reality?

  a. Collaboration between the dentist and the dental technician

  b. Digital models viewed in real-time

c. Allows the patient to see their new smile before they consent to the treatment

d. All of the above

e. Others

● If not, what is the reason for you not using AR?

    a. Expensive

b. Difficult to maintain

c. AR devices hacked by intruders

d. Do not have secured policies
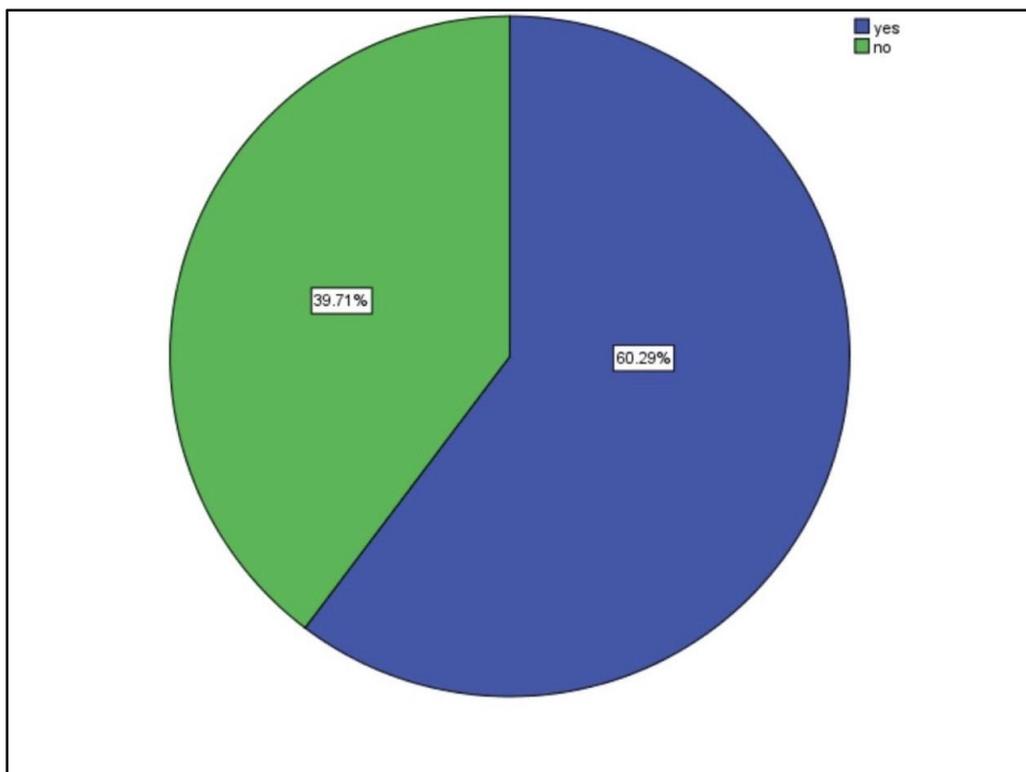
e. All of the above

f. Others

RESULTS AND DISCUSSION

Figure 3: represents the experience of VR by the dental practitioners, which shows 60.29% of the dental practitioners say that they have experienced the use of VR, while 39.71% of dentists say no to the experience of use of VR.
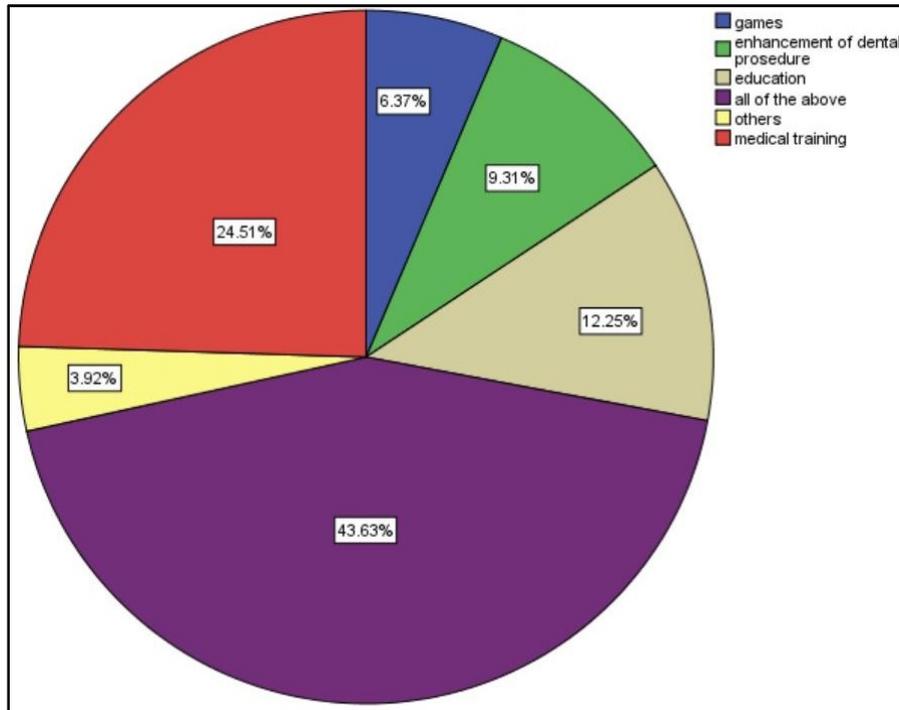
Figure 4: shows the use of VR by the dental practitioners in any of the ways, which shows, 6.3% of the dental practitioners consider games as the main use of virtual reality, while 9.3% dental practitioners consider dentistry as a main use of VR, 12.25% of dentist consider education, 43.63% of dentist consider all the above uses as the main use of virtual reality, while 3.92% of dentists consider other uses and 24.51% of dentist considered medical training as the main use of VR
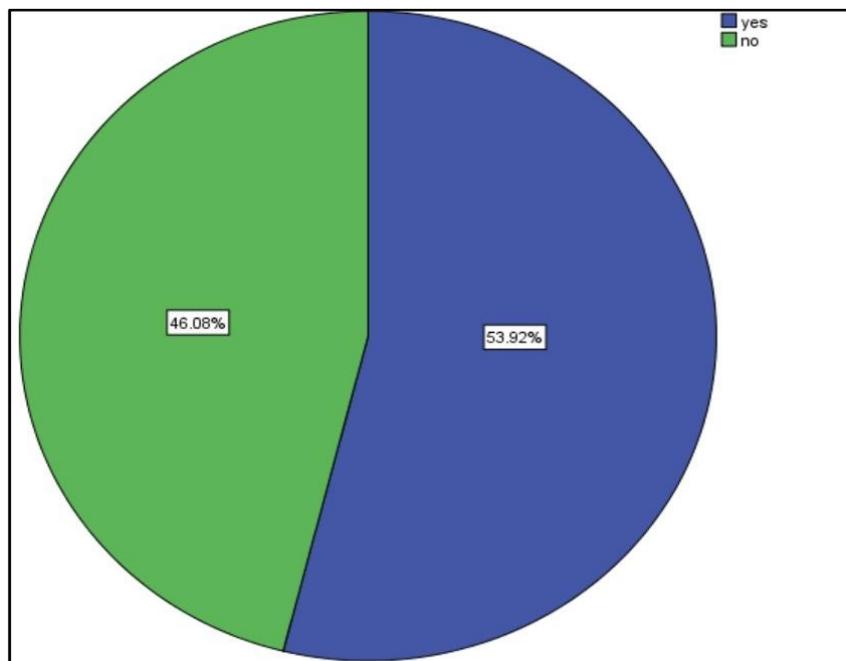

Figure 5: Shows the knowledge of dental practitioners, about the use of VR in dentistry, In which 53.92% of dental practitioners say that they know that VR is used in dentistry and 46.08% of dental practitioners say that they do not know and are not aware of the use of VR in dentistry.
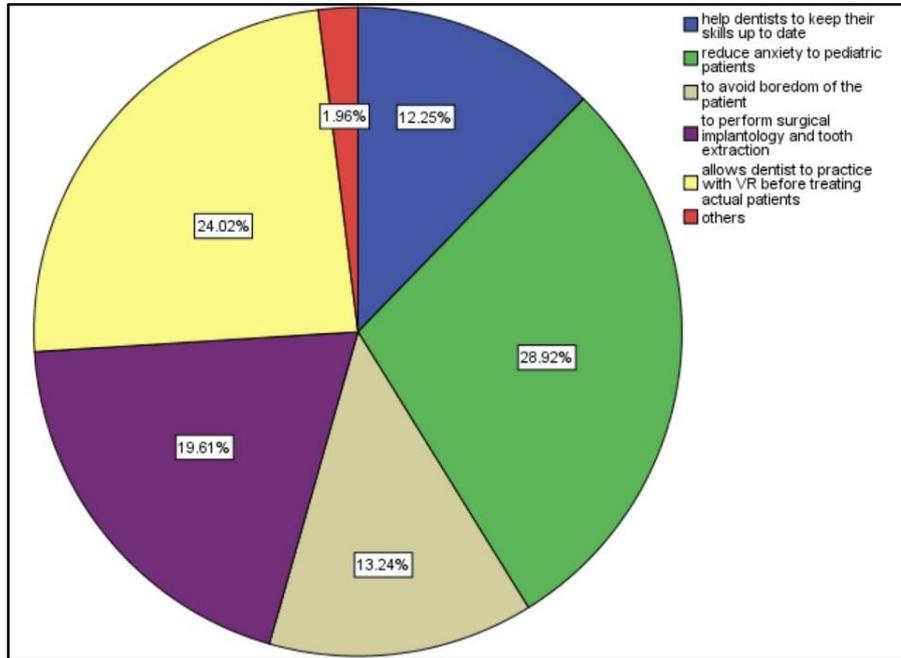
Figure 6: shows the preference of dental practitioners in using virtual reality in their dental procedures, which shows that 12.2% of dental practitioners consider using VR, to keep their skills up-to-date, 28.8% of dentists used VR to avoid the anxiety of pediatric patients, 13.2% of dental practitioners consider using VR to avoid the bottom of the patients, 19.5% of the dental practitioners prefer using VR for performing complex surgeries, implantology, and tooth extractions, 24.02% of dental practitioners use virtual reality which allowed practicing with the virtual reality before treating actual patients and 1.96% of dentists consider other uses.
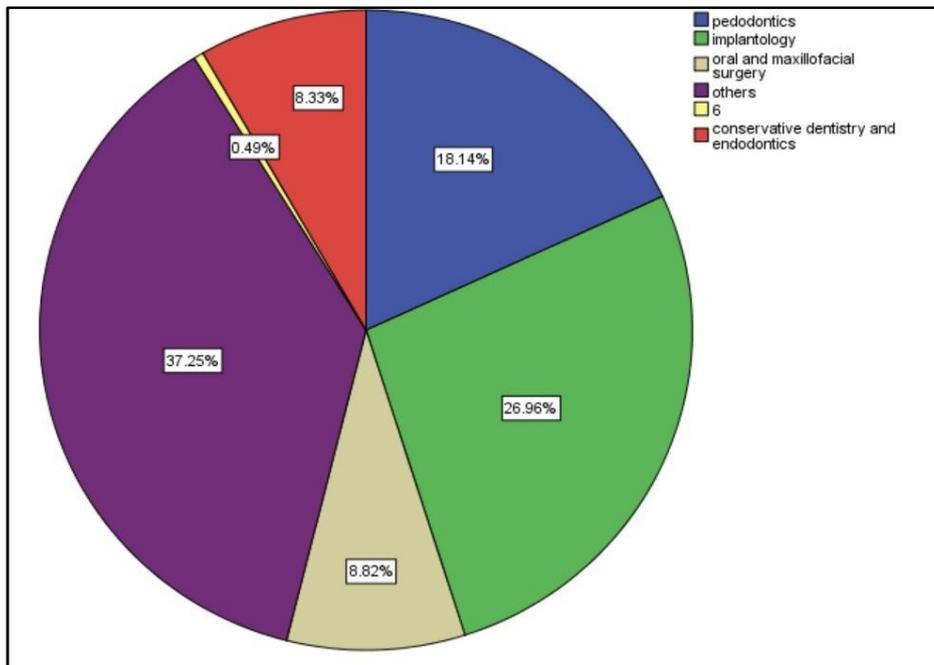

Figure 7: shows the knowledge and awareness of dentist about which branch of dentistry needs the efficient use of VR which shows 18.14% of dentists consider pedodontics as the most important branch which requires the use of virtual reality, 26.9% of dentist consider implantology, 8.82% of dental practitioners consider oral and maxillofacial surgery and 37.25% of the dental practitioners consider other branches of dentistry 8.33% of dentists consider Conservative dentistry, as the branches requiring the efficient use of virtual reality in dentistry.
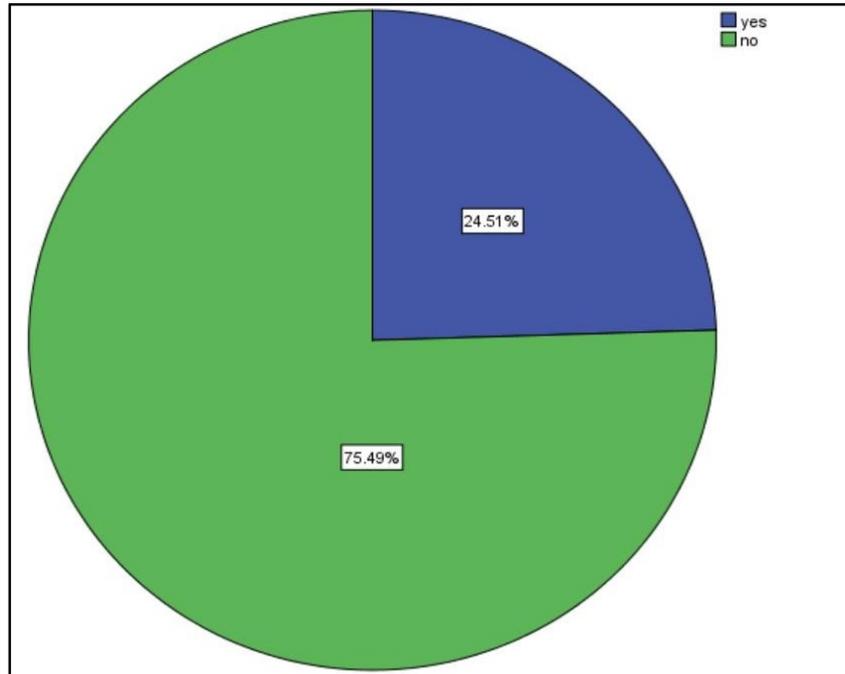
Figure 8: shows the statistical ratio of the number of dental practitioners using VR and the dental practice, which shows 24.51% of dentists say that they are using VR in their clinical practice, while 75.49% of dental practitioners are not using virtual reality for their clinical practice.
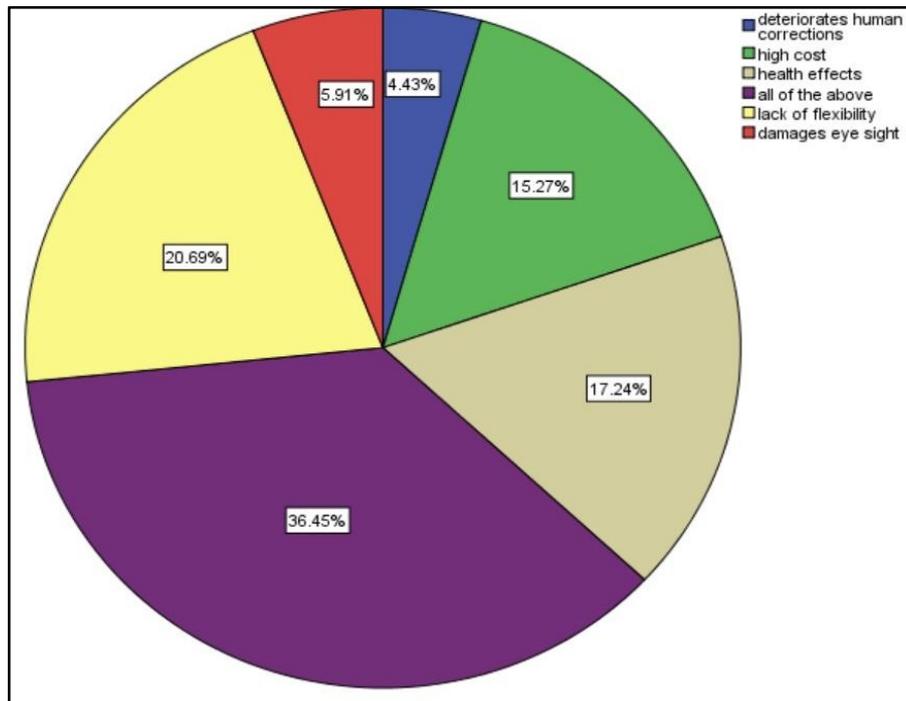

Figure 9: shows the disadvantage and the reason given by the dental practitioners for not using virtual reality in their clinical procedure which shows 4.43% of dental practitioners says deterioration of human correction As the main reason for not using VR in their clinical practice, 15.27% of dentists say high-cost, 20.69% report lack of flexibility, 5.91% of dentists considered damage of eyesight, 36.1% dental practitioners consider all the above-given reasons and 17.24% of dentists report health effects as the main reason for not employing VR in their clinical practice.
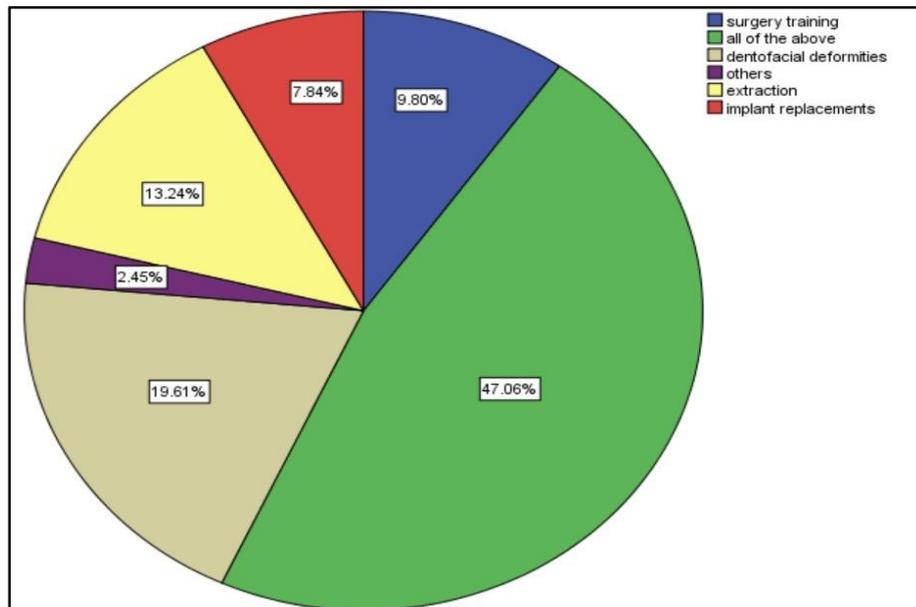
Figure 10: shows the knowledge of dental practitioners about the most important procedures requiring the employment of virtual reality which shows that 9.80% of dentists consider surgery training, 7.84% of dentist consider implant replacement, 13.24% of dentists consider extraction, 19.61% of dentists consider dental-facial deformity correction, 2.45% of dental practitioners consider other uses and 47.06% of dental practitioners consider all the above uses, as the main procedures and their preference in using virtual reality. Most of the dental practitioners consider surgery training, extraction, implant replacements and correction of dentofacial deformities is considered to be the most required use, which is proving to be the most ideal use like planning the surgical resection and the stimulation of facial structures for correction of dentofacial deformities, maxillofacial reconstruction after cancer resection and 3-D acquisition of the required a dentofacial structure.
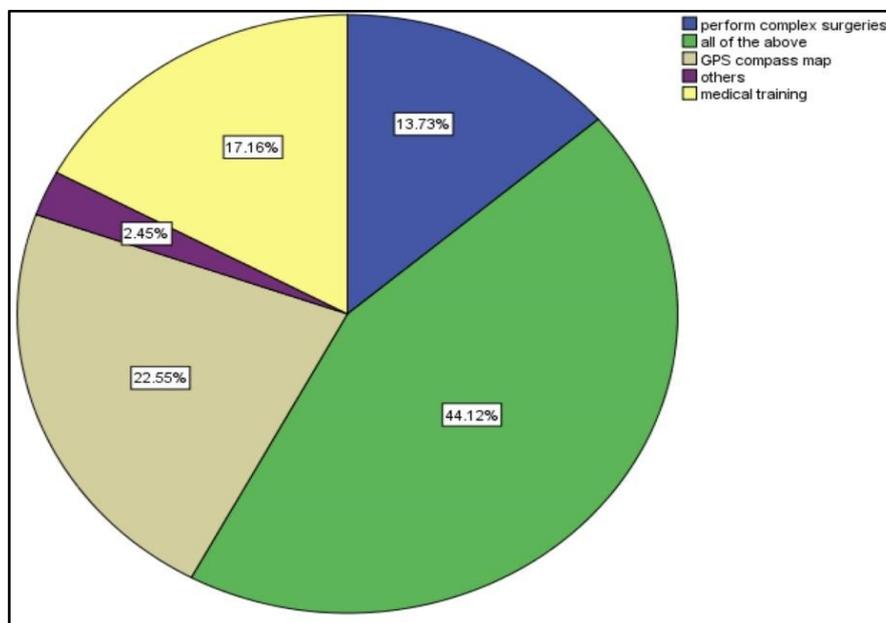

Figure 11: shows the awareness to dental practitioners about the use of augmented reality in dentistry which shows 13.73% of dental practitioners consider performing complex surgeries as the main use of AR, 44.12% of dentists give all the above options like the use of AR, 22.55% of dental practitioners consider GPS compass map, 2.45% of dental practitioners consider other uses and 17.16% of Dentist consider medical training as a mean use of augmented reality.

The main advantage of VR and AR is considered to be planning of treatment procedures like implants, complex surgeries by creating a virtual world and practicing the treatment procedure, before employing the treatment procedure directly to the patient, which gives a clear idea to the dentist about the result of the treatment to be acquired and also reduces the number of patient visits[16] (Figure 11).
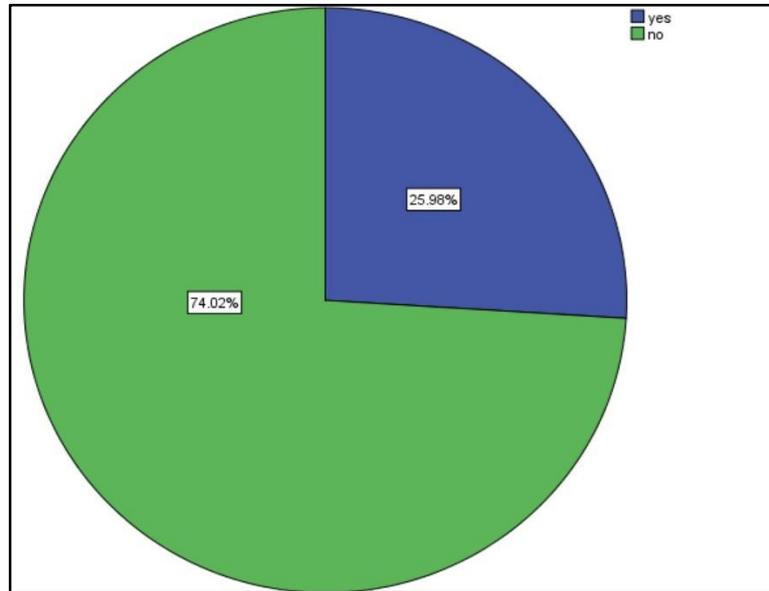

Figure 12: shows the use of augmented reality by dental practitioners in their clinical practice, which shows 25.98% of dental practitioners report that they use AR in their clinical practice and 74.02% of dentists say that they do not use AR in their clinical practice.
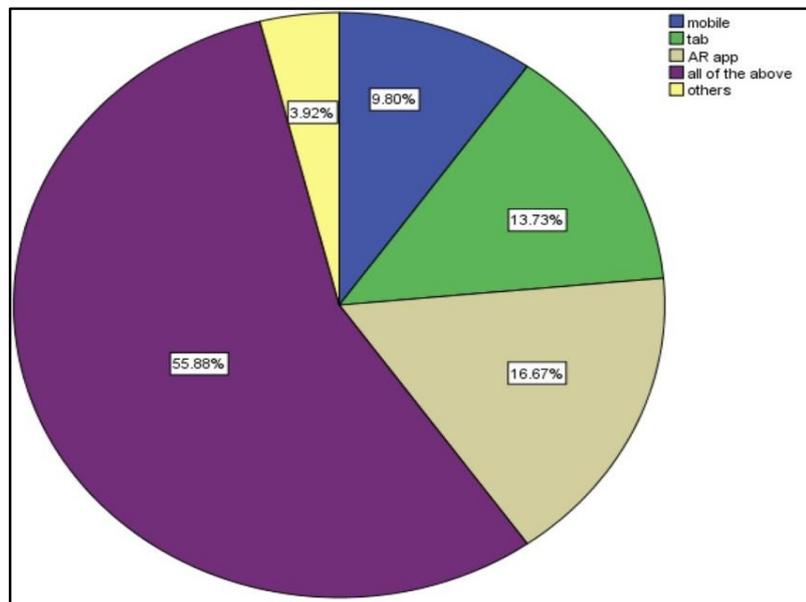

Figure 13: shows the knowledge of dental practitioners about the things needed for the setting up and implementing of augmented reality which shows 9.80% of dental practitioners consider mobile as the most needed thing for the setting up of augmented reality, 13.7% of dentists consider tab, 16.67% of dentists consider AR app, 55.88% of dental practitioners consider all the above things and 3.92% of dental practitioners say other things are needed, as the things required by the dentists according to their preference in setting up of augmented reality.
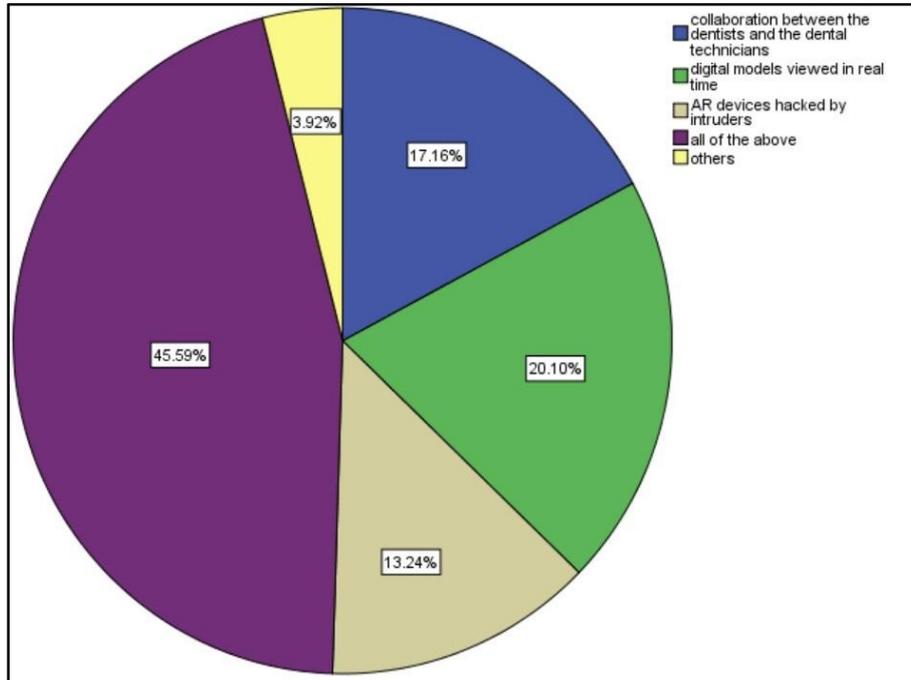
Figure 14: shows the advantages reported by dental practitioners in using augmented reality which shows 17.16% of dentists consider collaboration between dentists and dental technicians as the main advantage of using augmented reality, 20.10% of dentists consider viewing digital models in real-time, 13.24% of dentists consider all the above options and 3.92% of dentists consider other reasons, as the main advantages of using augmented reality in dental clinical practices.
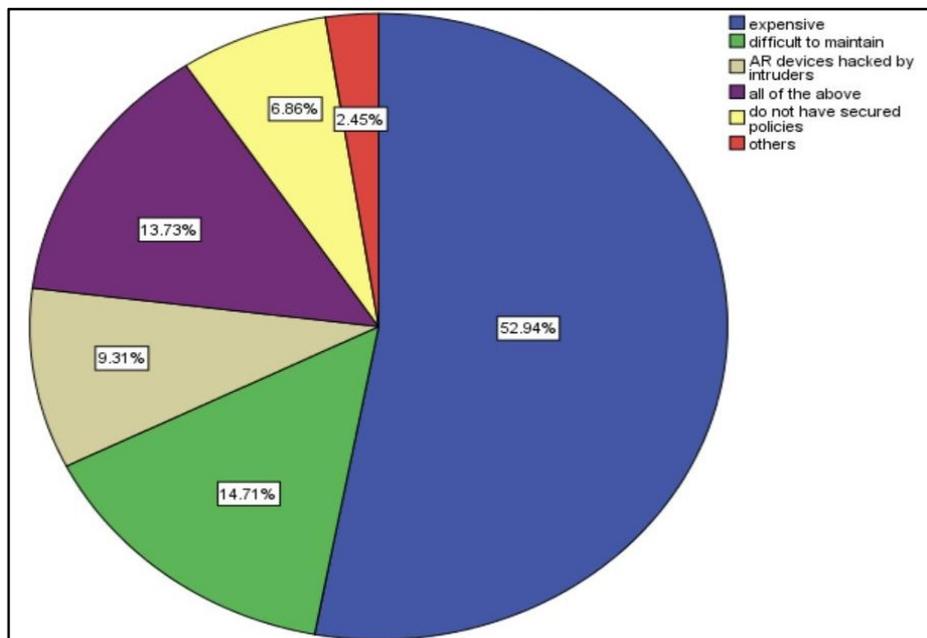
Figure 15: shows the disadvantages of setting up and using augmented reality, as reported by the dental practitioners, which shows 52.94% of dentists consider AR expensive, 14.71% of dentists consider augmented reality difficult to maintain, 9.31% of dentists considered that augmented reality devices are hacked by intruders, 6.86% of dental practitioners say that AR does not have secured policies, 13.73% of dentists consider all the above reasons and 2.45% of dental practitioners consider other reasons as the main disadvantages for not employing the augmented reality in their clinical practices.

Figure 16: shows Chi-square analysis between the gender of dentists (x-axis) and their experience of virtual reality in their clinical practice(y-axis) In which blue color represents yes and green color represents no.
It shows that 42.65% of males have experienced virtual reality whereas 35.78% of males have not experienced virtual reality. It shows that 17.65% of females have experienced virtual reality and 3.92% of females have not experienced VR. There is no significant difference between the male and female dentists in experience of virtual reality.
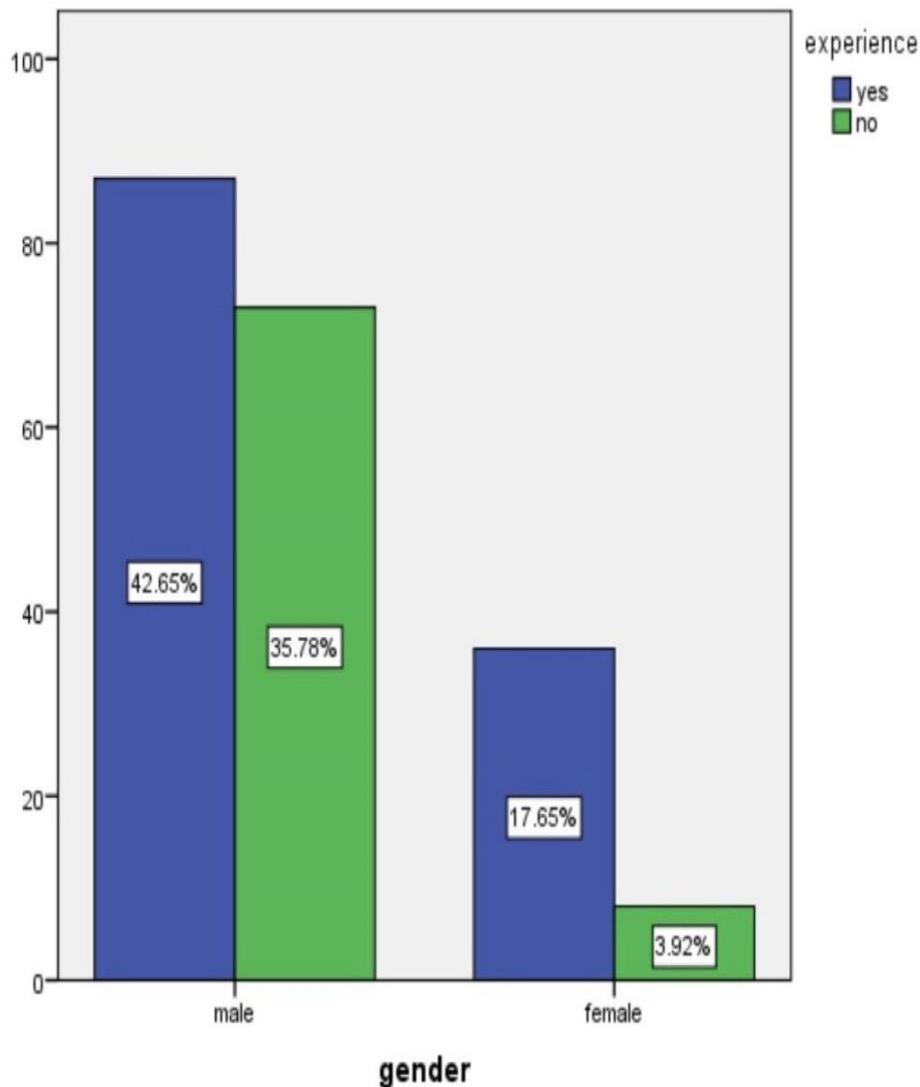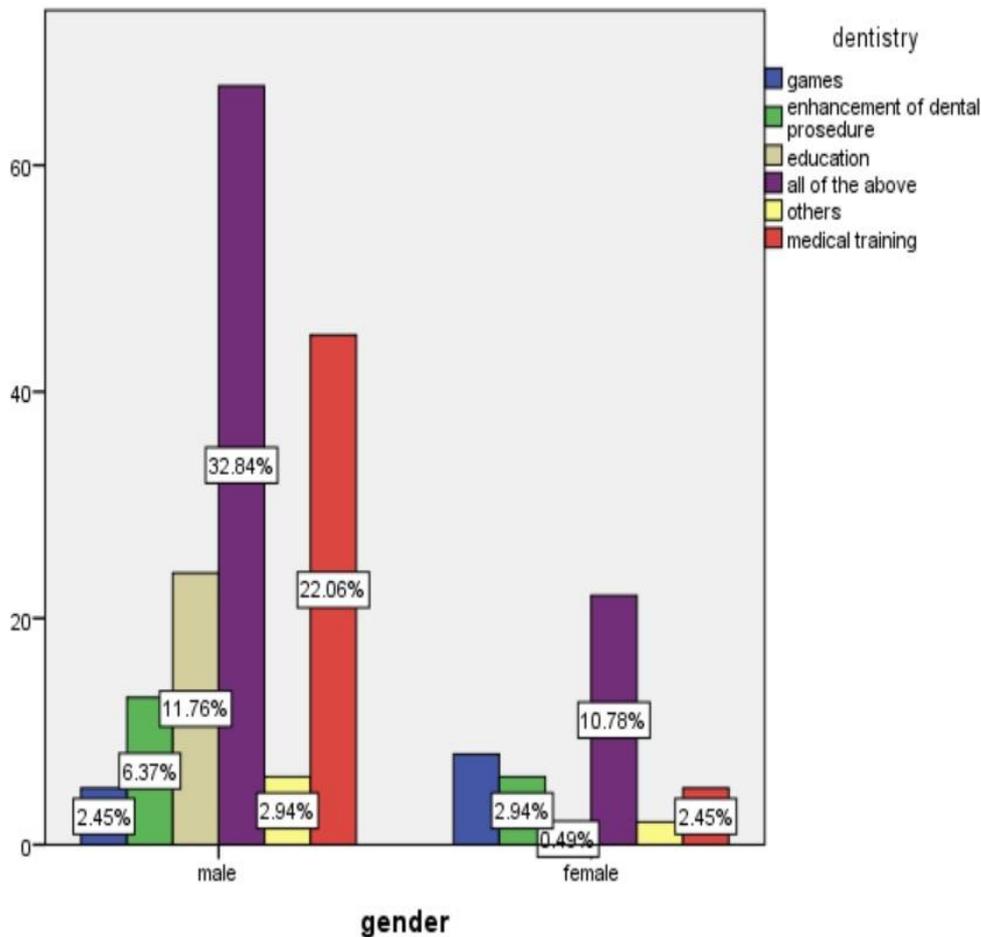*p* value >0.05 (*p* value=0.1)which is statistically insignificant.

Figure 17: shows the chi-square analysis between gender of dentists (X-axis) and their experience of virtual reality in many ways (Y-axis) in which blue color represent games, green color represents an enhancement of dental procedure, brown color represents education, purple color represent all of the above, yellow colors represent others and red color represent medical training.

It shows the experience of virtual reality by males in many ways in which 2.45% have experienced virtual reality in games, 6.37% have experienced it in the enhancement of dental procedure, 11.76% have experienced in education, 32.84% of experienced in all the above ways, 2.94% have experienced in other ways and 22.06% of males and experienced virtual reality in medical training. The experience of virtual reality by females shows that 2.94% of females have experienced virtual reality in the enhancement of dental procedure, 0.49% of experience in education, 10.78% have experienced all of the above ways, and 2.45% of experienced virtual reality in medical training.

There is a significant increase in the experience of virtual reality by male dentists in all the above ways than the female dentists.

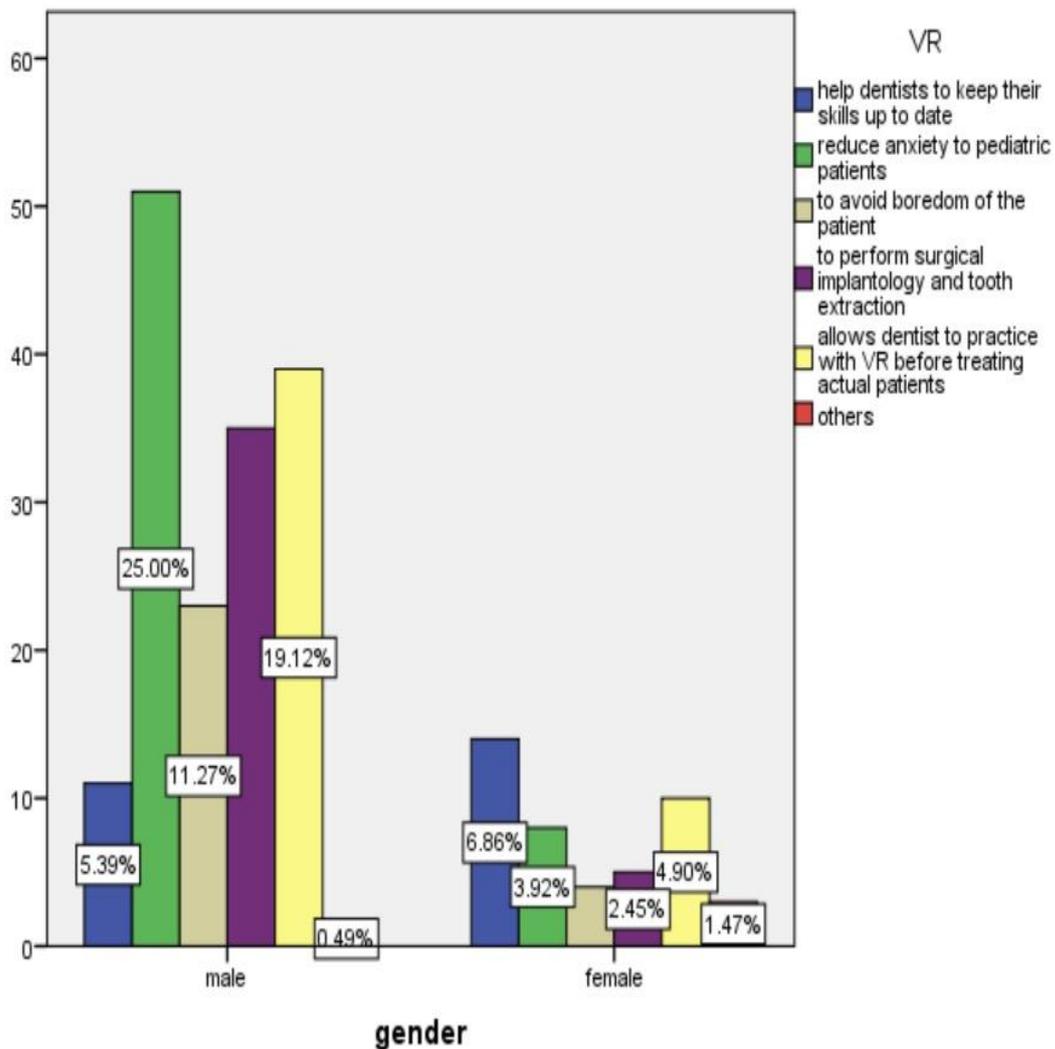*p* value <0.05 (*p* value=0.001)which is statistically significant.

Figure 18: shows the chi-square analysis between the gender of dentists (X-axis) and the Reasons for using VR in dentistry (Y-axis).
It shows the reasons for using virtual reality as given by male dentists which shows that 5.39% says that virtual reality helps a dentist to keep their skills up-to-date, 25% say virtual reality is used to reduce anxiety to pediatric patients, 11.27% of dentist say that virtual reality is used to avoid boredom of the patient, 9.12% say it helps the dentist to allow to practice with virtual reality before treating actual patients, 0.49% of male dentist claim other reasons for using virtual reality. It shows the reasons for using virtual reality as given by female dentist which shows that 6.86% say that virtual reality is used to help the dentist to keep their skills up-to-date, 3.92% dentist says it helps to reduce the anxiety of the paediatric patient, 2.45% of dentist say it helps to perform surgical implantology, 4.90% Dentist say that virtual reality allows the dentist to practice with virtual reality before treating actual patience and 1.47% of female dentist claim other reasons for using VR.
There is a significant increase in the reason given by male dental practitioners for using VR (reduce anxiety to pediatric patients) when compared with female dentists.
p value <0.05 (*p* value=0.001)which is statistically significant.
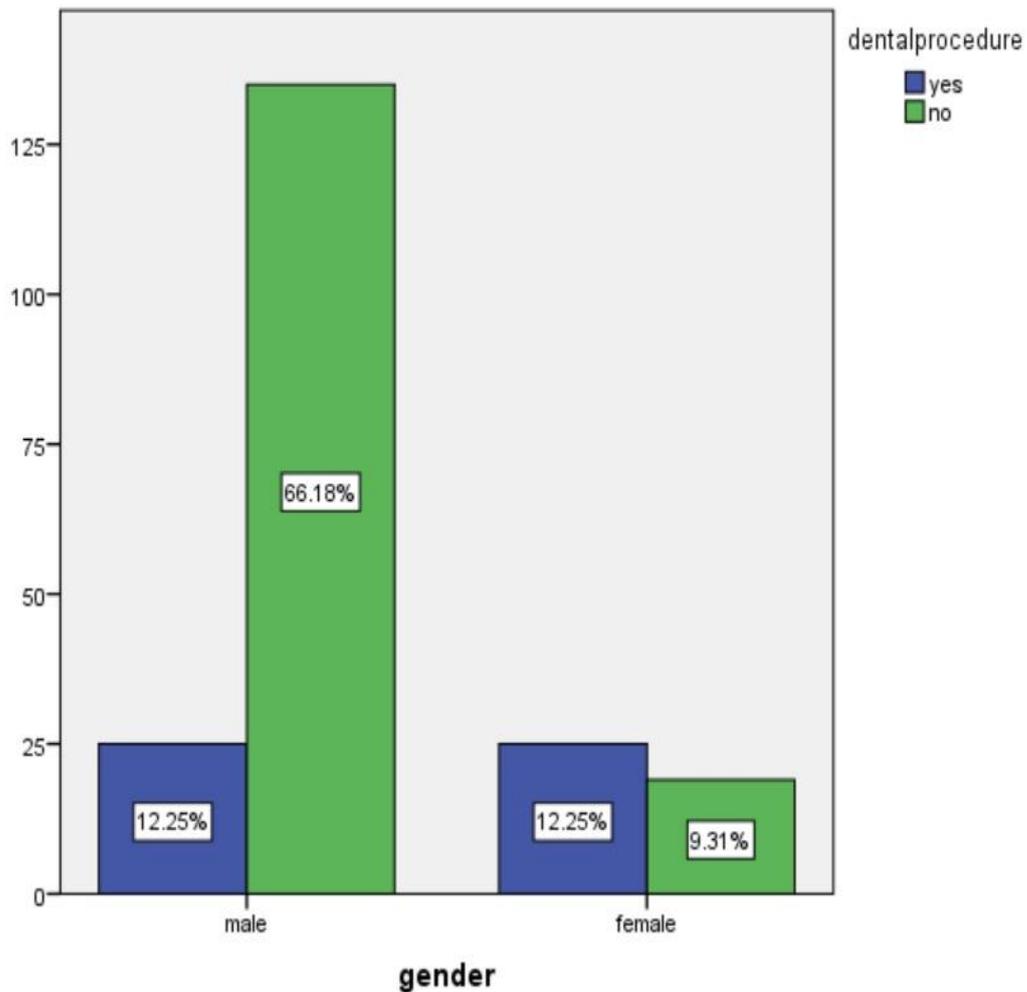
Figure 19: shows the chi-square analysis between the gender of dentists (X-axis) and the Use of VR by dental practitioners in their clinical practice (Y-axis).
The use of virtual reality in the clinical practice of male dentists shows that 12.25% of male dentists use virtual reality in the dental procedure and 66.18% of male dentists do not use virtual reality in their dental procedure. It also shows that 12.25% of dentists use virtual reality in their clinical practice and 9.31% of female dentists do not use virtual reality in their clinical practices.
There is a significant increase in using VR in the clinical practice of male dentists than female dentists.
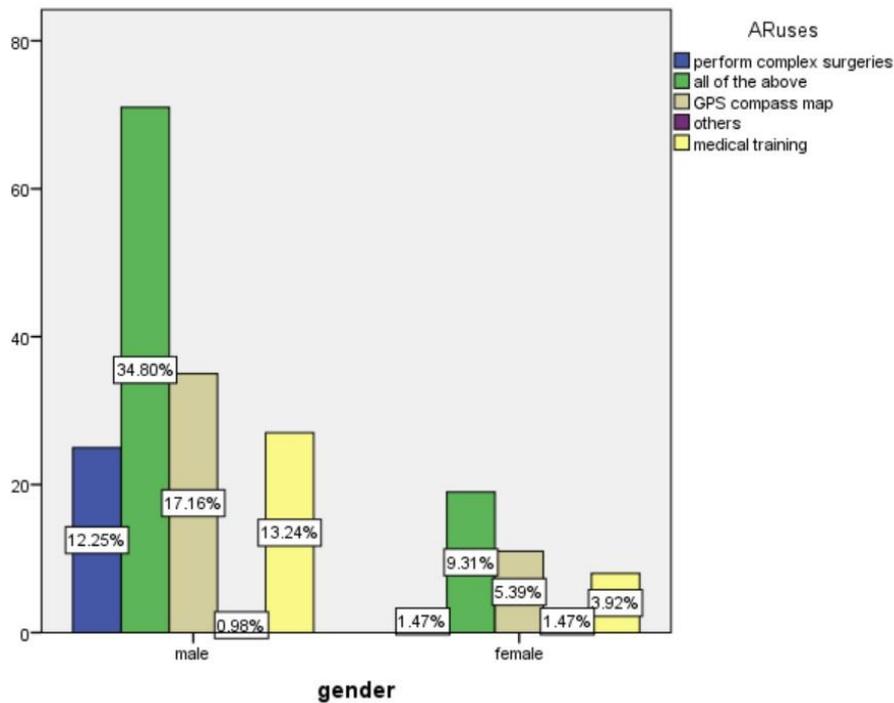*p* value <0.05 (*p* value=0.001)which is statistically significant.

Figure 20 shows the chi-square analysis between gender of dentists(X-axis) and the uses of augmented reality in dentistry (Y-axis) in which blue color denotes perform complex surgeries, green color denotes all the above, brown color denotes GPS compass map, purple color denotes others and yellow color denotes medical training.
It shows the uses of augmented reality as said by male dental practitioners which show that 12.25% say performing complex surgeries, 34.80% claim all the above uses, 17.16% of male dentist GPS campus map, 13.24% of male dentists say medical training as the mean uses of augmented reality. It also shows the uses of augmented reality as said by female dental practitioners which show that 1.47% say performing complex surgeries, 9.31% claim all the above uses, 5.39% GPS campus map as the mean use of augmented reality and 3.92% say medical training as the mean use of AR.
There is a significant increase in claiming the use of AR by male dentists than female dentists.
***p* value >0.05 (*p* value=0.1) which is statistically insignificant.**

A gender comparison between male and female dentists on the experience of virtual reality **(Figure 16)**, the experience of virtual reality in different ways **(Figure 17)**, reasons for using virtual reality in dentistry (figure 18), use of VR in clinical practice **(Figure 19)** and the uses of Augmented reality in dentistry was done using chi-square analysis in SPSS. It was found that the male dentists are using VR in their clinical practice and they are using different ways of VR for different reasons than the female dentists. As shown in **Figure 17, 18, And 19** the P-value for these parameters are also less than 0.05 and found to have a statistically significant difference in VR practice between male and female dentists.

Augmented reality and virtual reality helps not only in planning treatment procedures but also helps in guiding the dentist by playing virtual videos like a cavity preparation of the required class, steps in implant placement,

and other surgical procedures which help the dentist to ease their treatment procedures [17]. The main disadvantage and lack of use of VR and AR by many dental practitioners are that it is of high-cost which is a myth considered by most dental practitioners because there are many cost-efficient brands, which works for a long time and saves time, which is sometimes worth the money [18]. 60% of the dental practitioners, which is most of the dental practitioners are aware of the use and have experienced VR, while 39.5% of dentists, more than one-third of dentists who attended the survey, report that they have not experienced VR, which shows the lack of technology development in the clinical practice of most of the dental practitioners [19]. It also shows that only 24.4% of the dentist, employ VR in their clinical practice while 75.1%, which is the majority of the population do not use VR in the clinical practice, which shows the lack of awareness of dental practitioners about the advantages of creating a virtual world, for the betterment of treatment procedures in dentistry [20-22].

FUTURE PERSPECTIVE

We believe that in the future the VR and AR training and lessons can spread and apply to every department of dentistry to make the student and PG train their skill by

themselves. And because of the complete education and training, surgery would decrease the risk and create a safe surgical environment. And in the surgery, the visible can combine the accurate medical images, tracking system, targeting, registration, and computed even the HMD system or AR, to help the physicians execute the surgery. Depending on the physicians' experience and the complete hardware and software, it would build a trustable relation between the patients and doctors.

LIMITATIONS

Cost-effective application and less sample and so can be done on a large population

CONCLUSION

In the future of dental OSCE, the AR or VR simulators with direct feedback and objective evaluation feature can become an essential device. The development of VR or AR is a good tool for our society. Not only applied to education, but also developed in clinical treatment. This survey gives a better analysis about the knowledge and Awareness of Virtual reality and augmented reality in dentistry gives a clear view to all the dentists to get a clear view about the virtual environment which can be further implemented in a wide range in the dental field, which paves a better way for enhancing dental treatments in future.

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