Various Age Estimation Methods Commonly Used In India Among Medical And Dental Experts

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Abstract
Introduction: Forensic age estimation is an expertise in the forensic odontology field which aims to show the most accurate way to find the chronological age of an individual. Age estimation from dental and skeletal remains is of interest to forensic experts to identify an unknown person's age. Radiography is the most commonly and easily available method to determine the age of an individual.
Aim: The aim of the study was to know the various age estimation methods commonly used in India among Medical and Dental Experts.
Materials and Methods: Self evaluated questionnaire was prepared based on the different dental age estimation methods and distributed through an online survey link. The study population included Medical and Dental experts. The collected data were statistically analysed using SPSS software for further results and discussion.
Results and Discussion: In this study, 75.9% of the population responded that scoring method was the preferred method for estimating the age for children and 94.4% of the population responded that Gustafson method is reliable in estimating the age of adults. In a previous study, it was mentioned that demirjian method and gustafson method were the most used methods for age estimation and yielded positive results.
Conclusion: The present study concludes that Nolla method and Gustafson's method were the most used age estimation methods for children and adults respectively.

Keywords: Age estimation; innovative technique; methods; medical; dental experts

Introduction

Forensic age estimation is an expertise in forensic odontology which aims to show the most accurate way the chronological age of an individual. Age estimation from dental and skeletal remains is of interest to forensic experts to identify an unknown person's age. Radiography is the most common and widely spread method to determine the age of the majority of individuals. Estimation of age from dental remains is feasible through a widespread understanding of the relationship between the process and chronological measures. Age estimation can be performed by evaluating the pattern of dental development (1). Adult age indicates a reflection in degenerative changes that occur with advancing age. It is necessary to note that chronological age and biological age are not exactly correlated because the skeletal aging process is highly variable between individuals. Skeletal age estimation is a transformative process, where the forensic expert must change the descriptive skeletal age points and indicators into a chronological age. Age estimation may be determined by knowledge of biological parameters. For instance, development in females occurs earlier than in males. Teeth formation is one of the widely used parameters to assess maturity and to predict an individual's age (2). Teeth undergo age-related morphological and biochemical changes. There are high levels of variations in each and every method of age estimation for children (3). Software is developed to establish correlation between the chronological and biological age of an individual (4). Morphological changes such as attrition, secondary dentin deposition, gingival recession, cementum apposition, root resorption, dentin translucency, and color act as parameters in age estimation. The most frequently considered parameters have been dentin translucency and secondary dentin deposition (5). There are many methods to estimate the age of an individual for children and adults.
The idea for this survey originated from the current interest in our community. There is a need to understand the commonly used age estimation methods from every individual point of view to enable novel innovations The aim of the study was to know various age estimation methods commonly used in India among Medical and Dental Experts.

Materials and methods

A survey was conducted among professionals in the medical and dental fields to assess their knowledge and awareness of various age estimation methods. The study employed a **self-administered questionnaire**, designed to collect relevant data efficiently. This questionnaire consisted of **close-ended questions**, ensuring structured responses that could be statistically analyzed.

The questionnaire was distributed via an **online survey link**, allowing for wider participation and convenience in data collection. In addition to questions related to age estimation methods, the survey also included **demographic details** of the participants, such as their age, gender, educational qualification, and years of professional experience.

For statistical analysis, **SPSS software** was utilized to process and interpret the collected data. One of the key statistical tests applied was the **Pearson chi-square test**, which was used to determine whether there was a significant correlation between the participants' **years of experience** and their **level of knowledge regarding different age estimation methods**.

The results were visually represented through **pie charts** and **bar diagrams**, providing a clear and comprehensive overview of the findings. Pie charts were primarily used to depict categorical distributions, while bar diagrams illustrated comparative data trends, making it easier to interpret the relationship between experience and knowledge levels.

Results

The findings of our study provided insightful data regarding the knowledge, preference, and perceived reliability of various age estimation methods among medical and dental professionals. The results were analyzed statistically and represented using graphical illustrations such as pie charts and bar diagrams. The study sample predominantly comprised female participants (68.52%), while male participants accounted for 31.48% (Figure 1). This distribution highlights the gender composition of the surveyed professionals. In terms of experience, 37.04% of the participants had more than 5 years of professional experience (Figure 2), indicating a substantial proportion of experienced professionals in the field. 66.67% of the participants reported using radiographic examinations as a primary tool for age estimation (Figure 3). This suggests a strong reliance on imaging techniques due to their non-invasive nature and widespread clinical applicability.93% of the participants preferred to use the scoring method regularly for age estimation (Figure 4), possibly due to its structured approach and ease of application.

Additionally, 73.15% of the participants found the scoring method easy to use (Figure 5), reinforcing its popularity and efficiency in clinical and forensic settings. When comparing age estimation techniques, 50% of the participants favored the scoring method, while the other 50% preferred the atlas method (Figure 6). This equal distribution suggests that both methods are widely accepted, depending on the practitioner's preference and the specific case requirements.

Among the various radiographic-based techniques, 41.67% of the participants reported a preference for the Nolla method (Figure 7). The Nolla method is commonly used for dental age estimation as it provides a systematic assessment of tooth development. 50.93% of the participants believed that the Demirjian method yields more accurate results (Figure 8). This method is known for its reliability and is widely utilized in both forensic and clinical age estimation practices.

In terms of the Gustafson method, which is often applied in forensic age estimation, 94.44% of the participants considered it a reliable method (Figure 9). The Gustafson method assesses dental attrition, cementum apposition, and secondary dentin formation to estimate age. A significant 95.37% of the participants agreed that molecular methods aid in age estimation (Figure 10). This high percentage reflects the growing recognition of molecular biology techniques in forensic and medical research. Among molecular methods, 85.19% of the participants identified telomere shortening as the most reliable molecular indicator for age estimation (Figure 11). Telomere length is known to decrease with age, making it a valuable biomarker in forensic investigations. Additionally, 96.30% of the participants acknowledged that aspartic acid racemization is helpful in determining an individual's age (Figure 12). This method is based on the gradual conversion of L-aspartic acid to D-aspartic acid in teeth over time, making it a reliable age estimation tool. When asked about the accuracy of dental age estimation methods, 69.44% of the participants believed that these methods have more than 50% accuracy in determining an individual's actual age (Figure 13). This suggests a strong confidence in dental age estimation techniques as valuable tools in forensic and clinical applications.

The survey results indicate that professionals in the medical and dental fields rely on a combination of radiographic, scoring, and molecular methods for age estimation. The Demirjian and Gustafson methods were perceived as highly reliable, while molecular techniques such as telomere shortening and aspartic acid racemization were widely recognized for their accuracy. The study underscores the importance of integrating various age estimation techniques to enhance precision in forensic and clinical dentistry.

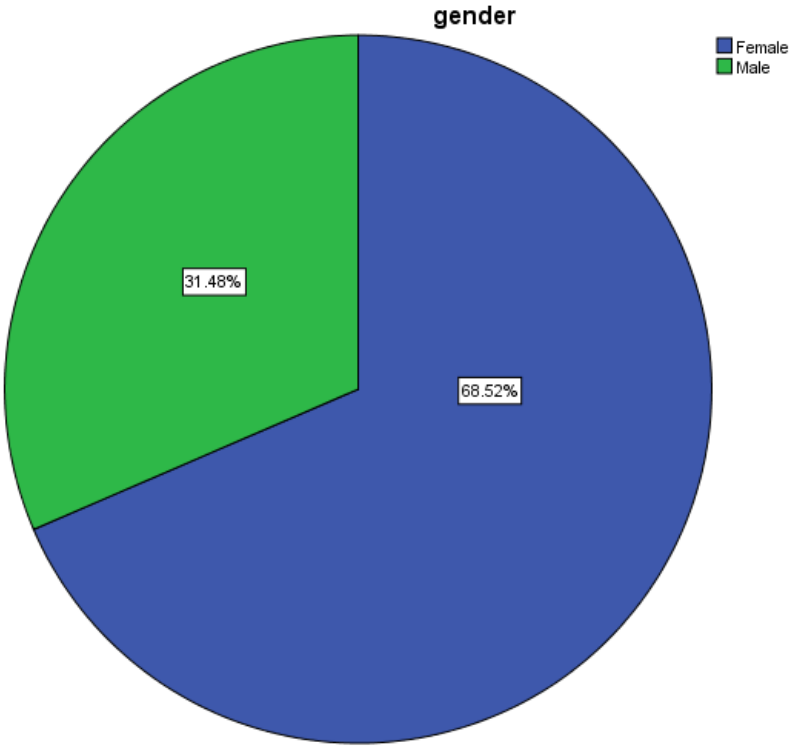

Figure-1: Pie chart showing the responses for gender of participants where blue denotes female and green denotes male. 68.52% of the participants were female and 31.48% were male. Majority of the participants were female.

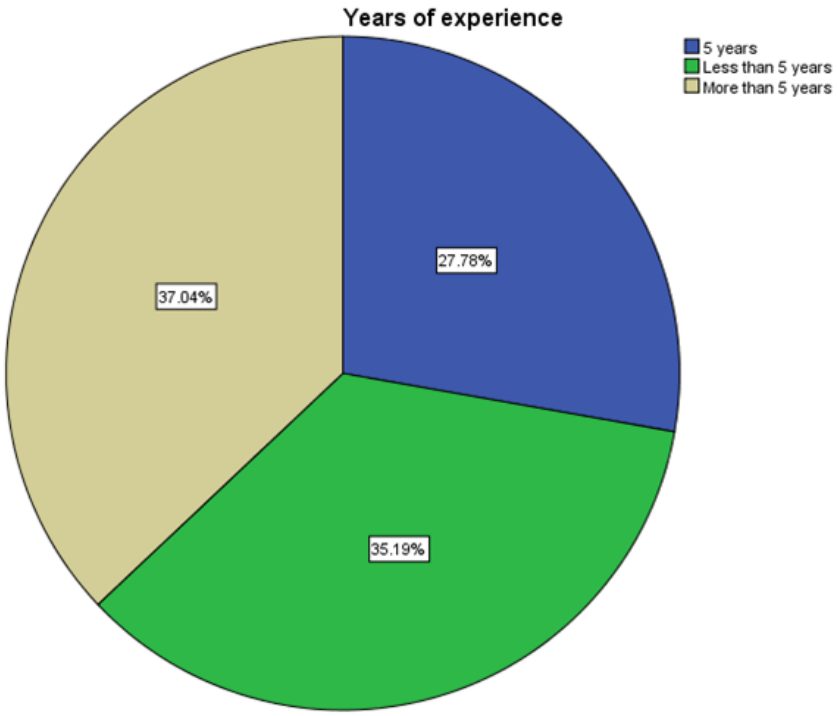

Figure-2: Pie chart showing the responses for years of experience of participants where blue denotes 5 years, green denotes less than 5 years. 35.19% of the participants had less than 5 years experience, 27.78% had 5 years experience and 37.04% had more than 5 years experience. Majority of the participants had more than 5 years of experience.

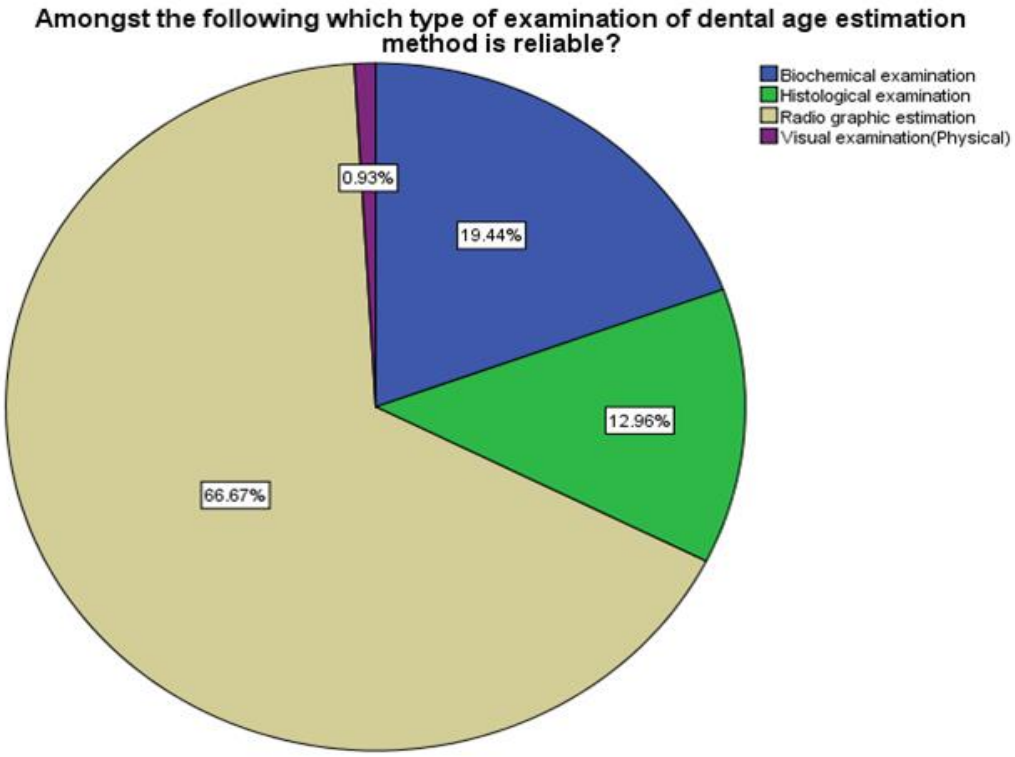

Figure-3: Pie chart showing the responses for reliable type of examination of dental age estimation where blue denotes biochemical examination, green denotes histological examination, beige denotes radiographic examination and purple denotes visual examination. 66.67% of the participants responded to radiographic examinations. 19.44% and 12.96% responded that biochemical and histological examinations are more reliable in dental age estimation respectively. Remaining 0.93% responded that visual examination is more reliable. Majority of the participants felt radiographic examination is more reliable.

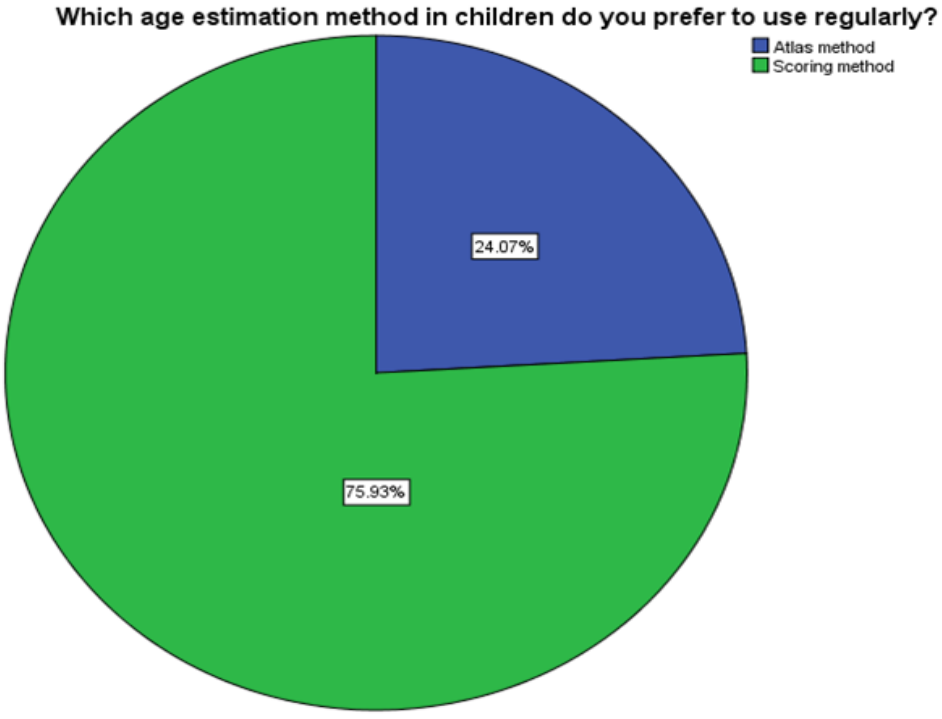

Figure-4: Pie chart showing the responses for the age estimation they prefer to use regularly where blue denotes atlas method and green denotes scoring method. 75.93% responded to the scoring

method and 24.07% responded to the atlas method. Majority of the participants preferred scoring methods regularly.

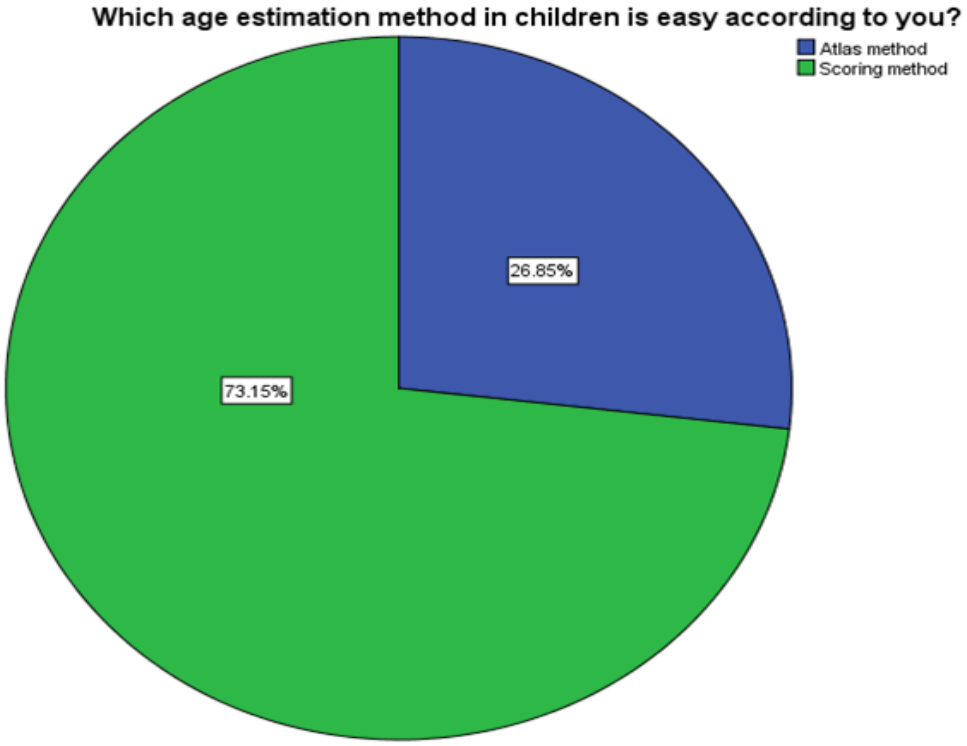

Figure-5: Pie chart showing the responses for easier age estimation method in children where blue denotes atlas method and green denotes scoring method. 73.15% responded that the scoring method is easy and 26.85% responded that the atlas method. Majority of the participants felt that the scoring method was easy in age estimation of children.

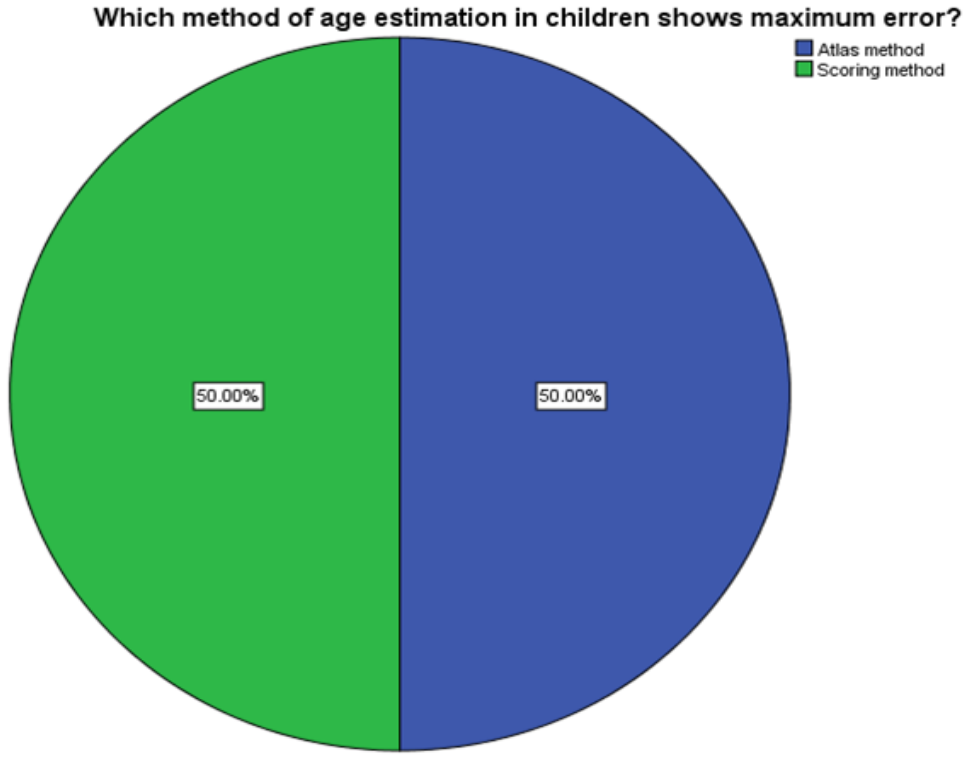

Figure-6: Pie chart showing the responses for the age estimation method which shows maximum error where blue denotes atlas method and green denotes scoring method. 50% of the participants responded as a scoring method and 50% of the participants responded as an atlas method.

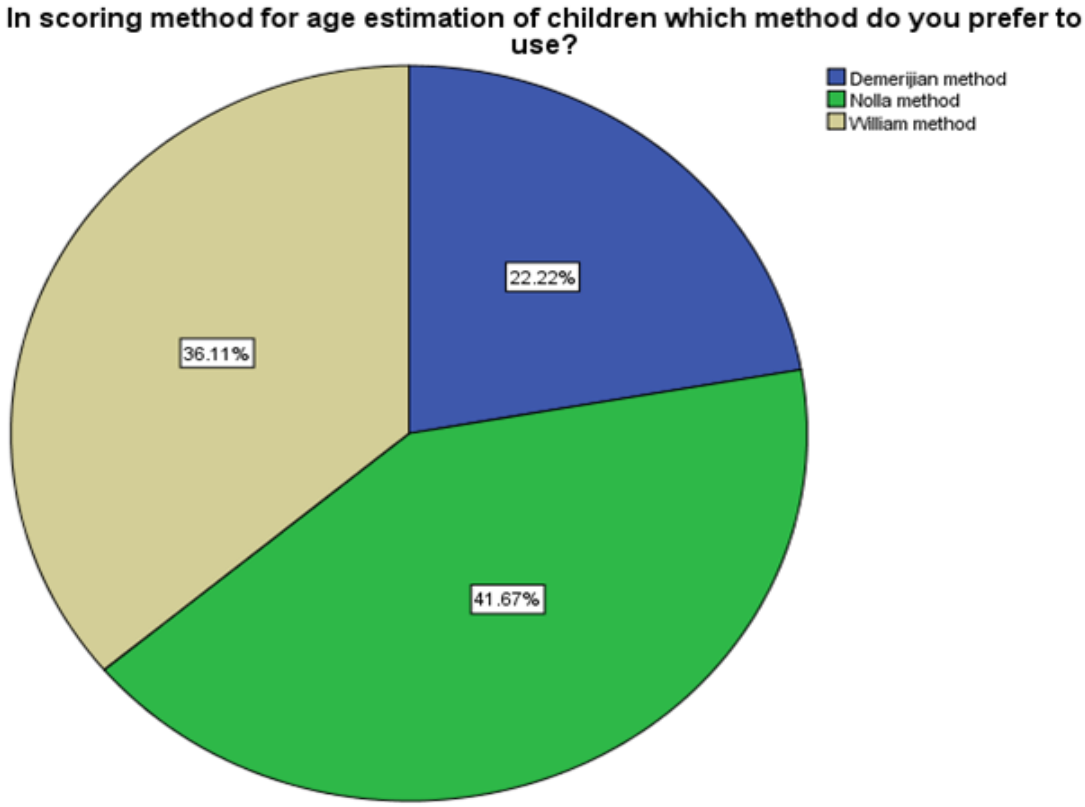

Figure-7: Pie chart showing the responses for preference for type of scoring method of age estimation in children where blue denotes demirjian method, green denotes nolla method and beige denotes william method. 41.67% responded that the nolla method, 36.11% responded William method and 22.22% responded demirjian method. Majority of the participants prefer the nolla method.

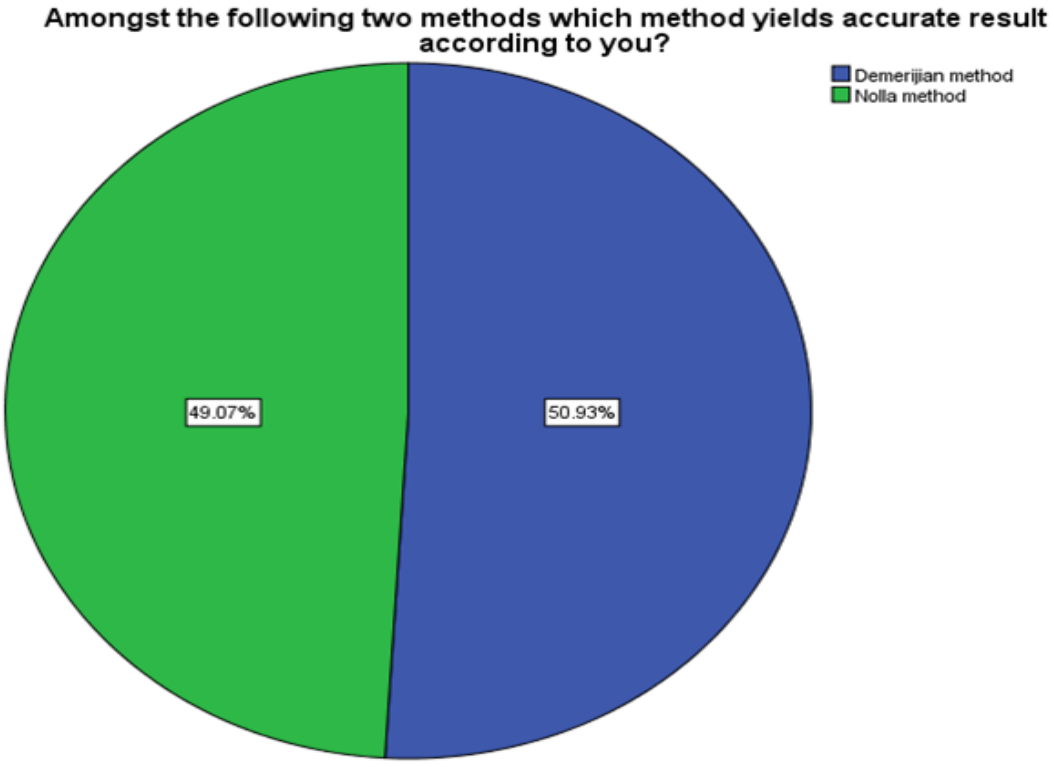

Figure-8: Pie chart showing the responses for age estimation method which yields more accurate results where blue denotes demirjian method and green denotes nolla method 49.07% and 50.93% of the population responded that nolla method and demirjian method respectively. Majority of the participants felt that the demirjian method yielded more accurate results.

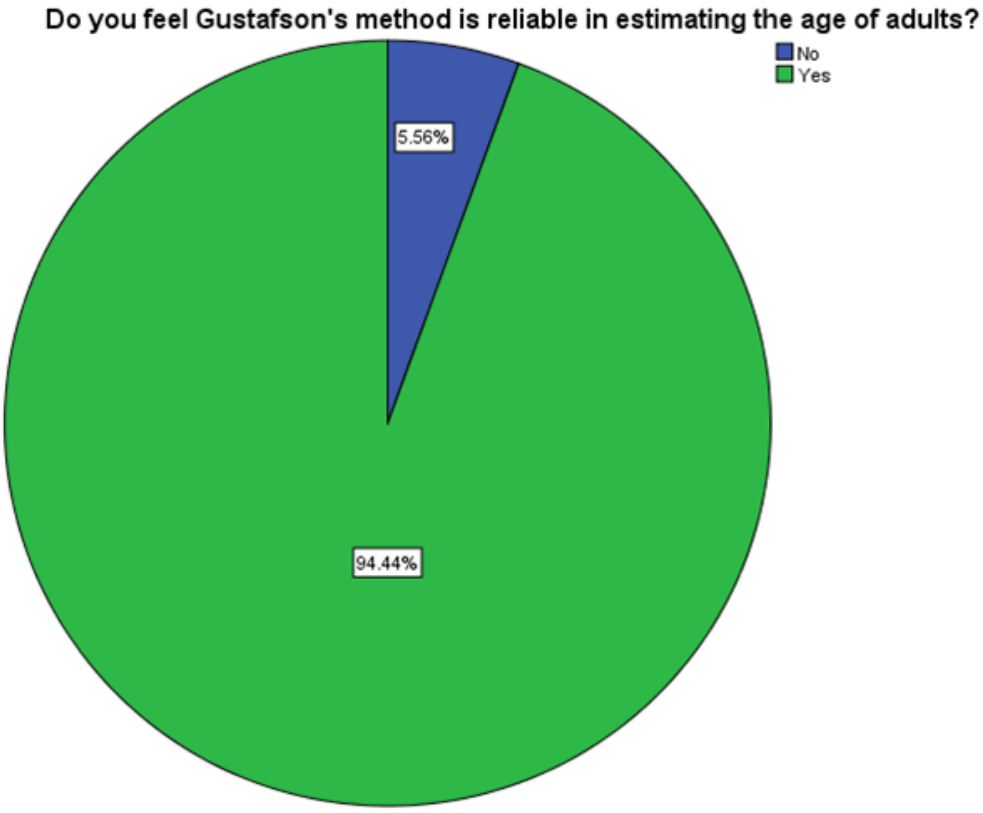

Figure-9: Pie chart showing the responses for reliability of Gustafson method where blue denotes no and green denotes yes. 94.44% of the participants responded yes and remaining 5.56% of the participants responded no. Majority of the participants felt that the gustafson method is reliable.

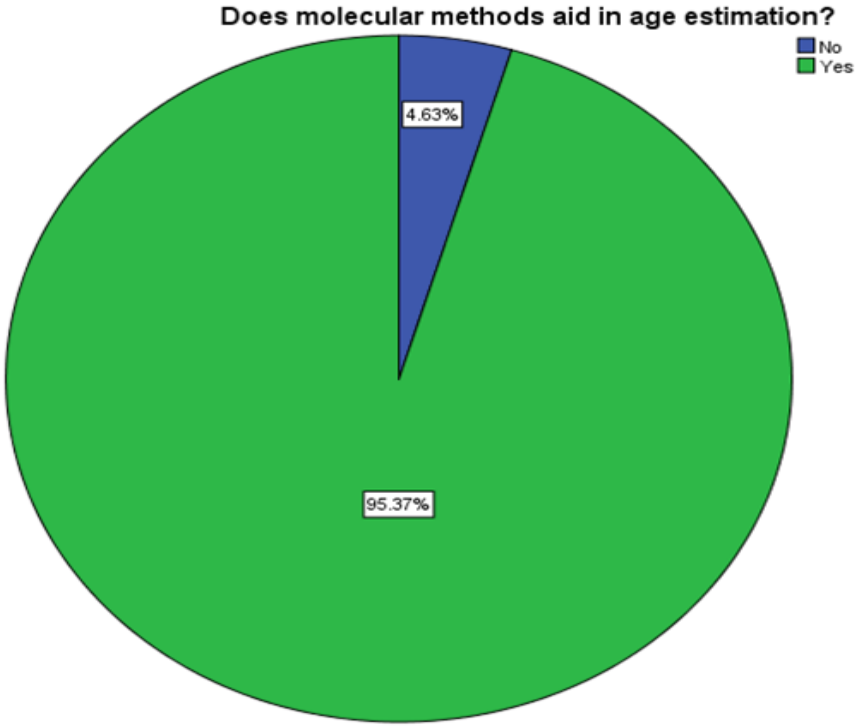

Figure-10: Pie chart showing the responses for molecular method in age estimation where blue denotes no and green denotes yes. 95.37% of the participants responded yes and the remaining 4.63% of the participants answered no. Majority of the participants felt that molecular methods aid in age estimation.

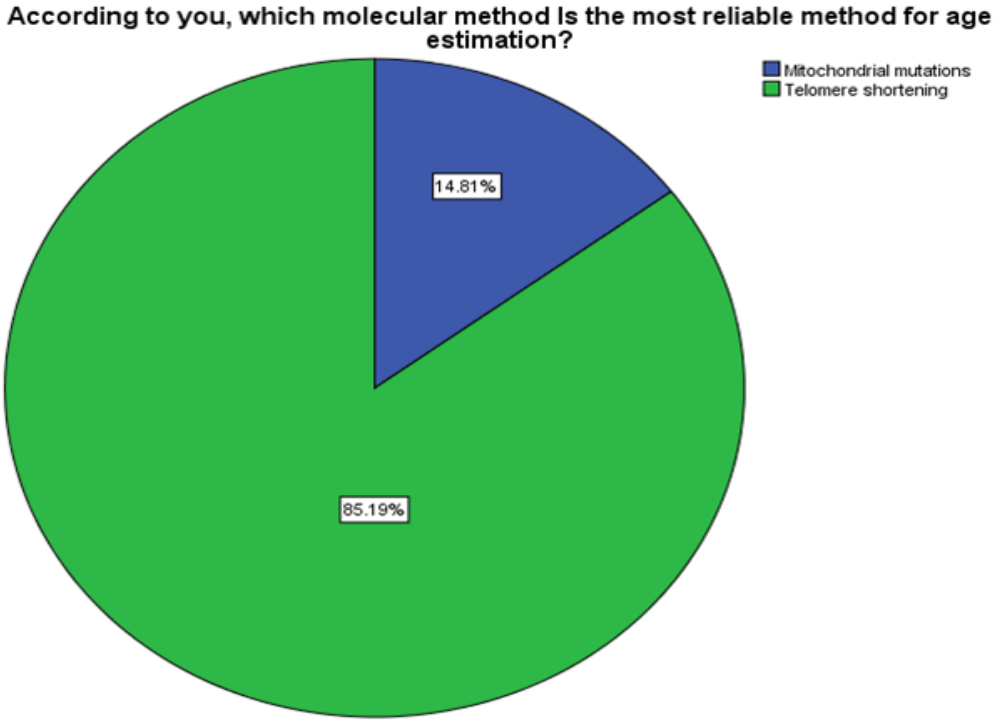

Figure-11: Pie chart showing the responses for most reliable molecular method in age estimation where blue denotes mitochondrial mutations and green denotes telomere shortening. 85.19% of the

participants responded telomere shortening and 14.81% responded that mitochondrial mutation. Majority of the participants felt that telomere shortening was the most reliable molecular method in age estimation.

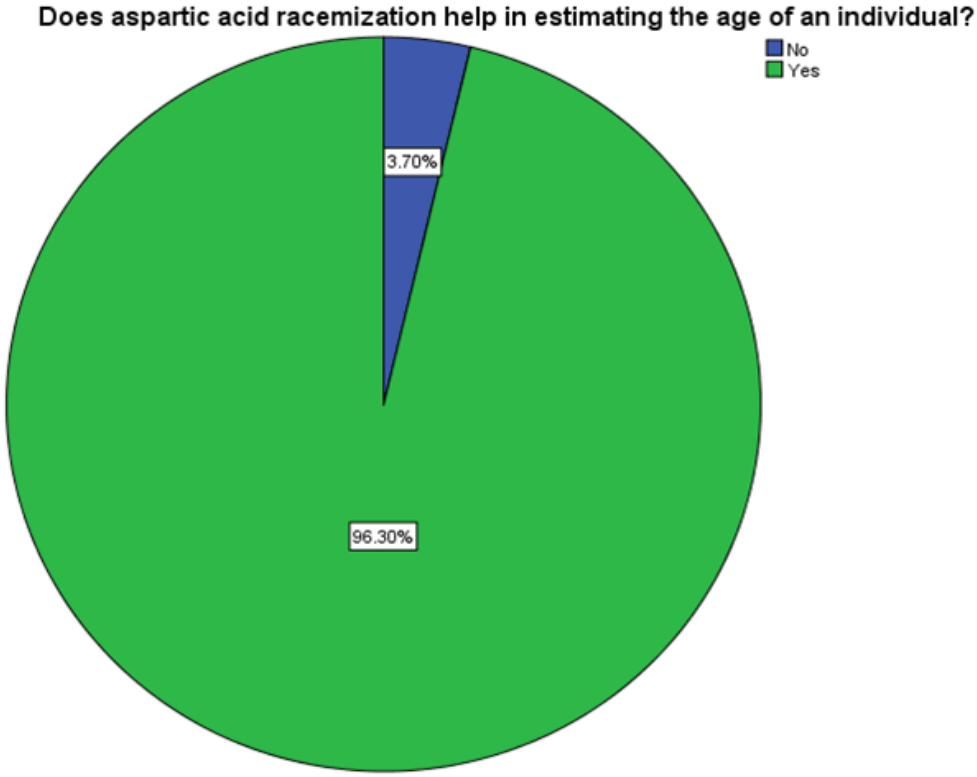

Figure-12: Pie chart showing the responses for aspartic acid racemization where blue denotes no and green denotes yes. 96.30% of the participants responded yes and 3.70% responded no. Majority of the participants responded that aspartic acid racemization helps in estimating the age of an individual.

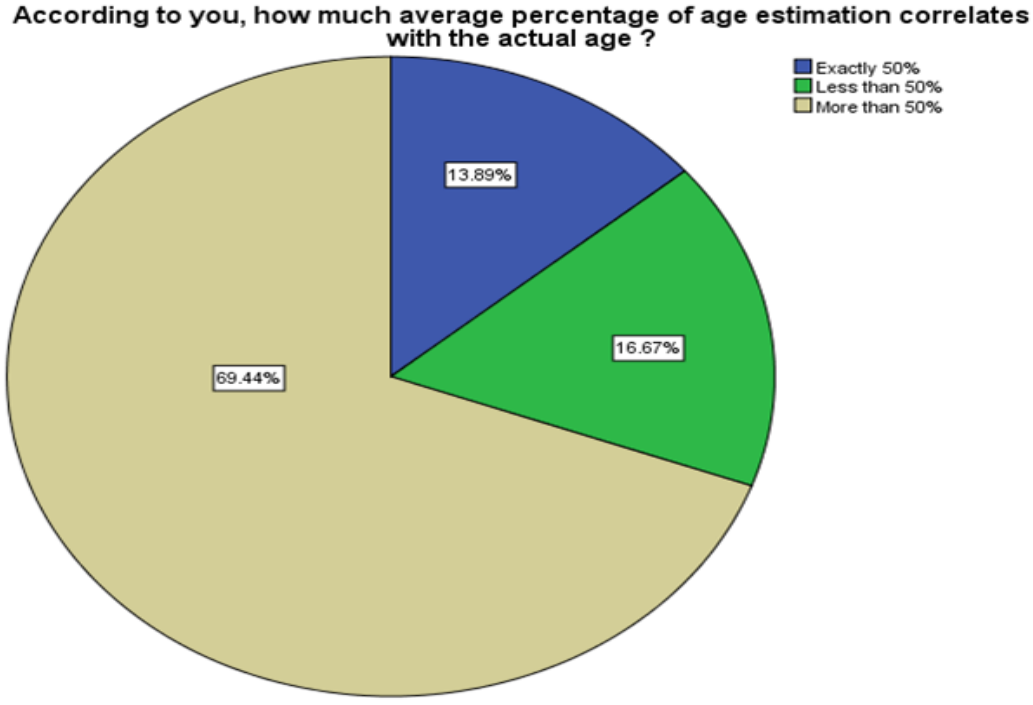

Figure-13: Pie chart showing the responses for average percentage of accuracy of chronological age and age determined through age estimation methods where blue denotes exactly 50%, green denotes

less than 50% and beige denotes more than 50%. 69.44% of the participants responded more than 50% of accuracy, 13.89% answered exactly 50% and 16.67% answered less than 50% correlation with the actual age. Majority of the participants responded that age determined through dental age estimation methods has more than 50% of accuracy with the actual age.

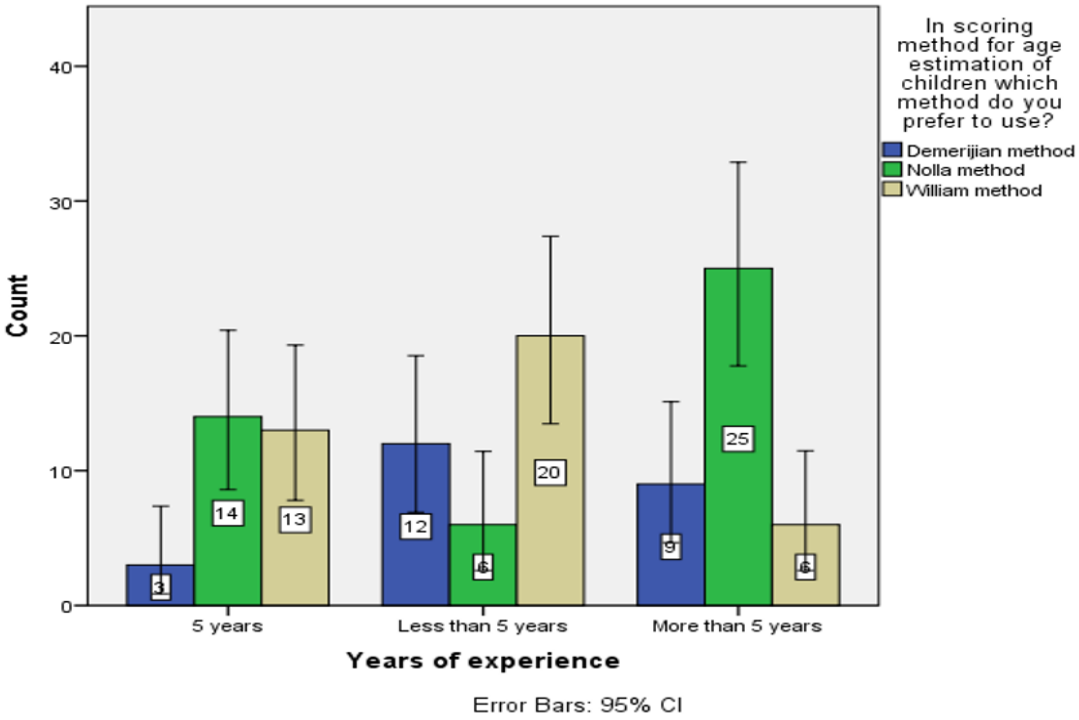

Figure-14: Bar graph depicting the association between years of experience and the most used scoring method where X-axis represents the years of experience and Y-axis represents the number of participants. The colour blue denotes demirjian method, green denotes nolla method and beige denotes william method. Out of 108 participants, 14 participants with less than 5 years experience, 6 participants with 5 years experience and 25 participants with more than 5 years of experience responded that they prefer to use nolla method regularly. (Pearson Chi square value-22.211, P-value-0.00[<0.05]-statistically significant).

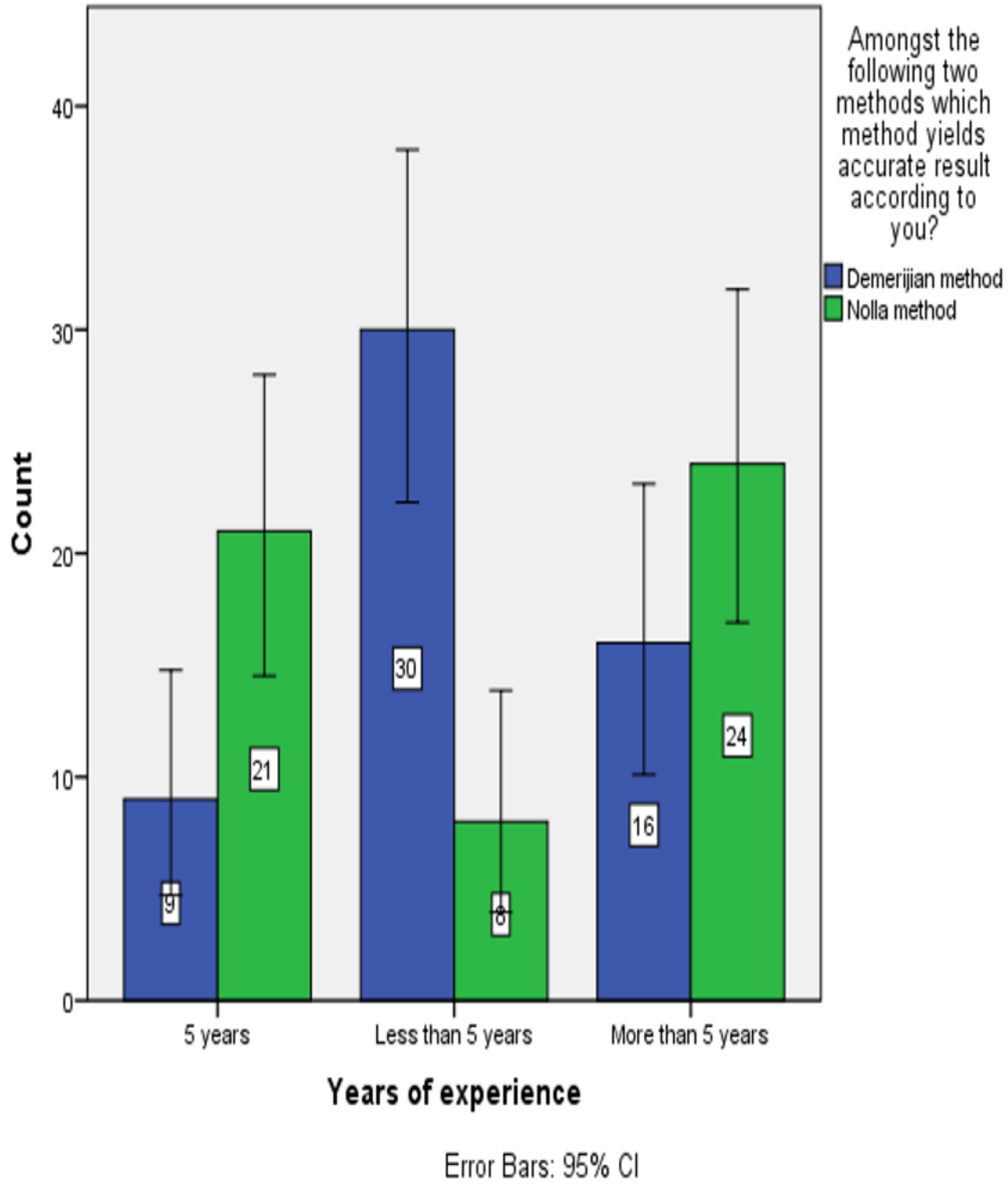

Figure-15: Bar graph depicting the association between years of experience and more accurate scoring method where X-axis represents the years of experience and Y-axis represents the number of participants. The colour blue denotes demirjian method and green denotes nolla method. Out of 108 participants, 9 participants with less than 5 years experience, 30 participants with 5 years experience and 16 participants with more than 5 years of experience responded that demirjian method yielded more accurate results than nolla method. (Pearson Chi square value-19.106, P-value-0.00[<0.05]-statistically significant).

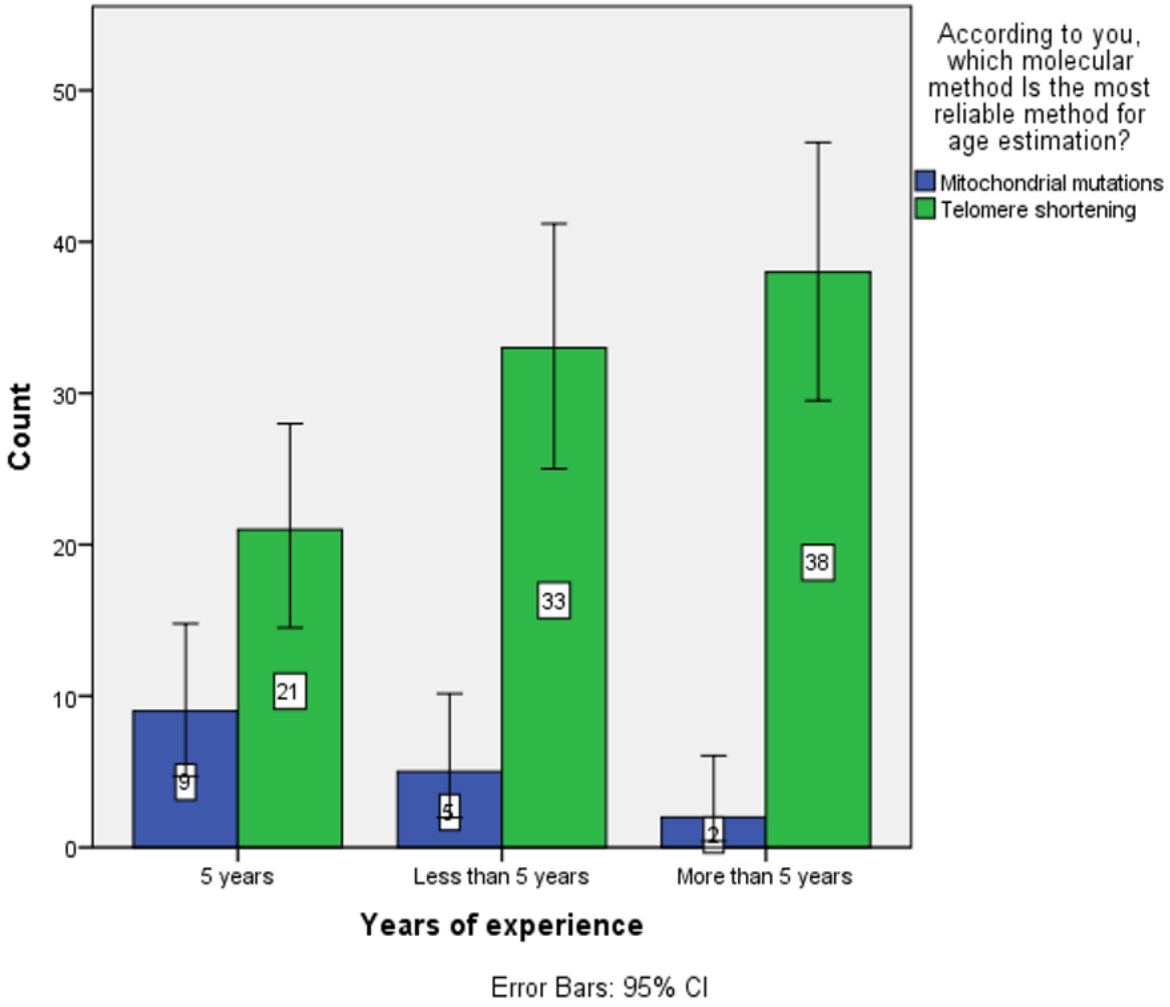

Figure-16: Bar graph depicting the association between years of experience and the most reliable molecular method where X-axis represents the years of experience and Y-axis represents the number of participants. The colour blue denotes mitochondrial mutations and green denotes telomere shortening. Out of 108 participants, 21 participants with less than 5 years experience, 33 participants with 5 years experience and 38 participants with more than 5 years of experience responded that telomere shortening was the most reliable molecular method in age estimation. (Pearson Chi square value-8.617, P-value-0.013[<0.05]-statistically significant).

Discussion

In the present study, 68.52% were female and 31.48% were female (Figure-1). 35.19% of the participants had less than 5 years experience, 27.78% had 5 years experience and 37.04% had more than 5 years experience (Figure-2).

About 66.67% of the participants responded that radiographic examination is more reliable in dental age estimation. 19.44% and 12.96% responded that biochemical and histological examinations are more reliable in dental age estimation respectively. Remaining 0.93% responded that visual examination is more reliable (Figure-3). In the study by Chaudhary et al., it was inferred that relative accuracy is found with radiographic examination (2). In the study by Alkass et al., apparently biochemical examination and radiocarbon analysis helped in estimating the age of the population (26). 75.93% responded that the scoring method is the age estimation method they prefer to use regularly while 24.07% responded as the atlas method (Figure-4). 73.15% responded that the scoring method is easy and 26.85% responded that the atlas method (Figure-5).

50% of the population answered that the atlas method shows maximum error and 50% answered that the scoring method shows maximum error (Figure-6). 41.67% responded that the nolla method is the type of scoring method they prefer to use in age estimation of children. In the study by Purv et al., Willem's method (Modified Demirjian method) shows accuracy in estimating chronological age for the population (27). 36.11% responded William method and 22.22% responded demirjian method are the types of scoring method they

prefer to use in age estimation of children (Figure-7). In a previous study by Arun et al., dental age estimation by Willems method was comparatively more accurate than Demirjian's and Haavikko's methods (28). 49.07% and 50.93% of the population responded that nolla method and demirjian method respectively will yield more accurate results when compared (Figure-8). In the study by Rezwana et al., Nolla's method showed more accuracy in estimating the dental age when compared with other methods of age estimation (29).

In the present study, 94.44% of the participants felt that the Gustafson method is reliable in estimating the age of adults. Remaining 5.56% of the participants felt that the Gustafson method is not relatable in estimating the age of adults (Figure-9). In the study by Zuhal et al., the three methods were not appropriate for age estimation (30). 95.37% of the participants answered that molecular methods help in age estimation and the remaining 4.63% of the participants answered that molecular methods do not help in age estimation (Figure-10). 85.19% responded that telomere shortening is the most reliable molecular method for age estimation. 14.81% responded that mitochondrial mutation is the most reliable molecular method for age estimation (Figure-11).

96.30% of the population responded that aspartic acid racemization helps in estimating the age of an individual and 3.70% responded that this method does not help in estimating the age of an individual (Figure-12). In the study by Shahrazad et al., the chronological age and dental age correlation lies between 60% to 95% accuracy (31). 69.44% of the participants responded that the age estimation method yields results which correlates more than 50% with the actual age. 13.89% answered exactly 50% and 16.67% answered less than 50% correlation with the actual age (Figure-13).

In the association between years of experience and the most used scoring method where X-axis represents the years of experience, out of 108 participants, majority 25 participants with more than 5 years of experience responded that they prefer to use the nolla method regularly (Figure-14). In the association between years of experience and more accurate scoring method, out of 108 participants, majority 30 participants with 5 years' experience responded that the demirjian method yielded more accurate results than the nolla method (Figure-15). In the association between years of experience and the most reliable molecular method, out of 108 participants, the majority 33 participants with 5 years' experience responded that telomere shortening was the most reliable molecular method in age estimation (Figure-16).

The limitations of the study were that the survey was conducted with a limited sample size. This survey can be used as a reference for future studies with a wider range of population.

Conclusion

The present study concludes that Nolla method and Gustafson's method were the most used age estimation methods for children and adults respectively. Age estimation in forensic odontology plays a significant role in identifying the unknown in case of crime or any mass disasters.

Acknowledgement

This research was done under the guidance of the Department of Research of Saveetha Dental College and Hospitals. We sincerely show gratitude to the corresponding guides who provided insight and expertise that greatly assisted the research.

Conflicts of Interest The authors declare that there are no conflicts of interest in the present study.

Source of Funding The present study was supported by the following agencies

- Molequle Solutions
- Saveetha Dental College
- Saveetha Institute of Medical and Technical Sciences

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