



Awareness Regarding the Use of Silver Diamine Fluoride in Dentistry - A Survey

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ABSTRACT

Dental caries is a complex progression due to dietary sugars, bacterial metabolism involving demineralization, and organic degradation. Caries are more prevalent among young children which are mostly untreated due to dental anxiety, behavioural changes, and mainly due to expensive treatment. So innovative approaches are needed to treat caries, especially in children. Arresting caries without restoration is possible by silver diamine fluoride (SDF) which is inexpensive topical medication. Silver diamine fluoride (SDF) is used to treat caries and also prevents future caries development. Silver diamine fluoride (SDF) is also used to treat sensitivity. Before silver diamine fluoride (SDF) silver nitrate and silver varnish were used to treat dental caries. Silver diamine fluoride (SDF) consists of silver, fluoride, ammonia, and water. Silver acts as an antimicrobial agent, fluoride as remineralization, and ammonia stabilizes high concentration. The study setting was an online survey. The number of participants involved was 129. A pre-tested questionnaire was circulated. The data was collected and analyzed using SPSS software. 41.9% of the population participated have heard of silver diamine fluoride (SDF), but 34% of the population are not aware of what it is used to treat. 37.2% of the population is also not aware of the method of application. From the studies, the participants are not aware of silver diamine fluoride (SDF), its uses, and its effectiveness. Oral education should be conducted to create awareness among people.



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INTRODUCTION

Dental caries is defined as breakdown or damage to the teeth by acids from bacteria. It can also be due to dietary sugars, snacking, which involves demineralization and organic degradation of the teeth. Collagenous organic matrix is exposed when the dentin surface is demineralized and destroyed by native and bacterial proteases which leads to enlargement of the lesion (Featherstone, 2004). The previous study has shown that oxidative stress can also be the reason for the pathogenesis of diseases (Ezhilarasan, 2018). Caries are more preva-

lent among young children which are mostly in untreated states (Wong *et al.*, 2001). The reason for ignoring the treatment of caries may be dental anxiety, behavioral aspects, and mainly due to expensive treatment. Fluoridated toothpaste is more expensive than non fluoridated, which is difficult for people from lower socioeconomic strata to procure. So innovative approaches are needed to resolve the difficulties faced by the patients. A previous study has shown that arresting caries is possible without restoration (Mäkinen *et al.*, 1996).

Silver diamine fluoride (SDF) is an inexpensive topical medication that is used to arrest carious lesions, prevent future development of caries, and also used to treat sensitivity. There is a recommended dose for the usage of silver diamine fluoride (SDF). For the effective treatment of caries, 38% of silver diamine fluoride (SDF) solution is recommended by saforide, Toyo seiyaku Kasei co Ltd, Osaka, Japan. Before the usage of silver diamine fluoride (SDF), silver nitrate, and fluoride varnish was used to treat caries (Rosenblatt *et al.*, 2009). Silver diamine fluoride (SDF) consists of silver, fluoride, ammonia, and water. Silver, when exposed to the tooth surface, forms silver phosphate (Research and Research, 2019). The topical application of silver forms a squamous layer exposed to dentin and plugs dentinal tubules (Mei *et al.*, 2013). Silver increases resistance to acid dissolution and enzymatic digestion (Mei *et al.*, 2012).

Hydroxyapatite and fluorapatite are formed on the exposed organic matrix, along with the presence of silver chloride and metallic silver. A pathological lesion is characterized by the accumulation of extracellular matrices. Silver directly acts against bacteria by breaking the membranes denaturing proteins and also by inhibiting DNA replication (Klasen, 2000). Silver also inhibits biofilm formation and cavity formation (Knight *et al.*, 2007). Silver is also an antibacterial agent. Silver kills the bacteria. When the killed bacteria is added on to the living bacteria, the silver ion in the killed bacteria is reactivated and it kills the living bacteria. This is termed as a "zombie effect" (Wakshlak *et al.*, 2015). Fluoride penetrates deeper into the tooth and forms a fluoride reservoir. Fluoride initiates remineralization. Fluoride causes fluorapatite formation, which makes the tooth harder and resistant to caries (Burgess and Vaghela, 2018).

Silver and fluoride penetrate ~25 microns in enamel and ~50-200 microns in dentin (Aasenden, 1974). Ammonia is used to stabilize the high concentration of the solution in silver diamine fluoride (Rosenblatt *et al.*, 2009). The method of application is

staining the carious lesion by SDF. Silver diamine fluoride (SDF) increases mineral density and hardness of the teeth and it causes the death of the lesion (Mei *et al.*, 2013). It also inhibits the proteins that break down the exposed dentin organic matrix (Mei *et al.*, 2014b). The proteins are metalloproteinases, cathepsins, and bacterial collagenases. Arrested caries lesions measure 130 microns thick (Mei *et al.*, 2014a). In August 2014, the food and drug administration approved silver diamine fluoride (SDF) usage for sensitivity. The drawbacks of silver diamine fluoride (SDF) are that after treating the caries tooth it turns the lesion darker, from brown to black and the solution has metallic taste (Chu *et al.*, 2002).

The nanoparticle of silver can be used as an alternative for the black lesion. Nanoparticles have specific drug delivery. Nanoparticles are made using less toxic chemicals which reduces toxicity. The advantage is silver diamine (SDF) is a low-cost treatment, and also a large population can be used. There is no need for expensive equipment. It is non-invasive, the spreading of infection is low. It is also a painless treatment for patients with dental anxiety and behavioural aspects. In pharmacokinetics aspects, there is no erythema, bleeding, ulceration, or pigmentation. Previous studies on cancer biology (Perumalsamy *et al.*, 2018; Ashwini *et al.*, 2017; Ezhilarasan *et al.*, 2017a), medicine (Gheena and Ezhilarasan, 2019; Anitha and Ashwini, 2017), nanoparticle technology (Ezhilarasan *et al.*, 2018; Lakshmi *et al.*, 2015; Mehta *et al.*, 2019; Sharma *et al.*, 2019; Ezhilarasan *et al.*, 2017b), by our team has made a platform for this study on awareness about the use of silver diamine fluoride in dentistry (Karthiga *et al.*, 2018; Rajeshkumar *et al.*, 2018b; Menon *et al.*, 2018; Rajeshkumar *et al.*, 2018a).

MATERIALS AND METHODS

The study setting was an online survey. The number of participants involved in the study was 129. The study is created in such a way to create and evaluate awareness about silver diamine fluoride (SDF). The study design was interventional non-controlled design. A set of pretested questionnaires was prepared and circulated. The sampling method was stratified random sampling. The data were collected using a digital survey. The data collected were manipulated in excel. The number of questions asked was 17. The data were analyzed using SPSS software. The statistical analysis used was the chi-square test. The results were verified and tabulated. The method of representation was a bar graph. The

independent variable included is age, occupation, gender. The dependent variables included are silver diamine fluoride (SDF), caries prevention, treat caries, black lesion formation.

RESULTS AND DISCUSSION

Figure 1 represents the gender of the participants, of which 56.6% of the participants were female than male 43.4%. Figure 2 represents occupation of the participants, 58.1% were ug students, 20.2% were pg, 17.8% were doing other works and very few of 3.9% of the participants were practitioners. Figure 3 depicts the data for the question "Whether the participants were aware of silver diamine fluoride or not?" 41.9% were aware of silver diamine fluoride (SDF), 34.9% were not aware and 23.3% of the population had no idea about silver diamine fluoride (SDF). Figure 4 represents the data for the usage of silver diamine fluoride (SDF), 34% report no idea about the usage of silver diamine fluoride (SDF), 24.8% says it is used to treat sensitivity, 22.5% participants report that silver diamine fluoride (SDF) is used to treat both caries and sensitivity. Figure 5 represents the data for the question "Does silver diamine fluoride (SDF) affect the soft dentin?", 43.4% of the population choose to be neutral, 17.8% of the participants strongly disagree with the opinion and 15.5% agree to the question.

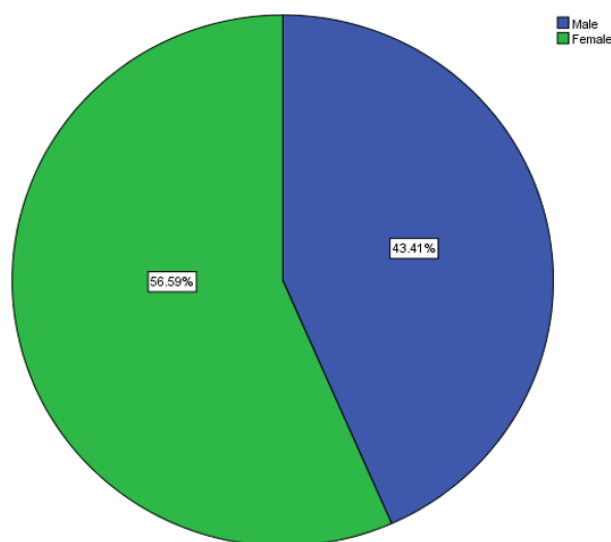


Figure 1: Pie chart representing the percentage distribution for the gender of the participants.

Figure 6 depicts the data for the question "Does silver diamine fluoride (SDF) reduce the risk of general anesthesia?", 35.7% choose to be neutral and 24% disagree with the question and 17.1% agree with the opinion. Figure 7 represents the data for components of silver diamine fluoride (SDF), 41.1% of the population says silver diamine fluoride (SDF) con-

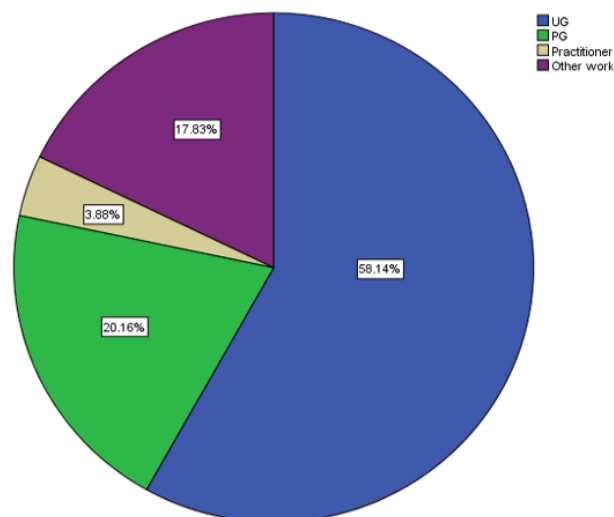


Figure 2: The pie chart representing the percentage distribution of occupation of the participants.

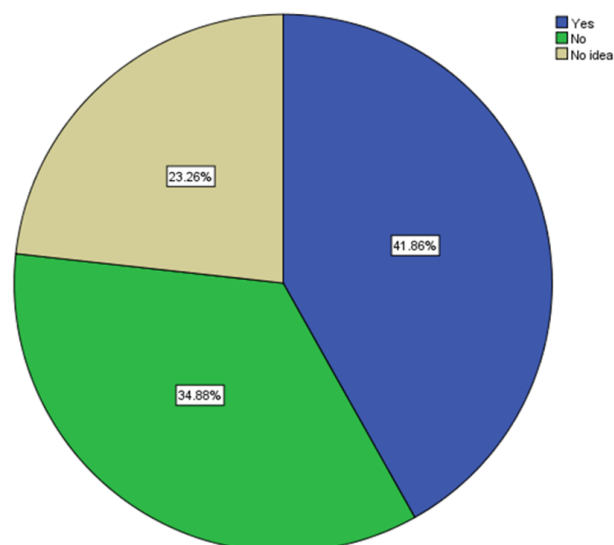


Figure 3: Pie chart depicting the percentage distribution for the question, "Whether the participants were aware of silver diamine fluoride?".

sists of silver, fluoride, and water, 34.1% choose silver, fluoride, water, and ammonia. Figure 8 depicts the data for the role of silver in SDF, 51.9% of the population chose silver as antibacterial, 24% choose they have no idea about the role of silver, 24% report antifungal. Figure 9 represents the recommended usage of silver diamine fluoride (SDF), 46.5% of the population report they have no idea, 24.8% report as 19%, 20.9% report as 38%. Figure 10 represents the data for the question "Does silver diamine fluoride (SDF) be used only for primary dentin?", 39.5% of the population chosen neutral, 20.9% agree to the question, 16.3% strongly disagree with the question.

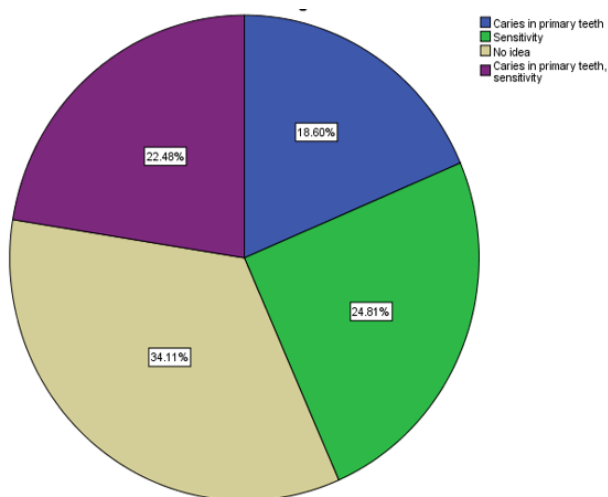


Figure 4: Pie chart representing the percentage distribution for the usage of silver diamine fluoride.

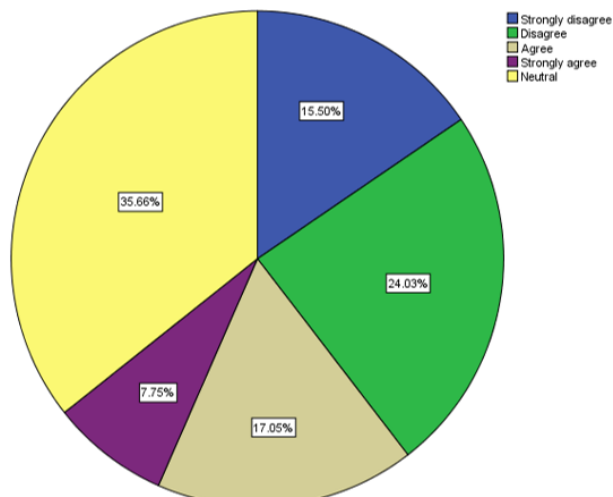


Figure 6: Pie chart depicting the percentage distribution for the question "Whether SDF reduces the risk of general anesthesia?".

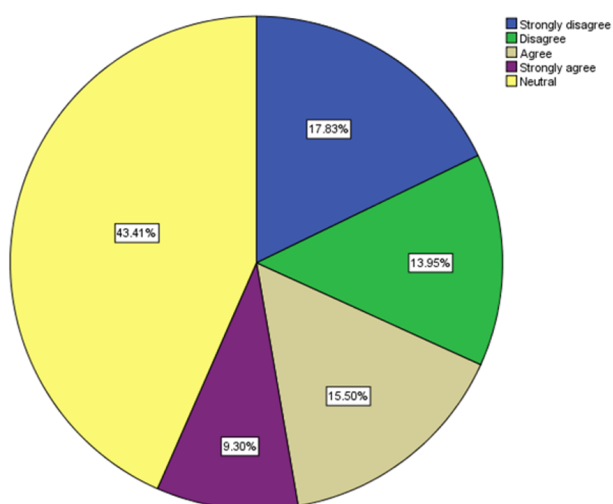


Figure 5: Pie chart representing the percentage distribution for the question "Does SDF affect the soft dentin?".

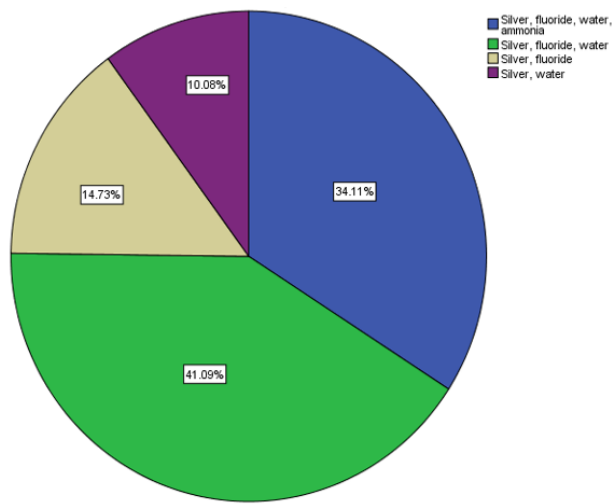


Figure 7: Pie chart representing the percentage distribution for the components of silver diamine fluoride (SDF).

Figure 11 depicts the data for silver diamine fluoride (SDF) causing black lesion, 41.9% chose no idea, 34.1% said 'yes', and 24% not aware. Figure 12 represents data for "Does silver diamine fluoride (SDF) provide a good alternative to other treatments for caries prevention?", 31.8% of the population choose to be neutral, 20.2% agree to the question, 19.4% disagree with the opinion. Figure 13 represents the association data between gender and awareness of SDF using the Chi-square test. Figure 14 represents the association data between gender and the usage of SDF using the Chi-square test. Figure 15 represents the association data between gender and about the role of silver in SDF using the Chi-square test. Figure 16 represents the association data between gender and "whether SDF reduces the risk of general anesthesia?" using the Chi-

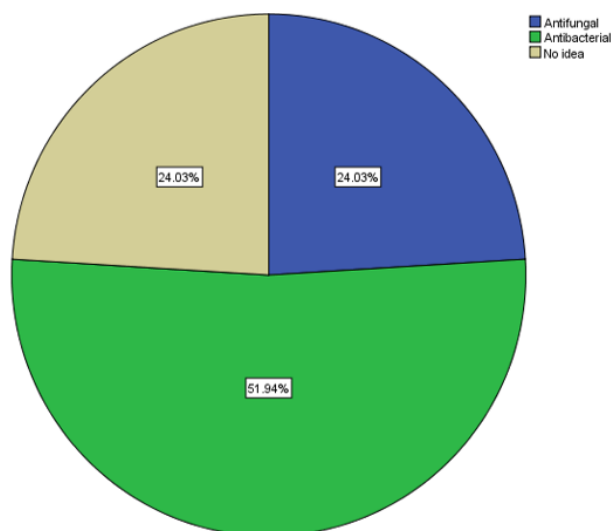


Figure 8: Pie chart depicting the percentage distribution for the role of silver in SDF.

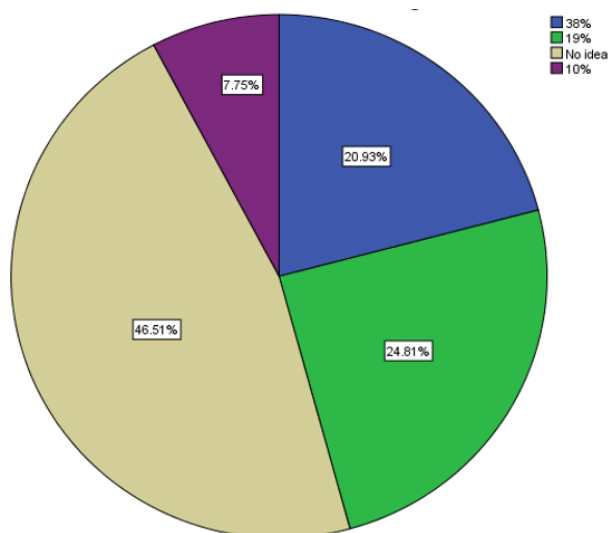


Figure 9: The pie chart representing the percentage distribution for the recommended level of silver diamine fluoride (SDF).

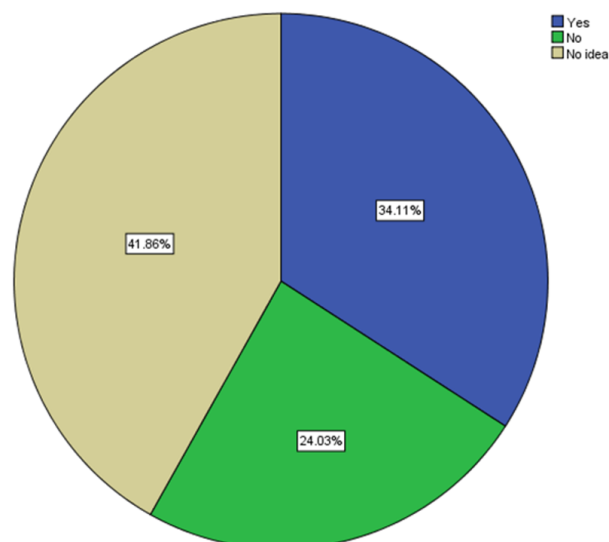


Figure 11: The pie chart representing the percentage distribution for the question, "whether SDF causes black lesion on treated caries teeth?".

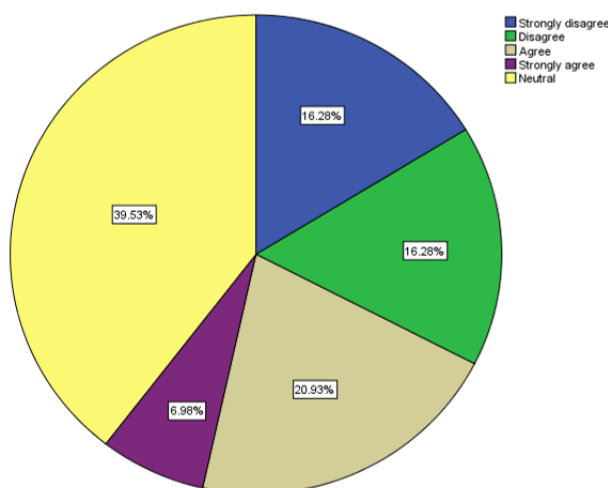


Figure 10: Pie chart depicting the percentage distribution for the question "Is SDF used only for primary dentin?".

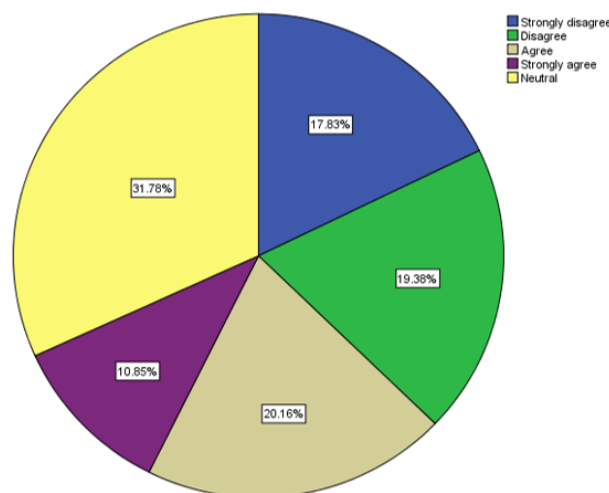


Figure 12: The pie chart depicting the percentage distribution for the question, "Does SDF provide a good alternative to other treatments?".

square test. Figure 17 represents the association data between gender and awareness of SDF causes black lesion using the Chi-square test

In the current study, 41.9% of the population who participated in the study have heard of the silver diamine fluoride (SDF) which is in correlation to the previous study done by Antonioni *et al.* (2019). In this study, 34.1% of the participants were not aware of the usage of silver diamine fluoride (SDF) which means there is a lack of awareness. A previous study also shows that silver diamine fluoride (SDF) is used to treat caries (Zhi *et al.*, 2012). Another study also shows that silver diamine fluoride (SDF) is used to treat sensitivity and prevent caries (Castillo *et al.*, 2011). Previous literature says that the caries teeth are stained by silver diamine

fluoride (SDF) (Gao *et al.*, 2016). In this study, 43.4% of the population choose to be neutral for silver diamine fluoride (SDF) which doesn't affect soft dentin. The study reported that silver diamine fluoride (SDF) prevents caries without harming the soft dentin in children (Kawasaki *et al.*, 2005). In this study, 35.7% of the participants chose to be neutral for SDF reduces the risk of general anesthesia. The previous study has shown that silver diamine fluoride (SDF) reduces the risk of general anesthesia (Nelson *et al.*, 2016). In this current study, people are not aware of their risk factors. In this current study, 46.5% of the population is not aware

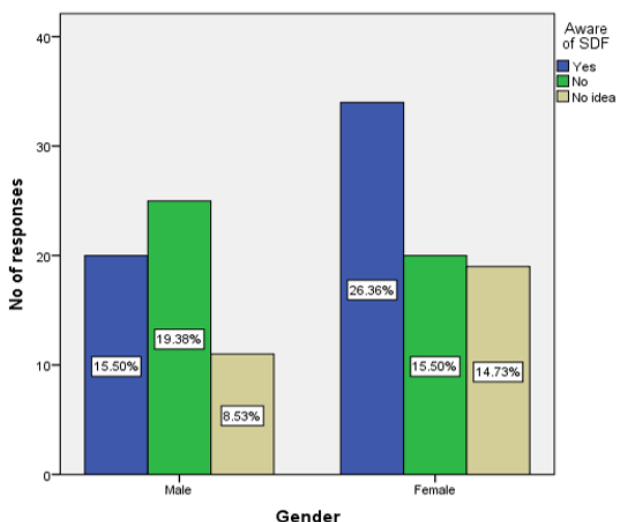


Figure 13: The graph depicts the association between gender and awareness of SDF.

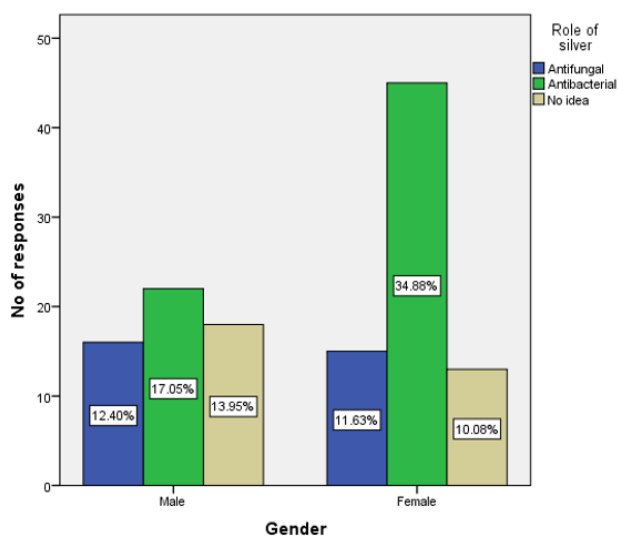


Figure 15: The graph depicts the association between gender and awareness of the role of silver in SDF.

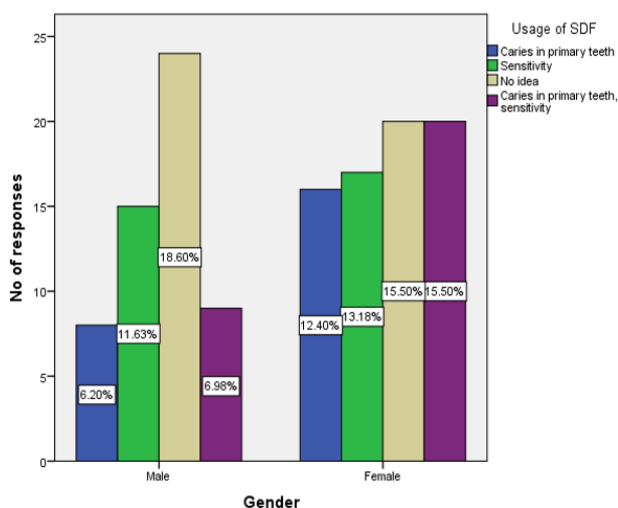


Figure 14: The graph depicts the association between gender and awareness on the usage of SDF.

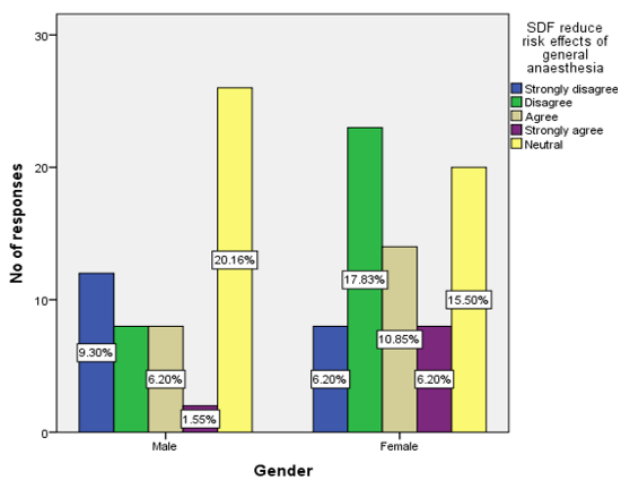


Figure 16: The graph depicts the association between gender and awareness on SDF reduces the risk of general anaesthesia.

of the recommended level of SDF. In the previous study recommended usage of silver diamine fluoride (SDF) is 38%, 12% is less effective (Lo et al., 2001). In this current study, 39.5% of the population chose neutral for SDF is used only for primary dentin. But several studies have shown that silver diamine fluoride (SDF) is used across age, both for deciduous and permanent dentin (Yee et al., 2009). In this study, 41.9% of participants chose no idea about the black lesion caused by SDF after treating the caries teeth.

In Figure 1, 56.6% of the participants were female (green) than male 43.4% (blue). In Figure 2, 58.14% were UG (blue), 20.2% were pg (green), 17.8% were doing other works (purple). In Figure 3, 41.9% were aware of SDF (blue), 34.9% were not aware (green) and 23.3% of the population had no idea (grey) about SDF. In Figure 4, 34.11% report no

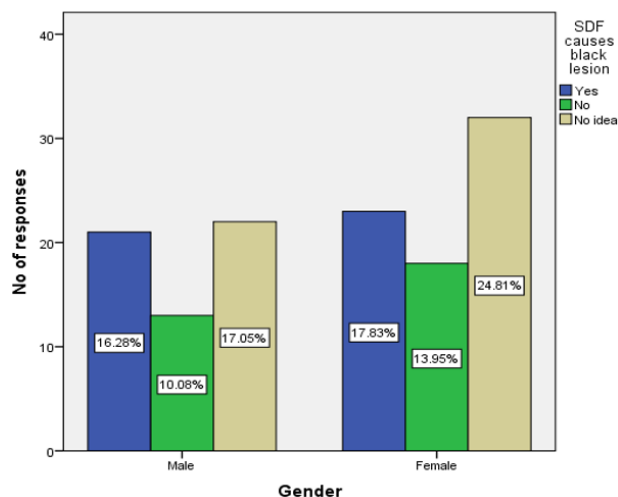


Figure 17: The graph depicts the association between gender and awareness of SDF causes black lesion.

idea (grey), 24.8% says it is used to treat sensitivity (green). 22.5% report that silver diamine fluoride (SDF) is used to treat both caries and sensitivity (purple). In Figure 5, 43.4% of the population choose to be neutral (yellow), 17.8% of the participants strongly disagree (purple) with the opinion and 15.5% agree (grey) to the question. In Figure 6, 35.7% choose to be neutral (yellow) and 24% disagree (green) with the question and 17.1% agree (grey) to the opinion.

In Figure 7, 41.1% of the population says silver diamine fluoride (SDF) consists of silver, fluoride, and water (green), 34.1% choose silver, fluoride, water, and ammonia (blue). In Figure 8, 51.9% of the population choose antibacterial (green), 24% choose they have no idea (grey) about the role, 24% report antifungal (green). In Figure 9, 46.5% of the population report they have no idea (grey), 24.8% report as 19% (green), 20.9% report as 38% (blue). In Figure 10, 39.5% of the population chose neutral (yellow), 20.9% agree (grey) to the question, 16.3% strongly disagree (green).

In Figure 11, 41.9% chose no idea (grey), 34.1% said 'yes' (blue), and 24% not aware (green) that SDF can cause a black lesion. In Figure 12, 31.8% of the population choose to be neutral (yellow) for SDF is a good alternative treatment, 20.2% agree to the question (grey), 19.4% disagree (green) with the opinion. In Figure 13, the X-axis represents the gender of the participants and the Y-axis represents the number of responses. Blue color denotes 'yes', green denotes 'no', grey denotes 'no idea'. Females had better awareness of SDF than males. A Chi-square test was done to find the association between gender and awareness of SDF and was found to be statistically not significant. Pearson chi-square value- 4.15 $p = 0.12$ (>0.05) hence statistically not significant.

In Figure 14, X-axis represents the gender of the participants and the Y-axis represents the number of responses. Blue color denotes 'caries in primary teeth', green denotes 'sensitivity', grey denotes 'no idea', purple denotes 'Both caries in primary teeth and sensitivity'. Females had better awareness of the usage of SDF than males. A Chi-square test was done to find the association between gender and awareness on usage of SDF and was found to be statistically not significant. Pearson chi-square value- 5.17 $p = 0.15$ (>0.05) hence statistically not significant.

In Figure 15, X-axis represents the gender of the population and the Y-axis represents the number of responses. Blue colors denote 'antifungal', green denotes 'antibacterial' and grey denotes 'no idea'. Females had better awareness of the role of silver

than males. A Chi-square test was done to find the association between gender and awareness of the role of silver and was found to be statistically significant. Pearson chi-square value- 6.60 $p = 0.03$ (<0.05) hence statistically significant.

In Figure 16, X-axis represents the gender of the participants and the Y-axis represents the number of responses. Blue color denotes 'strongly disagree', green denotes 'disagree', grey denotes 'agree', purple denotes 'strongly agree' and yellow denotes 'neutral'. Males had better awareness of SDF reducing the risk of general anesthesia than females. A Chi-square test was done to find the association between gender and awareness on SDF reduces the risk of anesthesia and was found to be statistically significant. Pearson chi-square value- 12.04 $p = 0.01$ (<0.05) hence statistically significant. In Figure 17, X-axis represents the gender of the participants and the Y-axis represents the number of responses. Blue color denotes 'yes', green denotes 'no', grey denotes 'no idea'. Males had better awareness that SDF causes black lesions than females. A Chi-square test was done to find the association between gender and awareness on SDF causes black lesion and was found to be statistically not significant. Pearson chi-square value- 0.51 $p = 0.77$ (>0.05) hence statistically not significant.

Limitations

Since it is a cross-sectional study and it is an online survey it is reliable. Quantitative data is decreased. The sample size of this study is less and the data are less reliable.

CONCLUSION

This study concludes that the majority of the population who participated in the study are not aware of silver diamine fluoride (SDF). Despite the disadvantage of turning the carious lesion into black. The advantages are silver diamine fluoride (SDF) is an inexpensive, good alternative treatment without involving expensive equipment, where a large population can be covered. Further studies can be done to overcome the disadvantage. This survey helps to assess oral education to the people who are not aware of silver diamine fluoride.

Conflict of interest

The authors declare that they have no conflict of interest for this study.

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The authors declare that they have no funding support for this study.

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