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Evaluation of the Physiological Changes in the Teeth that can help In Age Estimation of Adults

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ABBREVIATIONS

ABBREVIATIONS

A: Attrition

ASA: Average stage of attrition

C: Cementum Apposition et al: and others i.e.: that is

J: journal n: number

NS: Non significant

P: Peridontal Disease

R: Root resorption

S: Secondary Dentine Deposition

S.D: standard deviation

T: Root Transparency/ Translucency t: t test

%: Percentage µm: micron meter

±: plus minus

INTRODUCTION

Age is one of the essential factors in establishing the identity of the person. Estimation of the human age is a procedure adopted by anthropologists, archaeologists and forensic scientists. Different factors have been used for age estimation but none has withstood the test of time for adults above 25 years. (Pillai and Bhaskar 1974)

In this universe, most of the things, natural or artificial can be dated, numbered, quantified or measured. The concept of the age and time had come into the mind of the human being for centuries, possibly millennia. One can also measure life span of a person as well as ones age from the moment of conception. Age estimation can prove critical part in victim identification process. In cases of unknown dead bodies age estimation becomes necessary if there is no antemortem information available and a personal profile has to be reconstructed. In addition, age estimation can be done in precious archaeological skeletal material dating back to hundreds of years. (Helena Soomer et al 2003)

In a developing country like India, a large number of people are illiterate and have no knowledge or records of their date of birth which is required by law enforcing agencies in matters like criminal responsibilities, identification, judicial punishment, consent, rape, criminal abortion, employment, attainment of majority, kidnapping and prostitution (Pathak et al, 1999).

Determination of age is required also for the purposes like admission at the time of schooling, joining services and during retirement. Estimation of age is required during enhancement of pensions in the old age. Hence scientific determination of age is very important. Age can be determined from a variety of general physical factors like from height and weight which is applicable in early periods of life, dental development and changes occurring at puberty like appearance of hair and their growth and colour changes, development of breast in females, starting of menarche and from menopause. Age can also be calculated from the appearance of ossification centres and their fusions during skeletal development (Chhokar, Aggarwal and Bhardwaj, 1992).

Teeth in many ways form a unique part of human body e.g. they are most durable and resilient part of the skeleton. The upcoming science dealing with teeth is popularly known as Forensic Odontology or Forensic Dentistry. “Forensic Odontology is a branch of odontology which deals with the proper handling and examination of dental evidence and with proper evaluation and presentation of dental finding in the interest of justice” (Standish and Stimson, 1977). Amoedo, who has been called the father of Forensic Odontology incorparate many of the concepts of dental identification of the bazaar fire into the text, “ L’Art Dentaire en Medecine Legale”, published in French in 1898 (Luntz, 1977). It has now clearly established that dental evidence can be invaluable in personal identification and criminalistics. In the eyes of most law enforcements agencies and courts, it is valid and reliable method, ranking favourably with other methods of comparison such as fingerprints and blood grouping procedures (Vij K 2002).

Although, Forensic Odontology is a relatively small specialty, has been utilized for many years especially in establishing identity. The first reported crime in the history of mankind was solved when bite marks were discovered in the remains of the forbidden fruit in the Garden of Eden and identified as those of the Adam and Eve (Tedeschi, Eckert and Tedeschi, 1977).

Teeth are the strongest parts in human body and are therefore highly durable and very resistant to external influences like putrefaction, fire, explosions, and chemicals etc., which make them available for extensive post-mortem period. Age can be estimated from the teeth by various

methods like eruption of teeth which is known to be a good indicator of the age of the person. Teeth erupt in two sets i.e. temporary and permanent teeth. Temporary teeth will guide from six months to thirty-three months while the permanent teeth will help from six years to twenty-five years in age determination. From teeth age can also be estimated from microscopic examination of a section of central part of teeth by counting the cross striations which appear daily as devised by Boyde and Gustafson's method is used for the age estimation from teeth specially for the age above 25 years (Swami et al, 1992). The teeth also helps in identification if one is having detailed records of teeth and presence of any peculiarities like decay, malposition, overlapping, malrotation, fillings with different materials, gaps or dentures.

Teeth in mammals have some common features i.e. most mammals have a diphyodont i.e teeth erupt in two sets; heterodont dentition i.e. different types of teeth are present at same time having different function to be carried out like incisors for cutting, canines for tearing and premolars and molars for grinding and mastication of food. Teeth are attached to jaw by gomphosis and the bone supporting the teeth is called alveolar bone. Human teeth have seven components namely-Enamel crown, dentine, pulp cavity, cementum, fibres of peridontal ligament and epithelium of the mouth forming junctional waterproof seal.

At no time during life of an individual is a tooth unit static. It is constantly undergoing changes of one sort or another e.g. eruption, tilting or even lateral movement through jaw. The epithelium of mouth on crown of teeth also moves rootwards. Other changes which are appreciable with increasing age are attrition, peridontal disease, deposition of secondary dentine, root translucency, cementum apposition, root resorption, color changes and increase in root roughness. By taking in consideration these secondary changes in teeth with advancing age various studies were done to estimate the age of an individual. Such research has resulted in multifactorial methods that help in age estimation.

Other methods of age estimations from teeth are also developing using latest techniques like estimation of age by SEM Analysis from the fusion of the calcospherites in which the age of dentition over 21 may be estimated from the dental mineral structures of teeth by Scanning Electron Microscope - SEM analysis, where the changes in the structure of dentine tissue due to aging could be determined from the fusion of the calcospherites (Atsu et. al. 1998). A second method for age estimation by SEM, for adults could be done by formulating the micrometric measurements of tooth tissue layers, taken from certain landmarks of a tooth. The amount of abrasion of enamel tissue, the shrincage of pulp tissue, and the apposition of cementum tissue layers around the root structure was found to be in direct proportion with dental aging.(

Kedici et. al. 2000).

From the teeth along with the estimation of age, the social status of the deceased persons may be found out from the dental restorations of the dental remains, and also may be aproximately dated. In 900 BC, inlays of jade and turquise were made for the purpose of decoration in Mayan culture. (Ring 1992).

Dental development in children follows a specific timeline of dental formation, mineralisation and maturation, which over the years has been extensively studied. These studies have lead to quiet accurate pediatric age estimation methods. In adults, however, the age related changes in dentition are much more diverse and thus,the variation in age estimaions become considerably wider. Nevertheless, a number of age estimation have been developed for adult teeth. The simplest

method is so called “visual method, which is based on clinical experience without using formal methods. Formal methods of calculation based on morphometric measurements and aminoacid racemization have been developed. Latter method requires biochemistry laboratory and experience. It is also time consuming, costly and destructive. Problem with morphometric methods is that they have not been subsequently validated in independent material set or formally compared to each other (Soomer et al 2003).

Translucency of teeth and periodontal regression can be useful for dental age estimation. Peridontsis or gingival regression is caused by “the degeneration of the soft tissue surrounding the tooth as it progresses from the neck to the apex of the root and appears as a smooth and yellowish area below the enamel and darker than it but clearer than the rest of the root”. This measurement was taken from the labial surface and recoded the “maximum distance between the cementoenamel junction and the line of soft tissue attachment” transparency of teeth is a physiological feature that does not appear before age 20. Transparency is a result of the deposition of hydroxyapatite crystals in the dentine tubuli and is emphasized when the tooth is placed on light box (Debra et al).

Morphological methods for age estimation from teeth have been developed and applied to samples without taking the postmortem interval into consideration. Dental color, translucency length, attrition, cementum apposition and secondary dentin showed higher values from human skeletal remains than in fresh extracted teeth (Mandojana et al).

Gustafson in 1950 suggested the use of six retrogressive changes and ranked them on arbitrary scale, allotting 0-3 points according to degree of the change. Due to error in this morphometric method several modification were done in subsequent studies. Johanson (1971) in his research used same six criterions but different ranking scale and then estimated the age of an individual. Solheim (1980) used in situ teeth and eight variables which included two of color estimate, two for periodontosis, two for attrition, crown length and sex. None of the changes took singly proved more accurate than when these were studied together help in age estimation.

The aims of this study are to note the various physiological changes occurring in teeth with age. To find whether factors like socioeconomic status, sex, diet or any habit like chewing tobacco or pan affects the morphological changes occurring in teeth.

Attrition

Secondary Dentine Deposition

Root Translucency

Cementum Apposition

Root Resorption

GROUND SECTION OF PREMOLAR TOOTH

REVIEW OF LITERATURE

Gustafson (1950) was first to note the morphological changes in the structure of teeth. These were attrition, periodontosis, secondary dentition, cementum apposition, root translucency and root resorption. He awarded a score of 0-3 based upon visual severity of changes and estimated age. He calculated age using the regression formula derived from his observation: Y = 3.52 X + 8.88 (X =

Total Score and Y = Estimated Age). Gustafson established that the difference between calculated age and real age would not exceed +/-3.6 years in 33% of cases, +/- 7.3 years in 4.5%cases, +/-9.1 years in 1% of cases and +/-10.9 years in 0.3% cases.

Later Bang and Ramm (1970) used root dentine transparency in their study and recorded that this change with the age can be used for age estimation. They found a mean error of estimation of ± 4.7 years in 58% cases and ± 10 years in 79% of subjects.

Johanson (1970) also used same six criteria as used by Gustafson but instead of 0-3 he used seven bands to each factor and found that error was less as compared to other study.

Pillai and Bhaskar (1974) studied 83 anterior teeth collected from 59 cases (36 males and 23 females) and recorded physiological changes in tooth with age and comparison of these changes in males to that in females. Of the 63 mandibular teeth collected (76% of the total), 51 were medial incisors and 11 lateral incisors; there was one canine. The maxillary teeth collection comprised 14 medial incisors and 6 lateral incisors, a total of 20 samples. Single tooth was studied in from 38 cases whereas two teeth from each of 18 cases and 3 teeth from each of 3 cases. Teeth were grinded using two carborundum, rough and other smooth. Score was calculated and they plotted graph of known age Vs score and regression equation was deduced Y= 5.34 X – 4.08. They also found that the six factors used by Gustafson were age related variable but there was no significant relation with the sex of the person. They found that chewing habits exposed the teeth and surrounding tissue for degenerative changes thus giving rise to higher point value. Dark stains due to pan and tobacco tended to be more on gingival surface stimulating degenerative changes earlier although study proved that whether vegetarian or non-vegetarian doesn't seem to influence the age changes in and around teeth.

Akpata (1975) studied degree and gradient of attrition in 352 molar teeth of 88 selected Nigerian subjects. A method for the quantification of attrition experience per molar tooth was described. There was close correlation between age and the degree of attrition of the first molar. It was also found that wear of first molar was about two stages ahead of that on the second and third molars. It was suggested that the degree of attrition might be an index of masticatory activity.

Sivaram (1976) in a study found that absence of 2 left upper incisors and their sockets in the skull of a victim helped to pinpoint identity in a murder case. In this case, age of death of the victim was calculated using Gustafson' method.

Vlcek (1977) used modification Gustafson's method in estimating individual age according to the state of teeth in prehistoric bone material. Age estimation was made on the basis of Histological investigation of hard dental tissue and of the changes that affect the teeth as the individual grows old. Four markers were ascertained on thick sagittal section of single root teeth in pre-historical material: Degree of dental abrasion (Attrition), Secondary dentine deposition, cementum apposition and dental apex resorption, with score ranging from 0-3 points. By using this method he estimated the ages of Czech rulers from their dental remains with range of +/- 3 years. His modification made possible for anthropologist and Forensic experts to use histological section of Gustafson section in estimating the age both in pre-historical and in recent bone material.

Maples (1978) improved multiple regression analysis in improvement of age estimation from adult human teeth. He found that not only the estimates were more precise but also involving fewer variables, decreasing the probability of observer error. There was consistent evidence that the second molar was the best to use for histological aging techniques. The reduction in variables to

just secondary dentine and root transparency has also resulted in technique that can be used with some confidence in populations other than the one sampled. Thus, dental aging can be used in the same way as epiphyseal fusion, osteon aging, cranial sutures and changes in the public symphysis that have been used with other contemporary and prehistoric populations.

Nowell in 1978 used miles system of ageing, based upon analysis of the rate of molar wear, to evaluate the available sample from Tepe Hissar, Iran. The independently estimated ages for the mandibles and maxillae of the same individuals were found highly correlated (r= 0.87, p less than 0.001). Ages of the sub-sample of the dentitions were compared with skeletal ages for the same individuals estimated from pubic symphyseal faces and found to be significantly correlated (r= 0.82, p less than 0.005) with no significant differences in mean ages.

Helm and Prydso in 1979-recorded different stages of attrition of the mandibular molars in 235 Danish medieval skulls, 52 of which were in various states of mixed dentition. For the first and second molar, age of emergence and ages at occurrence of the earlier stages of attrition were estimated from the mixed dentitions, on the assumptions that the age at eruption of a given number of permanent teeth was similar in medieval and contemporary Danish children, and that the rate of attrition was similar for the first and second molars. It was found that assessment of age to death could be made fairly accurately for the age range 5 to 30 years and with decreasing accuracy until the about 40 years.

Maples and Rice in 1979 found that although Gustafson's method was a significant contribution to forensic identification but many statistical errors were present in the published articles. It was improved and new formula was found using multiple regression techniques. Formula derived was Y = 4.26 X + 13.45 (X = Total Score and Y = Estimated Age), (r = 0.912) and value of error as +/-7.03 years.

Tomenchuk and Mayhall in 1979 found that level of molar wear could be estimated reliably by measuring the cusp height. They found a correlation between age and the level of molar wear, expressed by a normalizing index of cusp height, was also found to exist in a sample of modern Igloolik Northwest Territories Eskimos. They derived linear regression models to test the degree of correlation in the sample of 46 female and 39 male maxillary casts of Igloolik Eskimos. It was discovered that male maxillary molar are worn approximately 30% more rapidly than female maxillary molars and this sexual dimorphism in molars wear was attributed to differential bruxism.

Solheim and Sundnes (1980) compared methods of Bang and Ramm, Miles, Johanson and Dalitz in addition to visual examination of un-sectioned teeth. They calculated the mean error as well as standard error for estimating age by noting the factors in the teeth changing with age. They found that all methods resulted in largest number of over estimates of age were in teeth from persons below 40 years and that too in teeth from males. They also found that there was overestimate of age by these methods when the teeth taken into consideration are from maxilla or extracted from corpses. Underestimation of age from these formulas was found in the case of teeth from persons above 50 years.

Whittaker in 1982 reviewed various method of age estimation and found that beyond young adulthood the age estimation becomes difficult. They found that Gustafson's method was quite satisfactory in estimation. It was suggested that most sensitive indicator of age estimation is the degree of development of translucent dentine at the apex.

Haertig, Crainic and Durigon (1985) found that the Gustafson's six criteria method of age estimation could be used to evaluate age of the victim in the acts of the wars or mass disaster where sometimes it is impossible to identify bodies. Teeth being resistant to fire, bacteria, etc when used to give age then age can be estimated with a margin of error of plus minus 4.6 years.

Singh and Mukerjee (1985) used same six criteria of secondary changes in the in elderly person and conducted study using one central incisor, one canine and one premolar in total of 150 cases out of which 114 males and 36 females. . So, in all 450 teeth were studied. They ranked these factors 0 to 3 score and calculated the age using this score. In 61.3% of total cases studied the error came out to be 4 years, 27.3% cases error was 5-7 years and in 11.4% cases error came above 7 years. The regression equation computed by was Y = 6.26 X – 6 (where X = Total Score and Y = Estimated Age). They found that error in estimation using this study was found +/- 4.9 years as compared to +/- 3.63 years from Gustafson's method.

Lorentsen and Solheim (1989) examined relationship between age of the person and area of translucent dentine at the root apex and compared with the methods of Johanson and Bang & Ramm. They used 500 teeth in their study, 50 of each tooth type, except molars and analyzed them under XT microscope and SPSS/PC regression programme was used. Regression analysis using several factors according to Johanson's method resulted in stronger correlation for most of the teeth, than that of Bang & Ramm method.

Solheim (1989) studied the apical translucent zone in 1000 human teeth. For each type of tooth, excluding molars, the size of the apical translucency was estimated according to the scoring methods of Gustafson, Dalitz & Johanson. The lengths of the translucent zones were measured on moist and then on dry teeth, both un-sectioned and sectioned, while the areas were measured on dry sectioned teeth only. Statistical analyses using the SPSS package in a Cyber computer indicated a symmetric distribution of the translucent zone in left and right teeth. The extent of the translucency showed little variation from one type of tooth to another. The length of the translucent zone measured on un-sectioned teeth demonstrated in most types the closest relation to age. Multiple regression analyses, including more than one method of measuring the size of the translucent zone, resulted in formulas showing a high correlation with age (from 0.68 to 0.86). Slightly larger translucent areas were found in teeth from males, in darker teeth and in teeth with increased thickness of the cementum. The increase in the translucent zone with advancing age was found to be almost linear and was not affected by periodontal destruction.

Song and Jia (1989) found that age estimation in unidentified bodies is inaccurate and usually only a broad range of ages, such as 20-30 years or 30-50 years, can be given, especially when postmortem change has occurred. Takei (1970, 1981), looked at the relationship between teeth and age by using the 'Theory of Quantification'. Song and Jia (1987), extended the use of this technique, adding multiple stepwise regression analysis, to the statistical examination of data derived from the study of attrition of the occlusal surfaces of teeth. The computer model thus derived provides a basis for an accurate assessment of age from qualitative material. They studied degree of occlusal attrition in 880 people, living in rural and urban areas of the Liaoning province of the People's Republic of China.

Drusini, Volpe and Dovigo (1990) in their study measured dentine root transparency (RDT) in 70 histological sections of teeth from 46 individuals of known sex and age. In order to obtain the estimates of individual chronological age, Bang & Ramm (1970) equations were applied to the value

obtained by the measurements. Using the percentage ratio h X 100 / H (after Lamendin & Cambray 1981) were h is the extension of the root transparency zone (in mm) and H is the total root length (in mm), some regression functions have been elaborated. The error of the age estimates obtained following Bang & Ramm was quite high in percentage, being comprised between +/- 5 years only in 21.13% of the cases.

Kashyap VK and Koteswara NR (1990) described a modified Gustafson's method of age estimation from teeth. They tried to decrease the subjective nature of scoring technique and to quantify the regressive changes in the enamel, dentine and cementum. Randomly selected teeth from 25 Indians were examined by Gustafson's method and by own modification. It was seen that the study was more accurate and standard error in estimation was low as compared to previous study.

Santini, Land and Raab (1990) measured the amount of tooth wear using the Brothwell chart based on the Miles method of ageing. They evaluated the accuracy of simple ordinal scoring in recording tooth wear and ageing skulls. A group of Chinese skulls of known age at death was used. The age range was from 16 to 60 years. A single score per molar tooth was used to record occlusal wear. The data were analyzed by regression methods using BMDP statistical software. The results showed that molar tooth wear continues throughout the life of the individual. The first molar teeth wear significantly more quickly than do second molar teeth. Use of a simple ordinal score method for recording wear gives an inaccurate estimate of an individual skull's age at death with a very wide 95% confidence interval.

Solheim in 1990 examined various ways of measuring cementum thickness, studied its relationship with age, and considered what contribution this factor offered in methods for age estimation. The amount of dental cementum apposition was studied in 1000 teeth, excluding molars, from a Caucasian population. Cementum thickness was estimated according to the scoring methods suggested by Gustafson and by Johanson. In addition, the width of the cementum was measured at the apex and also at approximately one third of the root length from the apex. Statistical analyses using the SPSS package in a Cyber computer indicated a symmetric left/right distribution of cementum thickness. The sum of the cementum thickness on vestibular and lingual surfaces, measured at one third of the root length from the apex, showed the strongest correlation with age ($r = 0.40$ to 0.65). A reduced rate of cementum apposition was observed in the elderly. Also, maxillary teeth had more cementum on the lingual than on the vestibular surfaces. A tendency was noted for less cementum to occur in women than in men and on teeth removed from deceased persons or extracted for pathologic reasons. Correlation coefficients indicated that, for at least some types of teeth, the cementum thickness might give a significant contribution to statistical methods of age assessment.

Drusini, Calliari and Volpe (1991) studied root dentine transparency (RDT) was used to estimate the ages of human subjects from 152 intact teeth. Teeth were from 134 subjects, both historical and recent, of known age and sex. They 1) compared two methods of using RDT to estimate age; 2) tested the applicability of the regression formulae for estimating age obtained from a recent sample on an historical sample; and 3) estimated the suitability of RDT to determine age at death of 100-year-old skeletons. RDT was measured by two techniques: 1) computerized densito-metric analysis and 2) vernier caliper. Age estimations based on computerized densito-metric analysis were no more accurate than were those determined by caliper measurement; both give a predictive success of +/- 5 years in about 45-48% of cases for premolars. The television-based digitization system has some disadvantages: It is expensive, not portable, and requires some training to use. However, it

furnishes a more standardized method, a rapid graphic illustration of the results, and an immediate storage of statistical information for future use.

Kambe, Yonemitsu, Kibayashi and Tsunenari (1991) devised a simple method to assess dental attrition in terms of its area and number of sites by using dental plaster casts and a computer assisted image analyzer. The changes presented on the occlusal surfaces of teeth were investigated for age estimation using these criteria. The area of attrition on each tooth demonstrated a significant positive correlation with age, but a wide individual variation was observed in the values for each tooth. Therefore, this method was unsuitable for accurate age estimation of a single tooth. They observed a strong negative correlation in the number of sites of attrition. A multiple stepwise regression analysis using the variables 'attrition area' and 'attrition number' revealed multiple correlation coefficient values of 0.93. The quantitative assessment of both horizontal and vertical factors of dental attrition would be essential to improve the accuracy of this method.

Richards and Millar (1991) studied the teeth wear scores (ratios of exposed dentin to total crown area), which were calculated from dental casts of Australian Aboriginal subjects of known age from three populations. Linear regression equations relating attrition scores to age were derived. The slope of the regression line reflects the rate of tooth wear, and the intercept is related to the timing of first exposure of dentin. They also found that differences in morphology between anterior and posterior teeth are reflected in a linear relationship between attrition scores and age for anterior teeth but a logarithmic relationship for posterior teeth. Correlations between age and attrition range from less than 0.40 for third molars (where differences in the eruption and occlusion of the teeth resulted in different patterns of wear) to greater than 0.80 for the premolars and first molars. Because of the generally high correlations between age and attrition, it is possible to estimate age from the extent of tooth wear with confidence limits of the order of +/- 10 years.

Xu et al in 1991 took 317 upper and lower third molars randomly and divided into working and control samples and used to estimate chorological age employing a method which combined multiple regression analysis of data from Gustafson's method and Maples's scoring system, direct morphological measurement obtained with Kontron image analysis system and logarithmic data transformation. The standard errors of estimate were 2.4-6.8 years in the working sample and 1.9-7.5 years when the derived formulae were tested on control sample, respectively. Compared to previous studies, the method provides a smaller standard error of age estimate from single molar teeth.

Lamendin et al in 1992 proposed a technique to study single rooted tooth. It is based on measurement of two dental features: periodontosis height times 100/root height (P) and Transparency of the root height times 100/ root height (T). Their sample consisted of 135 males, 73 females, 198 whites and 10 blacks. The sample ranged from 22 years to 90 years. By using formula (A =0.18 x P + 0.42 x T + 25.53, where A =Age in years, P = Periodontosis X 100/root height and T= Translucency height X 100/root height), they were able to calculate the age at death with an error between the actual age and calculated age, of +/- 10 years on their working sample and +/-8 years on a forensic control sample. A comparison of the Gustafson's method and Lamendin methods on the control sample of 39 teeth resulted in the advantage of the latter considering the mean error on the estimation (14.2 +/- 3.4 years versus 8.9 +/- 2.2 for Lamendin).

Solheim in 1992-studied amount of secondary dentin in a tooth has been used as one of several parameters in methods for age estimation. He took 1000 teeth of known age, 100 of each type

except molars and secondary dentin deposition was studied under stereoscopic microscope and measured according to various scoring systems, and the Pearson correlation coefficient with age has been found to be approximately 0.6. The teeth were prepared according to the half tooth technique. In addition, the area of the coronal pulp and the widths of the root and pulp chamber were measured in a stereomicroscope at the cemento-enamel junction and at three other defined points along the root. The Pearson correlation coefficient between age and secondary dentin varied in different types of teeth. Of the scoring systems, scores according to Johanson were most strongly correlated with age (r = 0.59 to 0.74). The scores according to Gustafson and Dalitz method also gave consistently strong correlation with age, but generally not as strong as Johanson. Correlation between age and the coronal pulp area varied from -0.47 to -0.72, and the range between age and ratio between pulp- and tooth width at the cemento-enamel junction was from -0.46 to -0.77. Correlations between age and ratio between sum of pulp widths and the sum of tooth widths for all four such measurements ranged from -0.58 to -0.81. It was also found that correlations between age and single measurement of secondary dentine formation are generally almost as strong as between age and color, or age and apical translucency but stronger than between age and attrition, or between age and cementum apposition. Multiple regression analyses showed that by combining several types of measurements, the correlation with age was increased. A tendency was also observed towards reduced speed of secondary dentin formation in the elderly and in women.

Solheim in 1992 also studied that recession of the periodontal ligament has been used as one of several indicators of age in methods for age estimation. In a sample of 1000 teeth the relationship between age and periodontal recession was studied for each type of tooth. Only a weak correlation was found, the least weak being for premolars. The mean of the periodontal recession measured in mm showed approximately the same correlation as when assessed by scoring systems. Logarithmic transformation of the mean of the recession resulted in a stronger correlation with age. The use of tooth age rather than individual age did not have the same effect. Periodontal recession tended to be more rapid in males than in females. The correlation of reason for extraction with periodontal recession was not found to be significant. He found that periodontal recession was not sufficiently accurate to be used as a sole indicator of age. However, in multiple regression methods for age estimation it contributes significantly to the age equation, especially for premolars.

Kwak and Kim (1993) studied 157 extracted teeth, 73 of the teeth originated from males and 84 from females from age groups 12 to 79 years. The correlation coefficient of each Gustafson's criteria in relation to age was carried. Age estimation were performed on 157 teeth according to the method by Gustafson's method and by use of multiple regression, as used by Johanson, after evaluating the six criteria of Gustafson by multiple regression computer analysis. Two prediction formulas and standard deviations were compared with each other. They found the following result:

1. Six Gustafson's criteria had strong correlation with age except root resorption and correlation coefficient were r = 0.79 (transparent dentine), r = 0.72 (secondary dentine), r = 0.69 (peridontal change), r = 0.63 (Attrition), r = 0.39 (root resorption).
2. The age estimation formula by Gustafson's method was calculated as follows: Y = 3.52X + 8.88, r = 0.87, r^2 = 0.76, SD = 8.18, F = 483.56 and $p < 0.01$. The age estimation formula by multiple regression was calculated as follows: Y = 6.37 T +4.63 P + 2.70 S + 2.40 C + 3.08 A + 1.34 R + 8.57, r = 0.89, r^2 = 0.78, SD = 7.82, F = 91.62 and $p < 0.01$. Durbin-Watson Coefficient = 1.09.

3. In comparison of two estimation formulas, the formula by multiple regression, the method of Johanson (SD = 7.82), was found to be slightly more reliable than Gustafson's method (SD = 8.18).
4. It was reaffirmed that Gustafson's six criteria could be independent variable in multiple regression analysis.

Solheim in 1993 found that there were several shortcomings in previous studies due to smallness of the material and improvements of the methods were desirable and seemed possible. As a contribution to such improvement various age related changes were studied in a material of 1000 teeth. For each type of change the kind of measurement most strongly related to age was chosen, and a multiple regression analysis was run with age as the dependent variable, using SPSS/PC+ statistical program. Statistically significant formulae were calculated for each type of tooth excluding molars. Because the sex of a deceased body may be unknown and the tooth colour influenced by changes after death, separate formulae excluding these factors were calculated. For the calculated formulae the Pearson correlation (tau) varied from 0.76 in mandibular second premolars (SEX and COLOUR excluded), to 0.91 for maxillary central incisors; a rather promising result compared with other methods. In addition, the inter-correlations between the age-related factors were calculated after control for the effect of age. In some types of teeth, but not in all, some of the factors displayed significant inter-correlation.

Solheim and Kvaal in 1993 examined 1000 permanent teeth excluding molars, by new scoring system for surface roughness in addition to Gustafson and Johnson's for root resorption. Statistical analysis using the SPS package indicated a symmetric left right root surface structure. The Pearson correlation between Age and Johnson's method varied from – 0.2 for maxillary central incisors to 0.54 for mandibular central incisors and was approximately the same for Gustafson's method.

Tomaru et al in 1993 estimated the age using attritions of lower incisors. Using the Amano's method, they took records of tooth attritions in the planted state of 83 subjects whose ages ranged from 14 to 76 years. A positive correlation-ship was found to exist between the tooth attrition index and the actual age, allowing establishing the following formula which graphically shows a straight line: $Y = 8.50X + 26.073$ ($r= 0.607$), where X is the mean attrition indexes of lower incisors and Y is the estimated age.

Kvaal and Solheim (1994) studied age related changes in 452 extracted, un-sectioned incisor, canines and premolars. The length of the apical translucent zone and extent of the periodontal retraction were measured on the teeth while pulp length and width as well as root length and width were measured on the radiographs and the ratios between the root and pulp measurements calculated. For all types of teeth significant, negative Pearson's correlation coefficients were found between the age and the ratios between the pulp and the root width. It was also found that there is correlation between age and length of apical translucent zone but the correlation was weaker than expected while the correlation of age with peridontal retraction was significant in maxillary premolars. The correlation coefficient ranged between $r = 0.48$ to $r = 0.90$ between chronological age and calculated age, using formulae from this multiple regression study. The strongest correlation coefficient was found for the premolars.

Lampe and Roetzscher (1994) examined 350 teeth of living and /or dead males and females from Heidelberg area, Germany. Using Gustafson's method they estimated the age of these individual, graded all the six factors in similar way with score of 0-3 and then using the regression curve and

plotting the score in the graph they calculated the age. They found almost similar result as that found by Gustafson.

Li and Ji (1995) studied permanent molars and changes occurring with the age i.e. attrition. A total of 633 teeth, including first and second molars of both the jaws, were collected from 57 cadavers and 54 modern dry skulls in northern china. The attrition of the molars was noted and new graduation method (ASA method) was established. Six new equations for the estimation of age were obtained by means of regression analysis. They found maximum error was 4.53 years. The results showed that this Average stage of Attrition (ASA) method can or do reflect the attrition of whole occlusal surface more objectively than some method using only one cusp of the tooth.

Lucy and Pollard in 1995 questioned the error estimate stated in Gustafson's paper outlining the relationship between certain dental attributes and age. They reviewed Maple and Rice study in which they identified a number of serious problems with the statistical treatment of the original data, but failed to substantiate Gustafson's original error estimate of +/- 3.63 years. They calculated an associated error of +/- 7.03 years using same original data. Lucy and pollard found that the regression line and errors derived from the regression line cited by Gustafson was impossible to replicate despite having all his data but the criticism cited by Maple and Rice have been borne out and regression line and an estimate of associated errors have been reproduced.

Lucy, Pollard and Roberts in 1995 study sample included 53 teeth from 33 individuals obtained from the Oral Surgery Department, St. Luke's Hospital, Bradford. Ages were then calculated using the Maples and Rice (1979) revised version of Gustafson's regression line, Johanson's multiple regression line, and Bang and Ramm's regression lines. The ages predicted using the formulae given by Gustafson (1950), Johanson (1971) and Bang and Ramm (1970) were separately plotted against the chronological age of the donor at extraction (the known age). They studied first the accuracy of the estimation; defined as how closely the predicted ages corresponded to the known ages. This was measured by the statistic of average absolute deviation (referred to as 'average deviation'), which is the average of the difference in years between the estimated age and the known age (irrespective of sign) across the whole sample. They selected average deviation in preference to standard deviation because it gave a direct estimate of the average difference between 'true' and predicted age. The second important quantity studied was the extent to which the quoted 'standard error' derived from the appropriate model corresponded to the real errors, which was calculated independently from the age at extraction for each tooth. This was measured by noting the percentage of estimated ages which fell within one quoted error of the known age and comparing this figure to the theoretical value of 68% (assuming that the 'standard errors' quoted by the original authors correspond to a one standard deviation confidence interval of the estimate. After the study they found that using Gustafson's method mean average deviation was of 4.5 years (i.e. the mean value of the average deviation across all 35 samples) while the quoted standard error is of 5.16 years for Gustafson's method. They also found that Bang and Ramm's method seems to produce a noticeably poorer average deviation of 5.15 years, with the quoted standard error being dependent upon tooth type however Johanson's technique offers a small advantage in terms of both accuracy and precision when measurements from a single root are taken as representing one individual. The maximum differences in the estimated age from multiple roots of the same tooth are 11.4 years using Gustafson's method, 16.7 years by Johanson and 12.9 years by Bang and Ramm. The maximum differences in the age estimates for the same individual using multiple teeth are 13.7, 19.5 and 13.8 years respectively.

Carranza and Ubios in 1996 stated that there is gradual increase in the cementum thickness with the increasing age and there is loose linear relation of this increase with increasing. Loose relation was due to the reason that the cementum apposition is also effected by other factors like disease condition. They found that normal thickness of cementum at coronal half of root was 16 – 60µm (i.e. about the thickness of hair). Thickness of cementum at the apex of the root of the teeth is normally 150 - 200µm. Average thickness of the cementum is 95µm at the age of 20 years and 215µm at 60 years.

Ship and Beck (1996) in their study examined 95 healthy men and women (aged 29 to 76 years at initial visit) from the oral physiology component of the Baltimore Longitudinal Study of Aging over a 10-year period. Periodontal measurements were taken at two visits, and recession, pocket depth, and level of attachment determined. The change of level of attachment and attachment loss was assessed as a longitudinal measure of disease progression. They found that overall there were only slight changes in periodontal measurements over the 10-year period. Attachment loss was age-dependent and was due primarily to increased recession not to changes in pocket depth. Periodontal disease destruction (as measured by attachment loss) occurred over time but was not related to the age or gender of a person. These results from healthy persons suggest that periodontal diseases are not a natural consequence of the aging process, and that advanced age is not an accurate predictor of attachment loss.

Gunsolley et al in 1998 did a cross-sectional study of 142 non-smoking subjects and 51 smoking subjects. Subjects could have no more than one tooth with a site of interproximal attachment loss > or =2 mm. Subjects could, however, have attachment loss associated with recession. For three different methods of summarizing attachment loss measurements at a subject level, including average attachment loss, percentage of teeth with one site of 2 mm of attachment loss, and the percentage of teeth with one site of 5 mm of attachment loss, smoking subjects had approximately twice as much attachment loss than their non-smoking counterparts. Smoking subjects also had significantly greater recession ($P < 0.05$) [0.056 ± 0.017 mm] than non-smoking subjects (0.025 ± 0.005 mm). They found that recession sites occurred primarily on the facial surface of maxillary molars and bicuspids and mandibular central incisors and bicuspids. Their study showed that there is a strong association between smoking and both attachment loss and recession in subjects who have minimal or no periodontal disease.

Sengupta et al (1999) studied root dentine translucency (RDT) in archaeological teeth. A protocol for measurement of RDT was established and applied to modern and archeological teeth of known age (Spitalfields sample). Percentage length of RDT in sectioned teeth was found to correlate well with chronological age in the modern sample but not in the archaeological sample. The majority of the archaeological sample was affected by a morphological change creating a chalky appearance to the dentine. From the study, he found that there is strong correlation of root dentine translucency with chronological age.

Angyal et al in 2000 examined 42 autopsy cases, aged 18 to 79. After the odontograms were taken, one tooth from each individual was removed from the corpses and examined using both the Gustafson's method and the Johanson's methods for age calculation. The results according to both methods showed a large standard deviation. It suggests the necessity of national database and the reexamination of all of the methods tested on different population samples.

Kim, Kho and Lee in 2000 tested the accuracy of a new scoring system in recording tooth wear for age estimation. Their material consisted of dental stone casts of 383 volunteers who had sound premolars and molars with normal occlusion. The degree of occlusal wear for all premolar and molar teeth was scored with the new system. The high intra- and inter-examiner concordance showed that the new score system was very reliable. The degree of tooth wear showed a significant positive correlation with age in each and every examined tooth of both males and females. Tooth wear scores of males were higher than those of females. Calculating tables for age estimation were designed and the accuracy of age estimation was obtained with the General Linear Models procedures. Their system provided estimation of an individual's age within ± 3 years in 42.4% of males and 49.4% of females, within ± 5 years in 61.8% of males and 63.3% of females. When the subjects were divided into two age groups and data were re-treated, the accuracy of age estimation was increased. Collectively, it was found that new system for scoring tooth wear is a reliable and accurate method for age estimation

Solheim in 2000 studied about the dental cementum apposition and examined various ways of measuring cementum thickness. He also studied relationship of dental cementum apposition with age and what contribution this factor might offer in the methods for age estimation. He took a sample consisting 1000 teeth, excluding molars from a Caucasian population. He estimated the thickness of cementum according to the scoring methods suggested by Gustafson and by Johanson. In addition he also measured the cementum thickness at the apex and at approximate one third of the root length from the apex. Statistical analysis using the SPSS package indicated symmetric left/ right distribution of cementum thickness. The sum the cementum thickness on vestibular and lingual surfaces, measured at the one third of the root length from the apex, strong a correlation with the age ($r = 0.40$ to 0.65). He also observed that there was reduced rate of cementum apposition in elderly and that less cementum apposition occurs in women than in men. He observed that maxillary teeth had more cementum on the lingual surface than on the vestibular surface. His results of correlation coefficients indicated that for at least some types of teeth, the cementum thickness might give significant contribution to statistical methods of age.

Vystr and Novotny (2000) did a research based on the confrontation of modification of Gustafson’s aging method with the aim of producing of up to date identification tables for anthropology. Sixty-three ground sections were evaluated following the methods of Kilian and Kashyap Koteswara Rao. Kilians method is based on the subjective evaluation of six factors the degree of attrition, the secondary dentine, secondary cementum, the resorption, the transparency and position of epithelium attachment while the study of Kashyap and Koteswara is based on the quantitative evaluation of four factors i.e. abrasion, secondary dentine, secondary cementum and transparency. The best results of age estimation were obtained using Kilian’s method after multiple regression of all studied changes were applied and absolute mean error of estimation was 4.97 years. It was found when ever any of the six factors were not included the error of estimation increased.

Ajmal, Mody and Kumar (2001) did a study on adult age determination from teeth using three methods, namely, Johanson method, methods of Kashyap and Koteswar Rao and the average stage of attrition method (ASA). A total of 100 patients were selected. Johanson and Kashyap method uses microscopic measurements, whereas ASA is purely a clinical method. ASA method was found to be the best method. Unsatisfactory results were seen more in Kashyap's technique. In all the three methods overestimates of age were common in mandibular teeth and in teeth taken from female

individuals. More studies were recommended to be done by Kashyap's method as there were certain difficulties encountered in measuring a few criteria.

Maat (2001) elucidated the impact of diet on age-at-death determinations based on molar attrition. A comparison was made between the established rate of attrition in three populations; a pre-mediaeval (British), a late mediaeval (Dutch) and a 17-18th century (Dutch) (western European). It appeared that the rate decreased dramatically during the overall time span and that this change was probably diet related and owing to the coarseness of foodstuffs. Their result strongly indicated that molar age-attrition tables should only be used for age-at-death determinations if their application is restricted to a particular cultural period and diet.

Pigno et al in 2001 studied the severity, distribution, and correlations of tooth wear in a sample of Mexican-American and European-American adults drawn from a community-based longitudinal aging study on oral health. The maxillary teeth of 71 subjects enrolled in a longitudinal aging study were assessed using a previously introduced five-point (0 to 4) ordinal scoring system in which each tooth is given a score describing the severity of wear. The tooth wear scores were compared with data concerning demographic factors, functional/para-functional habits, soft drink consumption, and bite force measurements to determine specific correlation with tooth wear. They found that mean wear score for all teeth was 1.50 on the five-point scale. There was a significant difference between the mean wear score of anterior teeth (1.85) and posterior teeth (1.17). Bi-variant analyses detected a moderate degree of correlation between maxillary tooth wear and age and bite force. Maxillary tooth wear was significantly greater in males and in subjects with reported teeth clenching/grinding. Multivariate analyses revealed that age; gender, bite force, self-reported teeth clenching/grinding, and number of daily meals/snacks had significant correlations with maxillary tooth wear.

Ball in 2002 in his study determined age of skeletal remains using anthropological examination of the remaining bones and dentition. The aging of the dentition is based on attrition which, if physiological will correlate with age. He supported that in certain cases microscopic examination of the teeth may not be possible and the age estimation is then often determined by the degree of attrition associated with the tooth. In more recent times the causes of attrition have involved other factors such as bruxism, diet, environment and medication. He found that although helping in age estimation from attrition, this method has its own weaknesses and limitations in age estimation by examination of dental attrition as the sole indicator.

Ekaterina, Robert and Wang (2002) in their study discussed diet and health changes of millet agriculturists in Northern China, Shaanxi province, during the period 7,000-4,000 BP. Human remains from the Longshan culture (5,000-4,000, BP) were found at the Kangjia site. They investigated whether the trajectory of diet and health changes persisted beyond the Longshan, a skeletal sample from the Xicun site of the Western Zhao Dynastic period (3,800-2,200 BP). They found that all Yangshao sites in their study were characterized by low frequencies of anemia and carious lesions. They also found that some subsistence changes probably occurred during the later phase of Yangshao culture that resulted in elevated masticatory stress and occlusal macro wear among the Shijia people. However, deterioration of community health did not begin until the Longshan, when increased occurrence of porotic hyperostosis and caries is accompanied by decreased adult stature. The transition to softer, more extensively processed food during Longshan was evident in decreased rates of occlusal wear. Increased population density and diminished food values were most likely responsible for these changes.

Murray et al in 2002 in their study determined the possible changes in pulp cell density, pulp area, and dentinal thickness with age. Their study included: Incisors (50), canines (39), premolars (51), and molars (7) extracted from 60 patients aged between 10 and 59 years, and were analyzed histomorphometrically for cell density (odontoblasts, subodontoblasts, and pulp core fibroblasts) and dentinal thickness. They found that with increasing patient age, in both crown and root aspects of teeth, dentinal thickness increased ($P < 0.001$), while the density of odontoblasts ($P < 0.001$), subodontoblasts ($P = 0.001$), and pulp fibroblasts (crown, $P < 0.011$; root, $P = 0.0015$) decreased. The degree of age-related changes in teeth appeared to be asymmetrical, with decreases in the root being greater than in the crown. At all ages pulp cell densities, including odontoblasts, within the crown were greater than in the root ($P < 0.001$), even though the calculated rate of dentinal deposition was greatest in the root. Thus it was suggested that decreases in pulp cell density may reduce pulp repair activity after restorative treatments, although increases in dentinal thickness may aid pulp protection.

Selukar, Diwan and Shroff in 2002 conducted study on 77 teeth of known age group out of which 17 were incisors, 9 canines, 33 premolars and 18 were molars. They noted all the six factors of Gustafson's method independently against the age of the tooth. The average was calculated from different index values as Age = [A + D + T + CE] / 4. They found that canines shows more accurate result and their observation suggested that there is significant positive correlation between age of individual and various parameters i.e. attrition, secondary dentine, translucency of root and cementum apposition.

Valenzuela et al (2002) studied: (1). Measured parameters that contribute significantly to estimates of dental age, using a combination of classic methods and a computer-assisted image analysis procedure to avoid the bias inherent in observer subjectivity; and (2). Development of new mathematical regression models for age prediction according to postmortem interval. Two different populations were studied. Forty-three permanent teeth (Group I), extracted for valid clinical reasons, were taken from patients 25-79 years of age. The other population group (Group II) was composed of 37 healthy erupted permanent teeth obtained from human skeletal remains (age 22-82 years) with a postmortem interval ranging from 21 to 37 years. Morphologic age-related changes were investigated by measuring variables on intact and half-sectioned teeth. Multiple regression analyses were performed with age as the dependent variable for each sample source. They found that in fresh extracted teeth, the variables that made the greatest contributions to predictions of age were dental attrition, dentin color, and translucency width; the latter measured with a computer-assisted image analysis method. They also found that in teeth from human skeletal remains, the variables that made the greatest contributions to age calculation were cementum apposition, pulp length measured by computer-assisted image analysis, dental attrition, root translucency, and dental color. Thus they recommended use of different regression models to calculate age depending on the postmortem interval.

Khocht et al (2003) examined the effects of alcohol and cocaine misuse on periodontal status in a group of alcohol-dependent patients. In their sample they took 40 verified alcoholics, either exclusively ($n = 10$) or with cocaine abuse ($n = 30$), and a matched comparison group of 25 non-alcoholic subjects, 14 of whom abused cocaine, were entered in the study. All subjects were free from systemic illnesses. Blood levels of gamma glutamyl transpeptidase (GGTP), a liver enzyme indicator of alcohol drinking, were determined. A comprehensive periodontal examination was performed on 6 sites per tooth. The gingival index (GI) and plaque index (PI) were recorded.

Attachment levels (AL) were computed as probing depth (PD) plus gingival margin level (GM). In their results they found no statistically significant differences between the groups for average AL, PD, GM, GI, and PI. In alcoholics, Pearson correlation showed a positive association between GGTP levels and loss of periodontal attachment ($P<0.05$). A series of regression analyses predicting AL from selected periodontal and demographic factors showed that alcoholics manifest AL by greater increases in GM than non-alcoholics ($P<0.07$). Severe alcohol use as measured by GGTP >51 iu/l worsens PI ($P<0.07$), which adversely impacts GM, GI, PD, and ultimately AL. No significant associations were found between cocaine use and AL. their study suggested that persistent alcohol abuse increases periodontosis development by heightening the loss of attachment through recession of gingival margins.

Morzavi et al in 2003 studied 210 teeth ranging between 25 to 60 years including 185 males and 25 females. By using 0.5 – 1 mm section of tooth, determined attrition, periodontosis, root resorption, secondary dentine deposition, cementum apposition and root translucency. They found that among different mandibular teeth, the sum ranks of the first premolars factors had best correlation with the age and also that the sum of the dental factors presented a better model than each of the factors alone. Correlation coefficient of age with attrition, periodontosis, root resorption, secondary dentine, cementum apposition and root translucency was found 0.394 ($p < 0.001$), 0.384 ($p < 0.001$), 0.169 ($p < 0.014$), 0.522 ($p < 0.001$), 0.251 ($p < 0.001$) and 0.344 ($p < 0.001$), respectively.

Soomer et al in 2003 studied the reliability and validity of eight dental age estimation methods for adults. They took 20 teeth, intact or with superficial filings and taken from 10 males and 10 females (known ages ranging from 14 to 95 years, mean age 47.5 years). They used Johanson's method and computed a formula: Age = 5.14 A + 2.3 S + 4.14 P + 3.17 C + 5.57 R + 8.98 T + 11.02. Other methods they studied were Kvaal and Solheim first formula, Kvaal and Solheim second formula, Solheim's method in-situ teeth, Solheim method for sectioned teeth, Lamendin method, Bang's method for extracted teeth and Bang's method for sectioned teeth. They applied ANOVA and Fisher's PLSD post-hoc analysis (t – test) to compare the mean ages error for each 28 possible pairs of methods. They found that sectioned methods gave a better result and with more precision than that from un-sectioned method. It was also seen that Kvaal's original data gave significantly better regression coefficient for that maxillary premolars teeth. In conclusion, each dental age estimation method presented provides a different combination of accuracy, precision, and procedure and require different equipment.

Ursula, Jutta and James (2003) in their study estimated age by noting the tooth-cementum annulations (TCA) in 363 teeth of known-age sample. Tooth-root cross sections were made using a refined preparation technique. Improved digital graphic procedures and enhancement strategies were used to produce digital images with a specially adapted software package. This resulted in high concordance between the TCA age estimates and chronological age. Assessment of the method's accuracy, as expressed by 95% confidence intervals, showed that error bounds for age estimates do not exceed 2.5 years. Sex differences, intra-individual correlations, and the effects of periodontal disease were studied. None of these indicators had a quantitative effect on the number of TCA bands when the proposed methodological standard was followed. Thus it was concluded that the TCA technique is a reliable method for estimating a subject's age from cementum annulation

AIMS AND OBJECTIVES

1. To note the various macroscopic and microscopic physiological changes occurring in teeth that can help in age estimation.
2. To find out any relationship of sex of a person with these physiological changes of the teeth.
3. To find the effect of the diet (vegetarian/ non- vegetarian) and other habits on these physiological changes.
4. To evaluate the effect of socioeconomic status on the physiological changes of the teeth.
5. To evaluate the efficacy/ evolve the formula for estimation of the age of the person.

MATERIAL AND METHODS

The medico legal cases received for the autopsy by the Department of Forensic Medicine, Government Medical College, Patiala, were taken for the study. A total of 100 cases were studied in the adults (age group of 25 to 70 years). This range was further divided in into six groups:

Group A - 25 - 30 years

Group B - 30 - 35 years

Group C - 35 - 45 years

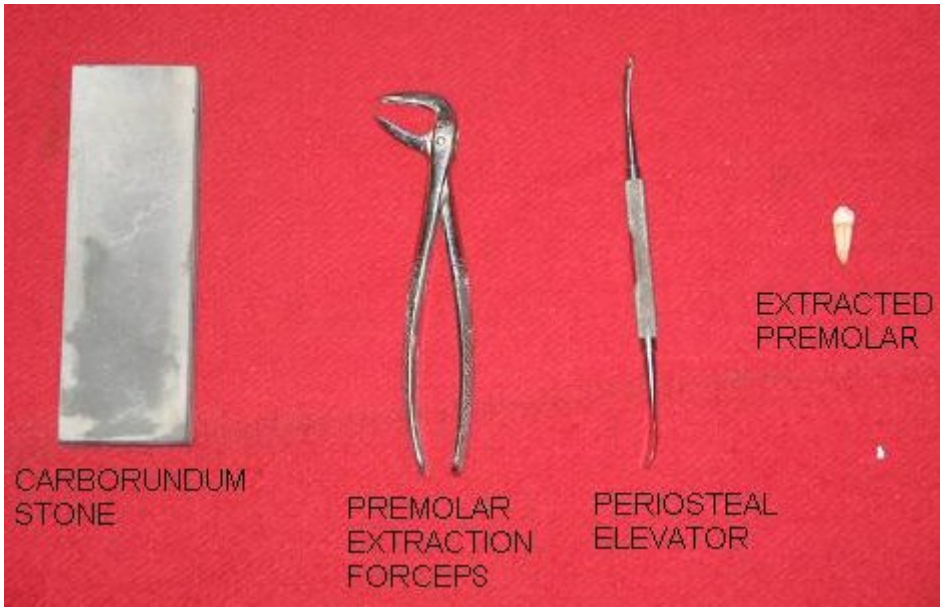
Group D - 45 - 50 years

Group E - 55- 60 years

Group F - above 60 years

The following 6 dental parameter were studied in each case:

1. Attrition
2. Peridontal disease
3. Cementum apposition
4. Secondary dentine deposition
5. Root translucency
6. Root resorption.



INSTRUMENTS USED FOR EXTRACTION OF PREMOLARS AND GROUND SECTION PREPARATION

APPARATUS

The apparatus used for the study were Tooth extraction forceps, periosteal elevator, Carborundum stone (rough and smooth), Alcohol and Xylene, Formaline, Microscope, DPX and slide, etc.

METHOD

The details regarding age, diet, habits and socioeconomic status of the deceased as noted from the relatives accompanying, was noted on the Performa. For the Socioeconomic status person occupation, education and monthly income was noted from the relatives and by using the scale given below, the socioeconomic status of the person was calculated. The scale was earlier formed by Kuppuswamy and later modified and known as Modified Kuppuswamy's socioeconomic status scale. [Source: Office of the Economic Advisor, Department of Industrial Development, Ministry of Industry, Government of India]

OCCUPATION	Score	EDUCATION	Score	INCOME (Rs)	Score

MODIFIED KUPPUSWAMY'S SOCIOECONOMIC STATUS SCALE

OCCUPATIONAL STATUS		EDUCATIONAL STATUS		INCOME	
Professional	10	Professional Degree and above	7	Above 20,000	12
Semiprofessional	6	Graduate	6	10,000 - 19,999	10
Clerk/ Shopkeeper	5	Intermediate	5	7,500 - 9,999	6
Skilled Worker	4	High School Level	4	5,000 - 7,499	4
Semi Skilled Worker	3	Middle School	3	3,000 - 4,999	3
Unskilled Worker	2	Primary School	2	1,000 - 2,999	2
Unemployed	1	Illiterate	1	Less than 1000	1

SOCIOECONOMIC STATUS: Score

LOWER : <5

UPPER LOWER : 6-10

LOWER MIDDLE : 11-15

UPPER MIDDLE : 16-25 UPPER : 26-29

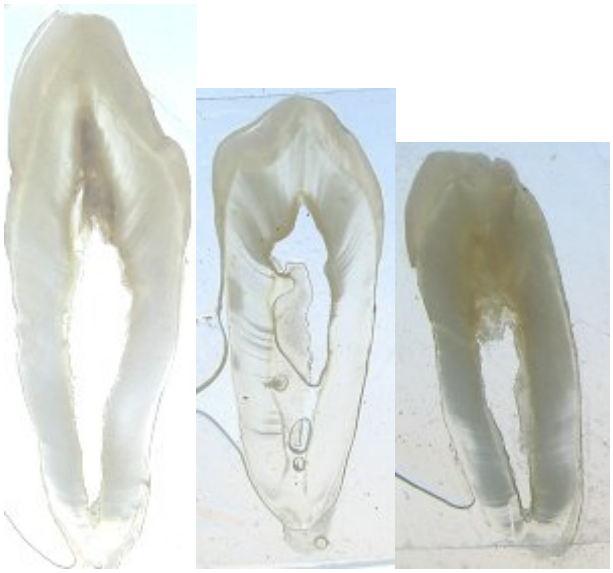
After collecting the details, teeth to be studied were selected and this selection was made based on the study of Solheim (1980) with priority given to first premolars then second premolars and canines and lastly incisors. In our study we took first premolars as they gave strongest coefficient (Kvaal and Solheim 1994). Degree of attrition and extent of peridontal disease was recorded before the extraction of the tooth and scoring is done depending upon the scale given below. Then the Tooth was extracted with extraction forceps and preserved in formalin till the ground section was prepared.

PREPARATION OF THE GROUND SECTION

For examination of a tooth, hand grinding was done manually first with rough carborundum stone fitted on the motor until a section of 2 to 3 mm was obtained and then on static carborundum stone with hand till the thickness is 1 mm. At this thickness, the root translucency was noted. Grinding was further done using fine stone till the section of 0.25-mm thickness was left. Finally cleaned and dried section is mounted on slide using DPX and viewed under



PREPARED GROUND SECTIONS OF TEETH



No Attrition Attrition involving Attrition involving enamel only up to dentine

(Score – 0) (Score – 1) (Score – 2)

VARIOUS STAGE OF ATRITION AND ITS SCORING

microscope for secondary dentine, cementum apposition and root resorption. (Metzger Z, Buchner A and Gorsky M, 1980)

The factors seen in the tooth before and after sectioning were recorded in the Performa using 4 points allotment system (Krishan Vij) as follows:

Attrition (A): A0- No Attrition

A1- Attrition limited to enamel level

A2- Attrition limited to dentine level

A3- Attrition up to pulp cavity.

1. Peridontal disease (P):

P0- No obvious peridontal disease

P1- Beginning of peridontal ds. but no bone loss

P2- Peridontal disease more than 1/3rd of the root

P3- Peridontal disease more than 2/3rd of the root.

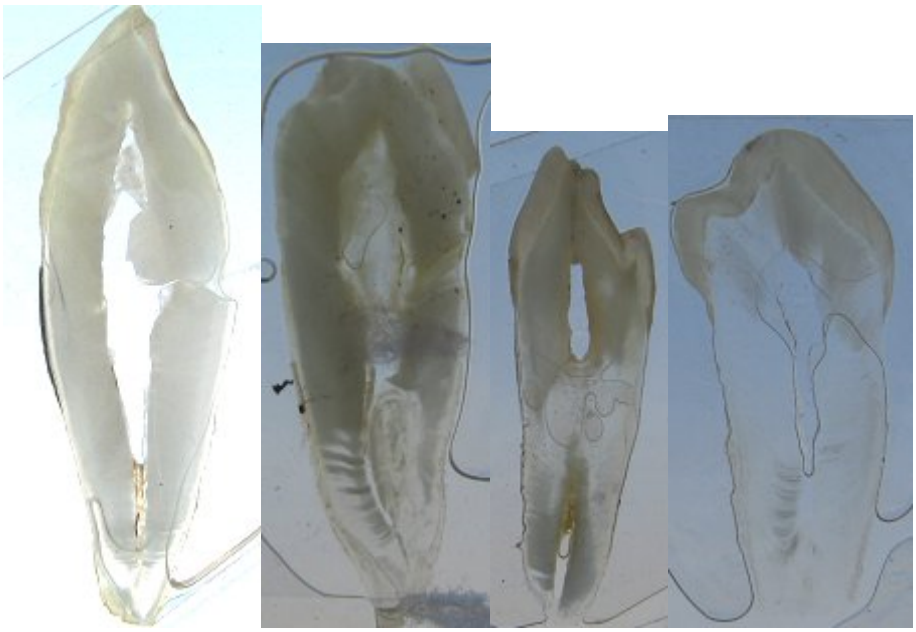
1. Secondary dentine (S):

S0- No secondary dentine formation

S1- Secondary dentine up to upper part of pulp cavity

S2- Secondary dentin up to 2/3rd of the pulp cavity

S3- Diffuse calcification of entire pulp cavity.



No Translucency Translucency Translucency Translucency

Lower 1/3rd 2/3rd of root whole root

(Score- 0) (Score – 1) (Score – 2) (Score – 3)

VARIOUS STAGE OF ROOT TRANSLUCENCY AND ITS SCORING

1. Root translucency (T):

T0- No translucency

T1- Beginning of translucency

T2- Translucency more than 1/3rd of the apical root

T3- Translucency more than 2/3rd of the apical root.

1. Cementum apposition (C):

C0- Normal cementum

C1- Thickness of cementum more than normal

C2- Abnormal thickness of cementum near the apex of the root

C3- Generalized abnormal thickness of cementum throughout the apex of the root.

1. Root resorption (R):

R0- No resorption

R1- Spotted resorption

R2- Resorption limited to cementum

R3- Extensive resorption of both cementum and dentin

After collecting the data and calculating the total score, a graph was plotted with actual age on one side and the score calculated on the other. This graph can be used to derive regression formula for the determination of age of the unknown cadaver.

The total score was also used in various previous known formula and age calculated and the difference is calculated from the actual age. Following formulas were used:

1. Formula A: Newly Derived
2. Formula B: y = 5.34 x - 4.08
3. Formula C: y = 4.56 x + 11.43
4. Formula D: y = 4.26 x + 13.45
5. Formula E: y = 6.26 x – 6.0
6. Formula F: y = 8.5 A – 26.073
7. Formula G: y = 6.37 T+ 4.63 P+2.7 S+ 2.4 C+ 3.08 A+ 1.34 R + 8.57

(where y – calculated age, x – total score, A – Attrition score, T – Root Translucency score, P – Peridontal Disease score, S – Secondary Dentine deposition score, C – Cementum Apposition Score and R – Root Resorption score)

The difference in the calculated age and actual age was found. From the above obtained difference maximum and minimum deviation of the calculated age from the actual age were also derived. Any correlation between socioeconomic statuses of the person with the total score recorded from the physiological factors of his teeth was also observed.

OBSERVATIONS

TABLE NO 1

Table showing various age group and number of cases in each group

Group	Age Group	No. of Cases
I	25 – 30	24
II	31 – 35	18
III	36 – 40	14
IV	41 – 45	8
V	46 – 50	12
VI	51 – 55	9
VII	56 – 60	11
VIII	Above 60	4
	TOTAL	**100**

A total of 100 cases were taken in the study and divided in 8 different groups with maximum no. of cases between the age group of 25 – 35 years.

TABLE NO 2

Table showing the sex distribution of the cases in the study

TABLE NO 3

Sex	No. of cases
Male	**63**
Female	**37**

Table showing distribution of cases according to diet

TABLE 4

Type of Diet	No. of cases
Vegetarian	76
Non- Vegetarian	24

Table showing distribution of cases according to Residence

TABLE5

Residence	No. of cases
Urban	50
Rural	50

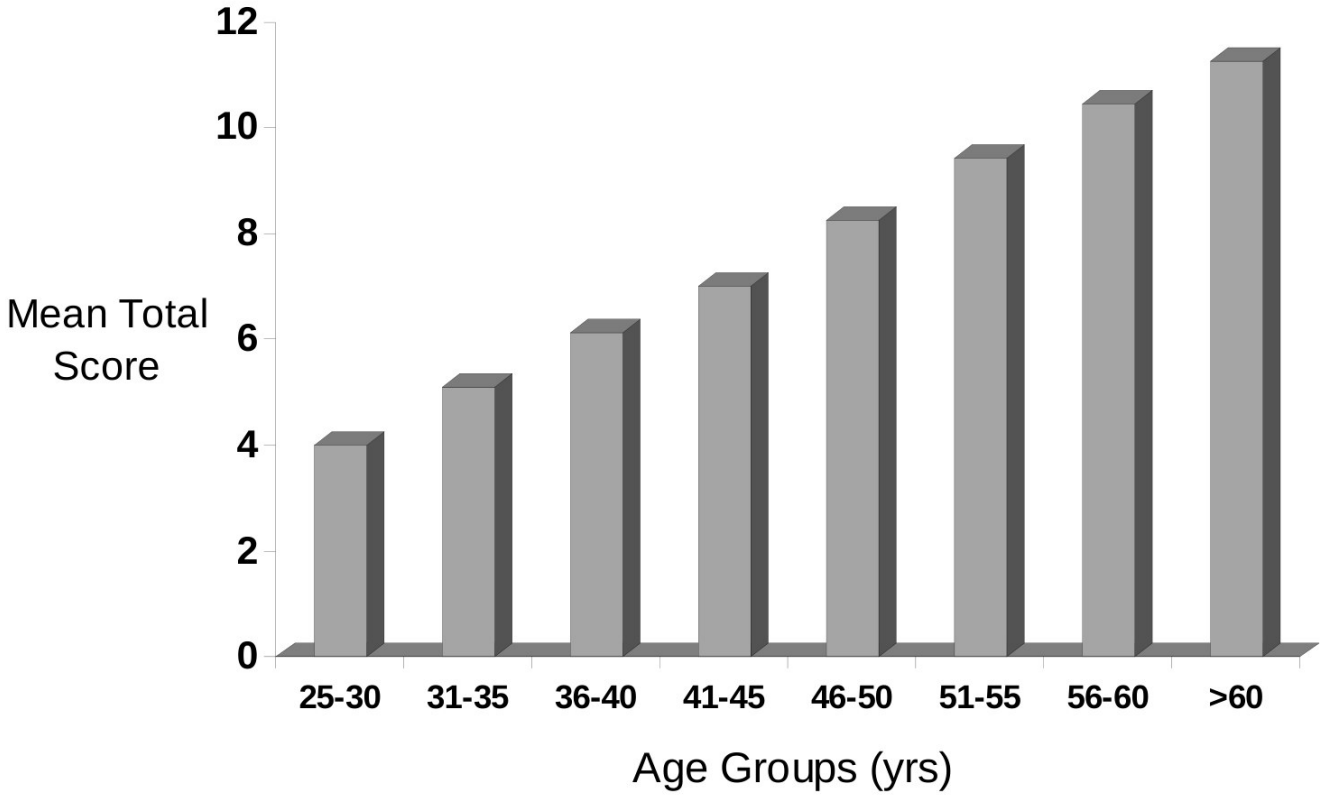
Table showing distribution of cases according to Socio-economic status

Group	Socio-economic status	No. of cases
A	Lower	46
B	Upper Lower	27
C	Lower Middle	13
D	Upper Middle	9
E	Upper	5

In the study of 100 cases, there were maximum number of cases from the lower socioeconomic status and least from higher socio-economic status.

TABLE 6

Table showing various group and mean total score calculated from all the six factors



Group	Age Group	Total Score of six factors
I	25 – 30	4.0 ± 0.41
II	31 – 35	5.11 ± 0.32
III	36 – 40	6.14 ± 0.36
IV	41 – 45	7.0 ± 0.53
V	46 – 50	8.25 ± 0.45
VI	51 – 55	9.44 ± 0.52
VII	56 – 60	10.45 ± 0.68
VIII	Above 60	11.25 ± 0.50

In this table various age groups and the mean of the total score calculated from six physiological changes occurring with age are shown. It was observed that score was significantly increasing with the increasing age.

TABLE 7

Table showing comparison of total score according to sex of the person

Sex	No. of cases	Range of total score	Mean ± S.D.	t	p	S
Male	63	4 – 12	6.92 ± 2.41	0.97	>0.05	NS
Female	37	3 - 11	6.43 ± 2.43			

In the study the number of females was half that of males and the mean of total score of various physiological factors in males were slightly higher as compared to that of females but statistically the relation of the total score to that of sex of person was non-significant.

TABLE 8

Table showing comparison of total score according to diet of the person

Diet	No. of cases	Range of total score	Mean ± S.D.	t	p	S
Vegetarian	76	3 – 12	6.60 ± 2.17	0.99	>0.05	NS
Non-vegetarian	24	4 - 11	7.16 ± 2.21			

There were more of vegetarian in the study group but the total score calculated was higher in non-vegetarian as compared to vegetarian. However this difference in score was statistically non-significant.

TABLE 9

Table showing comparison of total score according to area to which the person belongs

Area	No. of cases	Range of total score	Mean ± S.D.	t	p	S
Urban	50	3 – 12	6.78 ± 2.48	0.15	>0.05	NS
Rural	50	4 - 11	6.70 ± 2.40			

In this table it is seen that person belonging to urban area was equal to the number of person belonging to rural area with almost same values of mean of total score calculated and statistically also it was seen that difference of the scores according to the area at which person live was non-significant.

TABLE 10

Table showing comparison of total score according to Socio-economic status of the person

S. No.	Socio-economic status	No. of cases	Range	Mean ± SD
I	Lower	46	3 – 12	6.43 ± 2.39
II	Upper Lower	27	3 – 11	7.11 ± 2.37
III	Lower Middle	13	4 – 11	7.30 ± 2.52
IV	Upper Middle	9	4 – 11	6.66 ± 2.50
V	Upper	5	4 – 11	6.20 ± 2.94

Statistical Analysis

Comparison	T	P	Significance
I and II	1.16	>0.05	NS
I and III	1.14	>0.05	NS
I and IV	0.26	>0.05	NS
I and V	0.20	>0.05	NS
II and III	0.24	>0.05	NS
II and IV	0.48	>0.05	NS
II and V	0.76	>0.05	NS
III and IV	0.58	>0.05	NS
III and V	0.79	>0.05	NS
IV and V	0.31	>0.05	NS

In the study, it was found that the total score was having highest value amongst teeth of the person belonging to lower middle socioeconomic status but it was also seen that although there was difference in the total scores in various socioeconomic groups, statistically there was no significant

difference in the total scores calculated from various physiological changes of teeth in various socioeconomic status groups.

TABLE 11

Table showing age calculated using Pillai and Bhaskar formula B: y= 5.34 x – 4.08 (x = Total Score and y = Estimated Age)

TABLE 12

S. No.	Actual Age	Total Score	Calculated age with formula B	Difference in age
1	27	4	17.28	-9.72
2	34	5	22.62	-11.38
3	35	6	27.96	-7.04
4	29	4	17.28	-11.72
5	58	11	54.66	-3.34
6	60	11	54.66	-5.34
7	38	6	27.96	-10.04
8	50	8	38.64	-11.36
9	40	6	27.96	-12.04
10	28	3	11.94	-16.06
11	30	5	22.62	-7.38
12	55	9	43.98	-11.02
13	62	11	54.66	-7.34
14	49	8	38.64	-10.36
15	32	5	22.62	-9.38
16	46	8	38.64	-7.36
17	25	4	17.28	-7.72
18	42	7	33.3	-8.7
19	52	9	43.98	-8.02
20	28	4	17.28	-10.72
21	50	8	38.64	-11.36
22	47	8	38.64	-8.36
23	35	5	22.62	-12.38
24	28	4	17.28	-10.72
25	40	6	27.96	-12.04
26	50	9	43.98	-6.02
27	57	10	49.32	-7.68
28	29	4	17.28	-11.72
29	30	4	17.28	-12.72
30	45	7	33.3	-11.7

S. No.	Actual Age	Total Score	Calculated age with formula B	Difference in age
31	26	4	17.28	-8.72
32	27	4	17.28	-9.72
33	30	4	17.28	-12.72
34	40	6	27.96	-12.04
35	55	9	43.98	-11.02
			TABLE 11 (contd.)	
36	48	8	38.64	-9.36
37	30	5	22.62	-7.38
38	28	4	17.28	-10.72
39	25	4	17.28	-7.72
40	37	6	27.96	-9.04
41	45	7	33.3	-11.7
42	48	8	38.64	-9.36
43	37	6	27.96	-9.04
44	65	11	54.66	-10.34
45	29	4	17.28	-11.72
46	25	3	11.94	-13.06
47	30	4	17.28	-12.72
48	40	7	33.3	-6.7
49	65	12	60	-5
50	32	5	22.62	-9.38
51	26	4	17.28	-8.72
52	33	5	22.62	-10.38
53	65	11	54.66	-10.34
54	37	6	27.96	-9.04
55	52	9	43.98	-8.02
56	32	5	22.62	-9.38
57	25	4	17.28	-7.72
58	32	5	22.62	-9.38
59	27	4	17.28	-9.72
60	45	7	33.3	-11.7

S. No.	Actual Age	Total Score	Calculated age with formula B	Difference in age
61	55	10	49.32	-5.68
62	28	4	17.28	-10.72
63	35	5	22.62	-12.38
64	28	4	17.28	-10.72
65	50	9	43.98	-6.02
66	42	6	27.96	-14.04
67	32	5	22.62	-9.38
68	40	7	33.3	-6.7
69	34	5	22.62	-11.38
70	36	6	27.96	-8.04
71	45	8	38.64	-6.36
72	60	11	54.66	-5.34
73	54	10	49.32	-4.68
74	27	4	17.28	-9.72
75	60	11	54.66	-5.34
76	55	10	49.32	-5.68
77	55	10	49.32	-5.68
			TABLE 11 (contd.)	
78	50	9	43.98	-6.02
79	47	8	38.64	-8.36
80	42	7	33.3	-8.7
81	57	10	49.32	-7.68
82	35	5	22.62	-12.38
83	51	9	43.98	-7.02
84	31	5	22.62	-8.38
85	56	9	43.98	-12.02
86	32	5	22.62	-9.38
87	60	11	54.66	-5.34
88	40	6	27.96	-12.04
89	40	6	27.96	-12.04
90	60	10	49.32	-10.68

S. No.	Actual Age	Total Score	Calculated age with formula B	Difference in age
91	32	5	22.62	-9.38
92	58	10	49.32	-8.68
93	35	5	22.62	-12.38
94	35	6	27.96	-7.04
95	32	5	22.62	-9.38
96	42	7	33.3	-8.7
97	47	8	38.64	-8.36
98	60	11	54.66	-5.34
99	40	6	27.96	-12.04
100	38	6	27.96	-10.04

Table showing age calculated using Gustafson's formula(C)

y = 4.56 x + 11.43 (x = Total Score and y = Estimated Age)

TABLE 13

S. No.	Actual Age	Total Score	Calculated age with formula C	Difference in age
1	27	4	29.67	2.67
2	34	5	34.23	0.23
3	35	6	38.79	3.79
4	29	4	29.67	0.67
5	58	11	61.59	3.59
6	60	11	61.59	1.59
7	38	6	38.79	0.79
8	50	8	47.91	-2.09
9	40	6	38.79	-1.21
10	28	3	25.11	-2.89
11	30	5	34.23	4.23
12	55	9	52.47	-2.53
13	62	11	61.59	-0.41
14	49	8	47.91	-1.09
15	32	5	34.23	2.23
16	46	8	47.91	1.91
17	25	4	29.67	4.67
18	42	7	43.35	1.35
19	52	9	52.47	0.47
20	28	4	29.67	1.67
21	50	8	47.91	-2.09
22	47	8	47.91	0.91
23	35	5	34.23	-0.77
24	28	4	29.67	1.67
25	40	6	38.79	-1.21
26	50	9	52.47	2.47
27	57	10	57.03	0.03
28	29	4	29.67	0.67
29	30	4	29.67	-0.33
30	45	7	43.35	-1.65

S. No.	Actual Age	Total Score	Calculated age with formula C	Difference in age
31	26	4	29.67	3.67
32	27	4	29.67	2.67
33	30	4	29.67	-0.33
34	40	6	38.79	-1.21
35	55	9	52.47	-2.53
		TABLE 12 (contd.)		
36	48	8	47.91	-0.09
37	30	5	34.23	4.23
38	28	4	29.67	1.67
39	25	4	29.67	4.67
40	37	6	38.79	1.79
41	45	7	43.35	-1.65
42	48	8	47.91	-0.09
43	37	6	38.79	1.79
44	65	11	61.59	-3.41
45	29	4	29.67	0.67
46	25	3	25.11	0.11
47	30	4	29.67	-0.33
48	40	7	43.35	3.35
49	65	12	66.15	1.15
50	32	5	34.23	2.23
51	26	4	29.67	3.67
52	33	5	34.23	1.23
53	65	11	61.59	-3.41
54	37	6	38.79	1.79
55	52	9	52.47	0.47
56	32	5	34.23	2.23
57	25	4	29.67	4.67
58	32	5	34.23	2.23
59	27	4	29.67	2.67
60	45	7	43.35	-1.65

S. No.	Actual Age	Total Score	Calculated age with formula C	Difference in age
61	55	10	57.03	2.03
62	28	4	29.67	1.67
63	35	5	34.23	-0.77
64	28	4	29.67	1.67
65	50	9	52.47	2.47
66	42	6	38.79	-3.21
67	32	5	34.23	2.23
68	40	7	43.35	3.35
69	34	5	34.23	0.23
70	36	6	38.79	2.79
71	45	8	47.91	2.91
72	60	11	61.59	1.59
73	54	10	57.03	3.03
74	27	4	29.67	2.67
75	60	11	61.59	1.59
76	55	10	57.03	2.03
77	55	10	57.03	2.03
			TABLE 12 (contd.)	
78	50	9	52.47	2.47
79	47	8	47.91	0.91
80	42	7	43.35	1.35
81	57	10	57.03	0.03
82	35	5	34.23	-0.77
83	51	9	52.47	1.47
84	31	5	34.23	3.23
85	56	9	52.47	-3.53
86	32	5	34.23	2.23
87	60	11	61.59	1.59
88	40	6	38.79	-1.21
89	40	6	38.79	-1.21
90	60	10	57.03	-2.97

S. No.	Actual Age	Total Score	Calculated age with formula C	Difference in age
91	32	5	34.23	2.23
92	58	10	57.03	-0.97
93	35	5	34.23	-0.77
94	35	6	38.79	3.79
95	32	5	34.23	2.23
96	42	7	43.35	1.35
97	47	8	47.91	0.91
98	60	11	61.59	1.59
99	40	6	38.79	-1.21
100	38	6	38.79	0.79

Table showing age calculated using Maple and Rice's formula (D): y = 4.26 x + 13.45 (x = Total Score and y = Estimated Age)

TABLE 14

S. No.	Actual Age	Total Score	Calculated age with formula D	Difference in age
1	27	4	30.49	3.49
2	34	5	34.75	0.75
3	35	6	39.01	4.01
4	29	4	30.49	1.49
5	58	11	60.31	2.31
6	60	11	60.31	0.31
7	38	6	39.01	1.01
8	50	8	47.53	-2.47
9	40	6	39.01	-0.99
10	28	3	26.23	-1.77
11	30	5	34.75	4.75
12	55	9	51.79	-3.21
13	62	11	60.31	-1.69
14	49	8	47.53	-1.47
15	32	5	34.75	2.75
16	46	8	47.53	1.53
17	25	4	30.49	5.49
18	42	7	43.27	1.27
19	52	9	51.79	-0.21
20	28	4	30.49	2.49
21	50	8	47.53	-2.47
22	47	8	47.53	0.53
23	35	5	34.75	-0.25
24	28	4	30.49	2.49
25	40	6	39.01	-0.99
26	50	9	51.79	1.79
27	57	10	56.05	-0.95
28	29	4	30.49	1.49
29	30	4	30.49	0.49
30	45	7	43.27	-1.73

S. No.	Actual Age	Total Score	Calculated age with formula D	Difference in age
31	26	4	30.49	4.49
32	27	4	30.49	3.49
33	30	4	30.49	0.49
34	40	6	39.01	-0.99
35	55	9	51.79	-3.21
			TABLE 13 (contd.)	
36	48	8	47.53	-0.47
37	30	5	34.75	4.75
38	28	4	30.49	2.49
39	25	4	30.49	5.49
40	37	6	39.01	2.01
41	45	7	43.27	-1.73
42	48	8	47.53	-0.47
43	37	6	39.01	2.01
44	65	11	60.31	-4.69
45	29	4	30.49	1.49
46	25	3	26.23	1.23
47	30	4	30.49	0.49
48	40	7	43.27	3.27
49	65	12	64.57	-0.43
50	32	5	34.75	2.75
51	26	4	30.49	4.49
52	33	5	34.75	1.75
53	65	11	60.31	-4.69
54	37	6	39.01	2.01
55	52	9	51.79	-0.21
56	32	5	34.75	2.75
57	25	4	30.49	5.49
58	32	5	34.75	2.75
59	27	4	30.49	3.49
60	45	7	43.27	-1.73

S. No.	Actual Age	Total Score	Calculated age with formula D	Difference in age
61	55	10	56.05	1.05
62	28	4	30.49	2.49
63	35	5	34.75	-0.25
64	28	4	30.49	2.49
65	50	9	51.79	1.79
66	42	6	39.01	-2.99
67	32	5	34.75	2.75
68	40	7	43.27	3.27
69	34	5	34.75	0.75
70	36	6	39.01	3.01
71	45	8	47.53	2.53
72	60	11	60.31	0.31
73	54	10	56.05	2.05
74	27	4	30.49	3.49
75	60	11	60.31	0.31
76	55	10	56.05	1.05
77	55	10	56.05	1.05
			TABLE 13(contd.)	
78	50	9	51.79	1.79
79	47	8	47.53	0.53
80	42	7	43.27	1.27
81	57	10	56.05	-0.95
82	35	5	34.75	-0.25
83	51	9	51.79	0.79
84	31	5	34.75	3.75
85	56	9	51.79	-4.21
86	32	5	34.75	2.75
87	60	11	60.31	0.31
88	40	6	39.01	-0.99
89	40	6	39.01	-0.99
90	60	10	56.05	-3.95

S. No.	Actual Age	Total Score	Calculated age with formula D	Difference in age
91	32	5	34.75	2.75
92	58	10	56.05	-1.95
93	35	5	34.75	-0.25
94	35	6	39.01	4.01
95	32	5	34.75	2.75
96	42	7	43.27	1.27
97	47	8	47.53	0.53
98	60	11	60.31	0.31
99	40	6	39.01	-0.99
100	38	6	39.01	1.01

Table showing age calculated using Singh and Mukerjee's formula (E): y = 6.26 x – 6 (x = Total Score and y = Estimated Age)

TABLE 15

S. No.	Actual Age	Total Score	Calculated age with formula E	Difference in age
1	27	4	19.04	-7.96
2	34	5	25.3	-8.7
3	35	6	31.56	-3.44
4	29	4	19.04	-9.96
5	58	11	62.86	4.86
6	60	11	62.86	2.86
7	38	6	31.56	-6.44
8	50	8	44.08	-5.92
9	40	6	31.56	-8.44
10	28	3	12.78	-15.22
11	30	5	25.3	-4.7
12	55	9	50.34	-4.66
13	62	11	62.86	0.86
14	49	8	44.08	-4.92
15	32	5	25.3	-6.7
16	46	8	44.08	-1.92
17	25	4	19.04	-5.96
18	42	7	37.82	-4.18
19	52	9	50.34	-1.66
20	28	4	19.04	-8.96
21	50	8	44.08	-5.92
22	47	8	44.08	-2.92
23	35	5	25.3	-9.7
24	28	4	19.04	-8.96
25	40	6	31.56	-8.44
26	50	9	50.34	0.34
27	57	10	56.6	-0.4
28	29	4	19.04	-9.96
29	30	4	19.04	-10.96
30	45	7	37.82	-7.18

S. No.	Actual Age	Total Score	Calculated age with formula E	Difference in age
31	26	4	19.04	-6.96
32	27	4	19.04	-7.96
33	30	4	19.04	-10.96
34	40	6	31.56	-8.44
35	55	9	50.34	-4.66
			TABLE 14 (contd.)	
36	48	8	44.08	-3.92
37	30	5	25.3	-4.7
38	28	4	19.04	-8.96
39	25	4	19.04	-5.96
40	37	6	31.56	-5.44
41	45	7	37.82	-7.18
42	48	8	44.08	-3.92
43	37	6	31.56	-5.44
44	65	11	62.86	-2.14
45	29	4	19.04	-9.96
46	25	3	12.78	-12.22
47	30	4	19.04	-10.96
48	40	7	37.82	-2.18
49	65	12	69.12	4.12
50	32	5	25.3	-6.7
51	26	4	19.04	-6.96
52	33	5	25.3	-7.7
53	65	11	62.86	-2.14
54	37	6	31.56	-5.44
55	52	9	50.34	-1.66
56	32	5	25.3	-6.7
57	25	4	19.04	-5.96
58	32	5	25.3	-6.7
59	27	4	19.04	-7.96
60	45	7	37.82	-7.18

S. No.	Actual Age	Total Score	Calculated age with formula E	Difference in age
61	55	10	56.6	1.6
62	28	4	19.04	-8.96
63	35	5	25.3	-9.7
64	28	4	19.04	-8.96
65	50	9	50.34	0.34
66	42	6	31.56	-10.44
67	32	5	25.3	-6.7
68	40	7	37.82	-2.18
69	34	5	25.3	-8.7
70	36	6	31.56	-4.44
71	45	8	44.08	-0.92
72	60	11	62.86	2.86
73	54	10	56.6	2.6
74	27	4	19.04	-7.96
75	60	11	62.86	2.86
76	55	10	56.6	1.6
77	55	10	56.6	1.6
			TABLE 14(contd.)	
78	50	9	50.34	0.34
79	47	8	44.08	-2.92
80	42	7	37.82	-4.18
81	57	10	56.6	-0.4
82	35	5	25.3	-9.7
83	51	9	50.34	-0.66
84	31	5	25.3	-5.7
85	56	9	50.34	-5.66
86	32	5	25.3	-6.7
87	60	11	62.86	2.86
88	40	6	31.56	-8.44
89	40	6	31.56	-8.44
90	60	10	56.6	-3.4

S. No.	Actual Age	Total Score	Calculated age with formula E	Difference in age
91	32	5	25.3	-6.7
92	58	10	56.6	-1.4
93	35	5	25.3	-9.7
94	35	6	31.56	-3.44
95	32	5	25.3	-6.7
96	42	7	37.82	-4.18
97	47	8	44.08	-2.92
98	60	11	62.86	2.86
99	40	6	31.56	-8.44
100	38	6	31.56	-6.44

Table showing age calculated Tomaru et al formula (F)

y = 8.50 A + 26.073 (A = Attrition score and y = Estimated Age)

TABLE 16

S. No.	Actual Age	Attrition Score	Calculated age with formula F	Difference in age
1	27	1	34.573	7.573
2	34	1	34.573	0.573
3	35	2	43.073	8.073
4	29	1	34.573	5.573
5	58	2	43.073	-14.927
6	60	2	43.073	-16.927
7	38	1	34.573	-3.427
8	50	2	43.073	-6.927
9	40	2	43.073	3.073
10	28	1	34.573	6.573
11	30	1	34.573	4.573
12	55	2	43.073	-11.927
13	62	2	43.073	-18.927
14	49	2	43.073	-5.927
15	32	2	43.073	11.073
16	46	2	43.073	-2.927
17	25	1	34.573	9.573
18	42	2	43.073	1.073
19	52	2	43.073	-8.927
20	28	1	34.573	6.573
21	50	2	43.073	-6.927
22	47	2	43.073	-3.927
23	35	1	34.573	-0.427
24	28	1	34.573	6.573
25	40	2	43.073	3.073
26	50	2	43.073	-6.927
27	57	2	43.073	-13.927
28	29	1	34.573	5.573
29	30	1	34.573	4.573
30	45	2	43.073	-1.927

S. No.	Actual Age	Attrition Score	Calculated age with formula F	Difference in age
31	26	1	34.573	8.573
32	27	1	34.573	7.573
33	30	1	34.573	4.573
34	40	2	43.073	3.073
35	55	2	43.073	-11.927
		TABLE 15 (contd.)		
36	48	2	43.073	-4.927
37	30	2	34.573	4.573
38	28	1	34.573	6.573
39	25	1	34.573	9.573
40	37	1	34.573	-2.427
41	45	1	43.073	-1.927
42	48	2	43.073	-4.927
43	37	2	34.573	-2.427
44	65	1	43.073	-21.927
45	29	2	34.573	5.573
46	25	1	34.573	9.573
47	30	1	34.573	4.573
48	40	1	43.073	3.073
49	65	2	51.573	-13.427
50	32	3	34.573	2.573
51	26	1	34.573	8.573
52	33	1	43.073	10.073
53	65	2	43.073	-21.927
54	37	2	34.573	-2.427
55	52	1	43.073	-8.927
56	32	2	43.073	11.073
57	25	2	43.073	18.073
58	32	2	43.073	11.073
59	27	2	34.573	7.573
60	45	1	43.073	-1.927

S. No.	Actual Age	Attrition Score	Calculated age with formula F	Difference in age
61	55	2	43.073	-11.927
62	28	2	34.573	6.573
63	35	1	34.573	-0.427
64	28	1	34.573	6.573
65	50	1	43.073	-6.927
66	42	2	43.073	1.073
67	32	2	43.073	11.073
68	40	2	43.073	3.073
69	34	2	34.573	0.573
70	36	1	43.073	7.073
71	45	2	43.073	-1.927
72	60	2	43.073	-16.927
73	54	2	43.073	-10.927
74	27	2	34.573	7.573
75	60	1	43.073	-16.927
76	55	2	43.073	-11.927
77	55	2	43.073	-11.927
			TABLE 15 (contd.)	
78	50	2	43.073	-6.927
79	47	2	43.073	-3.927
80	42	1	43.073	1.073
81	57	2	43.073	-13.927
82	35	1	34.573	-0.427
83	51	2	43.073	-7.927
84	31	1	43.073	12.073
85	56	2	43.073	-12.927
86	32	2	34.573	2.573
87	60	1	43.073	-16.927
88	40	2	43.073	3.073
89	40	2	43.073	3.073
90	60	1	43.073	-16.927

S. No.	Actual Age	Attrition Score	Calculated age with formula F	Difference in age
91	32	1	34.573	2.573
92	58	1	43.073	-14.927
93	35	2	34.573	-0.427
94	35	2	43.073	8.073
95	32	1	34.573	2.573
96	42	1	43.073	1.073
97	47	1	43.073	-3.927
98	60	1	43.073	-16.927
99	40	1	43.073	3.073
100	38	1	34.573	-3.427

Table showing age calculated Multiple Regression formula (G)

$y = 6.37\ T + 4.63\ P + 2.70\ S + 2.40\ C + 3.08\ A + 1.34\ R + 8.57$

TABLE 17

S. No.	Actual Age	SCORE						Calculated age with formula G	Difference in age
		A	P	S	C	T	R		
1	27	1	1	1	0	1	0	25.35	-1.65
2	34	1	1	1	1	1	0	27.75	-6.25
3	35	2	1	1	0	1	1	29.77	-5.23
4	29	1	1	1	0	1	1	26.69	-2.31
5	58	2	1	2	1	3	2	48.95	-9.05
6	60	2	2	2	1	3	1	52.24	-7.76
7	38	1	1	1	0	1	1	26.69	-11.31
8	50	2	1	1	1	2	1	38.54	-11.46
9	40	2	1	1	0	1	1	29.77	-10.23
10	28	1	0	1	0	1	0	20.72	-7.28
11	30	1	1	1	1	1	0	27.75	-2.25
12	55	2	2	1	1	2	1	43.17	-11.83
13	62	2	2	2	1	2	2	47.21	-14.79
14	49	2	1	1	1	1	1	32.17	-16.83
15	32	2	1	1	0	1	1	29.77	-2.23
16	46	2	1	1	1	2	1	38.54	-7.46
17	25	1	1	1	0	1	0	25.35	0.35
18	42	2	1	1	1	1	1	32.17	-9.83
19	52	2	1	1	1	2	1	38.54	-13.46
20	28	1	1	1	0	1	0	25.35	-2.65
21	50	2	1	1	1	2	1	38.54	-11.46
22	47	2	2	1	0	3	0	45.8	-1.2

23	35	1	1	1	1	1	0	27.75	-7.25
24	28	1	2	0	0	1	0	27.28	-0.72
25	40	2	1	1	0	1	1	29.77	-10.23
26	50	2	2	1	1	2	1	43.17	-6.83
27	57	2	1	2	1	2	2	42.58	-14.42
28	29	1	1	1	0	1	0	25.35	-3.65
29	30	1	2	0	0	1	0	27.28	-2.72
30	45	2	1	1	1	1	1	32.17	-12.83
31	26	1	2	0	0	1	0	27.28	1.28
32	27	1	1	1	0	1	0	25.35	-1.65
33	30	1	2	0	0	1	0	27.28	-2.72
34	40	2	1	1	0	1	1	29.77	-10.23

TABLE 16 (contd.)

35	55	2	2	1	1	2	1	43.17	-11.83
36	48	2	1	1	1	2	1	38.54	-9.46
37	30	1	1	1	1	1	0	27.75	-2.25
38	28	1	2	0	0	1	0	27.28	-0.72
39	25	1	1	1	0	1	0	25.35	0.35
40	37	1	1	1	1	1	1	29.09	-7.91
41	45	2	1	1	1	1	1	32.17	-12.83
42	48	2	1	1	1	2	1	38.54	-9.46
43	37	1	2	1	1	1	0	32.38	-4.62
44	65	2	2	2	1	3	1	52.24	-12.76
45	29	1	2	0	0	1	0	27.28	-1.72
46	25	1	1	0	0	1	0	22.65	-2.35

47	30	1	1	1	0	1	0	25.35	-4.65
48	40	2	1	1	1	1	1	32.17	-7.83
49	65	3	2	2	1	3	1	55.32	-9.68
50	32	1	1	1	1	1	0	27.75	-4.25
51	26	1	1	1	0	1	0	25.35	-0.65
52	33	2	1	1	0	1	0	28.43	-4.57
53	65	2	2	2	1	3	1	52.24	-12.76
54	37	1	1	1	1	1	1	29.09	-7.91
55	52	2	2	1	1	2	1	43.17	-8.83
56	32	2	1	1	0	1	0	28.43	-3.57
57	25	2	1	0	0	1	0	25.73	0.73
58	32	2	1	1	0	1	0	28.43	-3.57
59	27	1	1	1	0	1	0	25.35	-1.65
60	45	2	1	1	1	1	1	32.17	-12.83
61	55	2	2	2	1	2	1	45.87	-9.13
62	28	1	2	0	0	1	0	27.28	-0.72
63	35	1	1	1	1	1	0	27.75	-7.25
64	28	1	1	1	0	1	0	25.35	-2.65
65	50	2	2	1	1	2	1	43.17	-6.83
66	42	2	1	1	0	1	1	29.77	-12.23
67	32	2	1	1	0	1	0	28.43	-3.57
68	40	2	1	1	1	1	1	32.17	-7.83
69	34	1	1	1	1	1	0	27.75	-6.25
70	36	2	2	1	0	1	0	33.06	-2.94
71	45	2	2	1	1	2	0	41.83	-3.17

72	60	2	1	2	1	3	2	48.95	-11.05
73	54	2	2	2	1	2	1	45.87	-8.13
74	27	1	1	1	0	1	0	25.35	-1.65
75	60	2	1	2	1	3	0	46.27	-13.73
76	55	2	2	2	1	2	1	45.87	-9.13

TABLE 16 (contd.)

77	55	2	1	2	1	2	2	42.58	-12.42
78	50	2	2	2	1	2	0	44.53	-5.47
79	47	2	2	1	1	2	0	41.83	-5.17
80	42	2	1	1	1	2	0	37.2	-4.8
81	57	2	2	2	1	2	1	45.87	-11.13
82	35	1	1	1	1	1	0	27.75	-7.25
83	51	2	2	2	1	2	0	44.53	-6.47
84	31	2	1	1	0	1	0	28.43	-2.57
85	56	2	2	2	1	2	0	44.53	-11.47
86	32	1	2	1	0	1	0	29.98	-2.02
87	60	2	1	2	1	3	2	48.95	-11.05
88	40	2	2	1	0	1	0	33.06	-6.94
89	40	2	2	1	0	1	0	33.06	-6.94
90	60	2	1	2	1	2	2	42.58	-17.42
91	32	1	1	1	1	1	0	27.75	-4.25
92	58	2	1	2	1	3	1	47.61	-10.39
93	35	1	2	1	0	1	0	29.98	-5.02
94	35	2	2	1	0	1	0	33.06	-1.94
95	32	1	1	1	1	1	0	27.75	-4.25

96	42	2	1	1	1	1	1	32.17	-9.83
97	47	2	1	1	1	3	0	43.57	-3.43
98	60	2	1	2	1	3	2	48.95	-11.05
99	40	2	1	1	1	1	0	30.83	-9.17
100	38	1	1	1	1	1	1	29.09	-8.91

Table showing age calculated using newly derived formula A

y= 4.7 x + 9.66 (x = Total Score and y = Estimated Age)

TABLE 18

S. No.	Actual Age	Total Score	Calculated age with new formula	Difference in age
1	27	4	28.46	1.46
2	34	5	33.16	-0.84
3	35	6	37.86	2.86
4	29	4	28.46	-0.54
5	58	11	61.36	3.36
6	60	11	61.36	1.36
7	38	6	37.86	-0.14
8	50	8	47.26	-2.74
9	40	6	37.86	-2.14
10	28	3	23.76	-4.24
11	30	5	33.16	3.16
12	55	9	51.96	-3.04
13	62	11	61.36	-0.64
14	49	8	47.26	-1.74
15	32	5	33.16	1.16
16	46	8	47.26	1.26
17	25	4	28.46	3.46
18	42	7	42.56	0.56
19	52	9	51.96	-0.04
20	28	4	28.46	0.46
21	50	8	47.26	-2.74
22	47	8	47.26	0.26
23	35	5	33.16	-1.84
24	28	4	28.46	0.46
25	40	6	37.86	-2.14
26	50	9	51.96	1.96
27	57	10	56.66	-0.34
28	29	4	28.46	-0.54
29	30	4	28.46	-1.54
30	45	7	42.56	-2.44

S. No.	Actual Age	Total Score	Calculated age with new formula	Difference in age
31	26	4	28.46	2.46
32	27	4	28.46	1.46
33	30	4	28.46	-1.54
34	40	6	37.86	-2.14
35	55	9	51.96	-3.04
			TABLE 17 (contd.)	
36	48	8	47.26	-0.74
37	30	5	33.16	3.16
38	28	4	28.46	0.46
39	25	4	28.46	3.46
40	37	6	37.86	0.86
41	45	7	42.56	-2.44
42	48	8	47.26	-0.74
43	37	6	37.86	0.86
44	65	11	61.36	-3.64
45	29	4	28.46	-0.54
46	25	3	23.76	-1.24
47	30	4	28.46	-1.54
48	40	7	42.56	2.56
49	65	12	66.06	1.06
50	32	5	33.16	1.16
51	26	4	28.46	2.46
52	33	5	33.16	0.16
53	65	11	61.36	-3.64
54	37	6	37.86	0.86
55	52	9	51.96	-0.04
56	32	5	33.16	1.16
57	25	4	28.46	3.46
58	32	5	33.16	1.16
59	27	4	28.46	1.46
60	45	7	42.56	-2.44

S. No.	Actual Age	Total Score	Calculated age with new formula	Difference in age
61	55	10	56.66	1.66
62	28	4	28.46	0.46
63	35	5	33.16	-1.84
64	28	4	28.46	0.46
65	50	9	51.96	1.96
66	42	6	37.86	-4.14
67	32	5	33.16	1.16
68	40	7	42.56	2.56
69	34	5	33.16	-0.84
70	36	6	37.86	1.86
71	45	8	47.26	2.26
72	60	11	61.36	1.36
73	54	10	56.66	2.66
74	27	4	28.46	1.46
75	60	11	61.36	1.36
76	55	10	56.66	1.66
77	55	10	56.66	1.66
			TABLE 17 (contd.)	
78	50	9	51.96	1.96
79	47	8	47.26	0.26
80	42	7	42.56	0.56
81	57	10	56.66	-0.34
82	35	5	33.16	-1.84
83	51	9	51.96	0.96
84	31	5	33.16	2.16
85	56	9	51.96	-4.04
86	32	5	33.16	1.16
87	60	11	61.36	1.36
88	40	6	37.86	-2.14
89	40	6	37.86	-2.14
90	60	10	56.66	-3.34

S. No.	Actual Age	Total Score	Calculated age with new formula	Difference in age
91	32	5	33.16	1.16
92	58	10	56.66	-1.34
93	35	5	33.16	-1.84
94	35	6	37.86	2.86
95	32	5	33.16	1.16
96	42	7	42.56	0.56
97	47	8	47.26	0.26
98	60	11	61.36	1.36
99	40	6	37.86	-2.14
100	38	6	37.86	-0.14

Table showing comparison of age calculated by new derived formula and actual age

Age	Range	Mean ± S.D.	t	p	S
Actual	25 – 65	41.23 ± 11.65	0.06	> 0.05	NS
Calculated	23.76 – 66.06	41.33 ± 11.38			

In the study, the new regression formula derived was used to calculate age of the person using total score and was compared with the actual age of the person. It was found that difference between the actual age and calculated age using score of physiological factors of teeth was statistically non-significant.

TABLE 19

Table showing Maximum and Minimum difference in actual age and calculated age by various formulae

TABLE 20 A

Table showing maximum and minimum difference of the age calculated using various previous regression formulae and it was seen that regression formula derived by Gustafson (formula C) and Maple & Rice (formula D) gave nearest value to the newly derived formula.

Formula	Formula	Maximum	Minimum
A	y = 4.7 x + 9.66	- 4.24	+ 3.46
B	y = 5.34 x - 4.08	- 16.06	- 3.34
C	y = 4.56 x + 11.43	- 3.53	+ 4.67
D	y =4.26 x + 13.45	- 4.69	+ 5.49
E	y = 6.26 x – 6	- 15.22	+ 4.86
F	y = 8.50 A + 26.073	- 21.92	+ 18.07
G	y = 6.37 T +4.63 P + 2.70 S + 2.40 C + 3.08 A + 1.34 R + 8.57	- 17.42	+ 1.28

Table showing calculated age using regression equation derived by scoring each physiological factor alone: Attrition (Formula: y = 16.89 x + 13.69)

TABLE 20 B

S No.	Actual Age	Age with Attrition factor	Difference
1	27	30.58	3.58
2	34	30.58	-3.42
3	35	47.47	12.47
4	29	30.58	1.58
5	58	47.47	-10.53
6	60	47.47	-12.53
7	38	30.58	-7.42
8	50	47.47	-2.53
9	40	47.47	7.47
10	28	30.58	2.58
11	30	30.58	0.58
12	55	47.47	-7.53
13	62	47.47	-14.53
14	49	47.47	-1.53
15	32	47.47	15.47
16	46	47.47	1.47
17	25	30.58	5.58
18	42	47.47	5.47
19	52	47.47	-4.53
20	28	30.58	2.58
21	50	47.47	-2.53
22	47	47.47	0.47
23	35	30.58	-4.42
24	28	30.58	2.58
25	40	47.47	7.47
26	50	47.47	-2.53
27	57	47.47	-9.53
28	29	30.58	1.58
29	30	30.58	0.58
30	45	47.47	2.47
31	26	30.58	4.58

S No.	Actual Age	Age with Attrition factor	Difference
32	27	30.58	3.58
33	30	30.58	0.58
34	40	47.47	7.47
35	55	47.47	-7.53
36	48	47.47	-0.53
37	30	30.58	0.58
38	28	30.58	2.58
39	25	30.58	5.58
40	37	30.58	-6.42
41	45	47.47	2.47
42	48	47.47	-0.53
43	37	30.58	-6.42
44	65	47.47	-17.53
45	29	30.58	1.58
46	25	30.58	5.58
47	30	30.58	0.58
48	40	47.47	7.47
49	65	64.36	-0.64
50	32	30.58	-1.42
51	26	30.58	4.58
52	33	47.47	14.47
53	65	47.47	-17.53
54	37	30.58	-6.42
55	52	47.47	-4.53
56	32	47.47	15.47
57	25	47.47	22.47
58	32	47.47	15.47
59	27	30.58	3.58
60	45	47.47	2.47
61	55	47.47	-7.53
62	28	30.58	2.58
63	35	30.58	-4.42

S No.	Actual Age	Age with Attrition factor	Difference
64	28	30.58	2.58
65	50	47.47	-2.53
66	42	47.47	5.47
67	32	47.47	15.47
68	40	47.47	7.47
69	34	30.58	-3.42
70	36	47.47	11.47
71	45	47.47	2.47
72	60	47.47	-12.53
73	54	47.47	-6.53
74	27	30.58	3.58
75	60	47.47	-12.53
76	55	47.47	-7.53
77	55	47.47	-7.53
78	50	47.47	-2.53
79	47	47.47	0.47
80	42	47.47	5.47
81	57	47.47	-9.53
82	35	30.58	-4.42
83	51	47.47	-3.53
84	31	47.47	16.47
85	56	47.47	-8.53
86	32	30.58	-1.42
87	60	47.47	-12.53
88	40	47.47	7.47
89	40	47.47	7.47
90	60	47.47	-12.53
91	32	30.58	-1.42
92	58	47.47	-10.53
93	35	30.58	-4.42
94	35	47.47	12.47
95	32	30.58	-1.42

S No.	Actual Age	Age with Attrition factor	Difference
96	42	47.47	5.47
97	47	47.47	0.47
98	60	47.47	-12.53
99	40	47.47	7.47
100	38	30.58	-7.42

Table showing calculated age using regression equation derived by scoring each physiological factor alone: Peridontal Disease (Formula: y = 6.69 x + 32.32)

TABLE 20 C

S No.	Actual Age	Age using Peridontal Disease factor	Difference
1	27	39.01	12.01
2	34	39.01	5.01
3	35	39.01	4.01
4	29	39.01	10.01
5	58	39.01	-18.99
6	60	45.7	-14.3
7	38	39.01	1.01
8	50	39.01	-10.99
9	40	39.01	-0.99
10	28	32.32	4.32
11	30	39.01	9.01
12	55	45.7	-9.3
13	62	45.7	-16.3
14	49	39.01	-9.99
15	32	39.01	7.01
16	46	39.01	-6.99
17	25	39.01	14.01
18	42	39.01	-2.99
19	52	39.01	-12.99
20	28	39.01	11.01
21	50	39.01	-10.99
22	47	45.7	-1.3
23	35	39.01	4.01
24	28	45.7	17.7
25	40	39.01	-0.99
26	50	45.7	-4.3
27	57	39.01	-17.99
28	29	39.01	10.01
29	30	45.7	15.7
30	45	39.01	-5.99
31	26	45.7	19.7

S No.	Actual Age	Age using Peridontal Disease factor	Difference
32	27	39.01	12.01
33	30	45.7	15.7
34	40	39.01	-0.99
35	55	45.7	-9.3
36	48	39.01	-8.99
37	30	39.01	9.01
38	28	45.7	17.7
39	25	39.01	14.01
40	37	39.01	2.01
41	45	39.01	-5.99
42	48	39.01	-8.99
43	37	45.7	8.7
44	65	45.7	-19.3
45	29	45.7	16.7
46	25	39.01	14.01
47	30	39.01	9.01
48	40	39.01	-0.99
49	65	45.7	-19.3
50	32	39.01	7.01
51	26	39.01	13.01
52	33	39.01	6.01
53	65	45.7	-19.3
54	37	39.01	2.01
55	52	45.7	-6.3
56	32	39.01	7.01
57	25	39.01	14.01
58	32	39.01	7.01
59	27	39.01	12.01
60	45	39.01	-5.99
61	55	45.7	-9.3
62	28	45.7	17.7
63	35	39.01	4.01

S No.	Actual Age	Age using Peridontal Disease factor	Difference
64	28	39.01	11.01
65	50	45.7	-4.3
66	42	39.01	-2.99
67	32	39.01	7.01
68	40	39.01	-0.99
69	34	39.01	5.01
70	36	45.7	9.7
71	45	45.7	0.7
72	60	39.01	-20.99
73	54	45.7	-8.3
74	27	39.01	12.01
75	60	39.01	-20.99
76	55	45.7	-9.3
77	55	39.01	-15.99
78	50	45.7	-4.3
79	47	45.7	-1.3
80	42	39.01	-2.99
81	57	45.7	-11.3
82	35	39.01	4.01
83	51	45.7	-5.3
84	31	39.01	8.01
85	56	45.7	-10.3
86	32	45.7	13.7
87	60	39.01	-20.99
88	40	45.7	5.7
89	40	45.7	5.7
90	60	39.01	-20.99
91	32	39.01	7.01
92	58	39.01	-18.99
93	35	45.7	10.7
94	35	45.7	10.7
95	32	39.01	7.01

S No.	Actual Age	Age using Peridontal Disease factor	Difference
96	42	39.01	-2.99
97	47	39.01	-7.99
98	60	39.01	-20.99
99	40	39.01	-0.99
100	38	39.01	1.01

Table showing calculated age using regression equation derived by scoring each physiological factor alone: Secondary Dentine Deposition (Formula: y = 16.78 x + 22.43)

TABLE 20 D

S No.	Actual Age	Age using Secondary Dentine Deposition factor	Difference
1	27	39.21	12.21
2	34	39.21	5.21
3	35	39.21	4.21
4	29	39.21	10.21
5	58	55.99	-2.01
6	60	55.99	-4.01
7	38	39.21	1.21
8	50	39.21	-10.79
9	40	39.21	-0.79
10	28	39.21	11.21
11	30	39.21	9.21
12	55	39.21	-15.79
13	62	55.99	-6.01
14	49	39.21	-9.79
15	32	39.21	7.21
16	46	39.21	-6.79
17	25	39.21	14.21
18	42	39.21	-2.79
19	52	39.21	-12.79
20	28	39.21	11.21
21	50	39.21	-10.79
22	47	39.21	-7.79
23	35	39.21	4.21
24	28	22.43	-5.57
25	40	39.21	-0.79
26	50	39.21	-10.79
27	57	55.99	-1.01
28	29	39.21	10.21
29	30	22.43	-7.57
30	45	39.21	-5.79
31	26	22.43	-3.57

32	27	39.21	12.21
33	30	22.43	-7.57
34	40	39.21	-0.79
35	55	39.21	-15.79
36	48	39.21	-8.79
37	30	39.21	9.21
38	28	22.43	-5.57
39	25	39.21	14.21
40	37	39.21	2.21
41	45	39.21	-5.79
42	48	39.21	-8.79
43	37	39.21	2.21
44	65	55.99	-9.01
45	29	22.43	-6.57
46	25	22.43	-2.57
47	30	39.21	9.21
48	40	39.21	-0.79
49	65	55.99	-9.01
50	32	39.21	7.21
51	26	39.21	13.21
52	33	39.21	6.21
53	65	55.99	-9.01
54	37	39.21	2.21
55	52	39.21	-12.79
56	32	39.21	7.21
57	25	22.43	-2.57
58	32	39.21	7.21
59	27	39.21	12.21
60	45	39.21	-5.79
61	55	55.99	0.99
62	28	22.43	-5.57
63	35	39.21	4.21
64	28	39.21	11.21

65	50	39.21	-10.79
66	42	39.21	-2.79
67	32	39.21	7.21
68	40	39.21	-0.79
69	34	39.21	5.21
70	36	39.21	3.21
71	45	39.21	-5.79
72	60	55.99	-4.01
73	54	55.99	1.99
74	27	39.21	12.21
75	60	55.99	-4.01
76	55	55.99	0.99
77	55	55.99	0.99
78	50	55.99	5.99
79	47	39.21	-7.79
80	42	39.21	-2.79
81	57	55.99	-1.01
82	35	39.21	4.21
83	51	55.99	4.99
84	31	39.21	8.21
85	56	55.99	-0.01
86	32	39.21	7.21
87	60	55.99	-4.01
88	40	39.21	-0.79
89	40	39.21	-0.79
90	60	55.99	-4.01
91	32	39.21	7.21
92	58	55.99	-2.01
93	35	39.21	4.21
94	35	39.21	4.21
95	32	39.21	7.21
96	42	39.21	-2.79
97	47	39.21	-7.79

98	60	55.99	-4.01
99	40	39.21	-0.79
100	38	39.21	1.21

Table showing calculated age using regression equation derived by scoring each physiological factor alone: Cementum Apposition (Formula: y = 16.26 x + 31.63)

TABLE 20 E

S No.	Actual Age	Age using Cementum Apposition factor	Difference
1	27	31.63	4.63
2	34	47.89	13.89
3	35	31.63	-3.37
4	29	31.63	2.63
5	58	47.89	-10.11
6	60	47.89	-12.11
7	38	31.63	-6.37
8	50	47.89	-2.11
9	40	31.63	-8.37
10	28	31.63	3.63
11	30	47.89	17.89
12	55	47.89	-7.11
13	62	47.89	-14.11
14	49	47.89	-1.11
15	32	31.63	-0.37
16	46	47.89	1.89
17	25	31.63	6.63
18	42	47.89	5.89
19	52	47.89	-4.11
20	28	31.63	3.63
21	50	47.89	-2.11
22	47	31.63	-15.37
23	35	47.89	12.89
24	28	31.63	3.63
25	40	31.63	-8.37
26	50	47.89	-2.11
27	57	47.89	-9.11
28	29	31.63	2.63
29	30	31.63	1.63
30	45	47.89	2.89
31	26	31.63	5.63

S No.	Actual Age	Age using Cementum Apposition factor	Difference
32	27	31.63	4.63
33	30	31.63	1.63
34	40	31.63	-8.37
35	55	47.89	-7.11
36	48	47.89	-0.11
37	30	47.89	17.89
38	28	31.63	3.63
39	25	31.63	6.63
40	37	47.89	10.89
41	45	47.89	2.89
42	48	47.89	-0.11
43	37	47.89	10.89
44	65	47.89	-17.11
45	29	31.63	2.63
46	25	31.63	6.63
47	30	31.63	1.63
48	40	47.89	7.89
49	65	47.89	-17.11
50	32	47.89	15.89
51	26	31.63	5.63
52	33	31.63	-1.37
53	65	47.89	-17.11
54	37	47.89	10.89
55	52	47.89	-4.11
56	32	31.63	-0.37
57	25	31.63	6.63
58	32	31.63	-0.37
59	27	31.63	4.63
60	45	47.89	2.89
61	55	47.89	-7.11
62	28	31.63	3.63
63	35	47.89	12.89

S No.	Actual Age	Age using Cementum Apposition factor	Difference
64	28	31.63	3.63
65	50	47.89	-2.11
66	42	31.63	-10.37
67	32	31.63	-0.37
68	40	47.89	7.89
69	34	47.89	13.89
70	36	31.63	-4.37
71	45	47.89	2.89
72	60	47.89	-12.11
73	54	47.89	-6.11
74	27	31.63	4.63
75	60	47.89	-12.11
76	55	47.89	-7.11
77	55	47.89	-7.11
78	50	47.89	-2.11
79	47	47.89	0.89
80	42	47.89	5.89
81	57	47.89	-9.11
82	35	47.89	12.89
83	51	47.89	-3.11
84	31	31.63	0.63
85	56	47.89	-8.11
86	32	31.63	-0.37
87	60	47.89	-12.11
88	40	31.63	-8.37
89	40	31.63	-8.37
90	60	47.89	-12.11
91	32	47.89	15.89
92	58	47.89	-10.11
93	35	31.63	-3.37
94	35	31.63	-3.37
95	32	47.89	15.89

S No.	Actual Age	Age using Cementum Apposition factor	Difference
96	42	47.89	5.89
97	47	47.89	0.89
98	60	47.89	-12.11
99	40	47.89	7.89
100	38	47.89	9.89

Table showing calculated age using regression equation derived by scoring each physiological factor alone: Root Translucency (Formula: y = 14.11x + 20.19)

TABLE 20 F

S No.	Actual Age	Age using Root Translucency factor	Difference
1	27	34.3	7.3
2	34	34.3	0.3
3	35	34.3	-0.7
4	29	34.3	5.3
5	58	62.52	4.52
6	60	62.52	2.52
7	38	34.3	-3.7
8	50	48.41	-1.59
9	40	34.3	-5.7
10	28	34.3	6.3
11	30	34.3	4.3
12	55	48.41	-6.59
13	62	48.41	-13.59
14	49	34.3	-14.7
15	32	34.3	2.3
16	46	48.41	2.41
17	25	34.3	9.3
18	42	34.3	-7.7
19	52	48.41	-3.59
20	28	34.3	6.3
21	50	48.41	-1.59
22	47	62.52	15.52
23	35	34.3	-0.7
24	28	34.3	6.3
25	40	34.3	-5.7
26	50	48.41	-1.59
27	57	48.41	-8.59
28	29	34.3	5.3
29	30	34.3	4.3
30	45	34.3	-10.7
31	26	34.3	8.3

S No.	Actual Age	Age using Root Translucency factor	Difference
32	27	34.3	7.3
33	30	34.3	4.3
34	40	34.3	-5.7
35	55	48.41	-6.59
36	48	48.41	0.41
37	30	34.3	4.3
38	28	34.3	6.3
39	25	34.3	9.3
40	37	34.3	-2.7
41	45	34.3	-10.7
42	48	48.41	0.41
43	37	34.3	-2.7
44	65	62.52	-2.48
45	29	34.3	5.3
46	25	34.3	9.3
47	30	34.3	4.3
48	40	34.3	-5.7
49	65	62.52	-2.48
50	32	34.3	2.3
51	26	34.3	8.3
52	33	34.3	1.3
53	65	62.52	-2.48
54	37	34.3	-2.7
55	52	48.41	-3.59
56	32	34.3	2.3
57	25	34.3	9.3
58	32	34.3	2.3
59	27	34.3	7.3
60	45	34.3	-10.7
61	55	48.41	-6.59
62	28	34.3	6.3
63	35	34.3	-0.7

S No.	Actual Age	Age using Root Translucency factor	Difference
64	28	34.3	6.3
65	50	48.41	-1.59
66	42	34.3	-7.7
67	32	34.3	2.3
68	40	34.3	-5.7
69	34	34.3	0.3
70	36	34.3	-1.7
71	45	48.41	3.41
72	60	62.52	2.52
73	54	48.41	-5.59
74	27	34.3	7.3
75	60	62.52	2.52
76	55	48.41	-6.59
77	55	48.41	-6.59
78	50	48.41	-1.59
79	47	48.41	1.41
80	42	48.41	6.41
81	57	48.41	-8.59
82	35	34.3	-0.7
83	51	48.41	-2.59
84	31	34.3	3.3
85	56	48.41	-7.59
86	32	34.3	2.3
87	60	62.52	2.52
88	40	34.3	-5.7
89	40	34.3	-5.7
90	60	48.41	-11.59
91	32	34.3	2.3
92	58	62.52	4.52
93	35	34.3	-0.7
94	35	34.3	-0.7
95	32	34.3	2.3

S No.	Actual Age	Age using Root Translucency factor	Difference
96	42	34.3	-7.7
97	47	62.52	15.52
98	60	62.52	2.52
99	40	34.3	-5.7
100	38	34.3	-3.7

Table showing calculated age using regression equation derived by scoring each physiological factor alone: Root Resorption (Formula: y = 14.11x + 20.19)

TABLE 21

S No.	Actual Age	Age using Root Resorption factor	Difference
1	27	34.3	7.3
2	34	34.3	0.3
3	35	34.3	-0.7
4	29	34.3	5.3
5	58	62.52	4.52
6	60	62.52	2.52
7	38	34.3	-3.7
8	50	48.41	-1.59
9	40	34.3	-5.7
10	28	34.3	6.3
11	30	34.3	4.3
12	55	48.41	-6.59
13	62	48.41	-13.59
14	49	34.3	-14.7
15	32	34.3	2.3
16	46	48.41	2.41
17	25	34.3	9.3
18	42	34.3	-7.7
19	52	48.41	-3.59
20	28	34.3	6.3
21	50	48.41	-1.59
22	47	62.52	15.52
23	35	34.3	-0.7
24	28	34.3	6.3
25	40	34.3	-5.7
26	50	48.41	-1.59
27	57	48.41	-8.59
28	29	34.3	5.3
29	30	34.3	4.3
30	45	34.3	-10.7
31	26	34.3	8.3

S No.	Actual Age	Age using Root Resorption factor	Difference
32	27	34.3	7.3
33	30	34.3	4.3
34	40	34.3	-5.7
35	55	48.41	-6.59
36	48	48.41	0.41
37	30	34.3	4.3
38	28	34.3	6.3
39	25	34.3	9.3
40	37	34.3	-2.7
41	45	34.3	-10.7
42	48	48.41	0.41
43	37	34.3	-2.7
44	65	62.52	-2.48
45	29	34.3	5.3
46	25	34.3	9.3
47	30	34.3	4.3
48	40	34.3	-5.7
49	65	62.52	-2.48
50	32	34.3	2.3
51	26	34.3	8.3
52	33	34.3	1.3
53	65	62.52	-2.48
54	37	34.3	-2.7
55	52	48.41	-3.59
56	32	34.3	2.3
57	25	34.3	9.3
58	32	34.3	2.3
59	27	34.3	7.3
60	45	34.3	-10.7
61	55	48.41	-6.59
62	28	34.3	6.3
63	35	34.3	-0.7

S No.	Actual Age	Age using Root Resorption factor	Difference
64	28	34.3	6.3
65	50	48.41	-1.59
66	42	34.3	-7.7
67	32	34.3	2.3
68	40	34.3	-5.7
69	34	34.3	0.3
70	36	34.3	-1.7
71	45	48.41	3.41
72	60	62.52	2.52
73	54	48.41	-5.59
74	27	34.3	7.3
75	60	62.52	2.52
76	55	48.41	-6.59
77	55	48.41	-6.59
78	50	48.41	-1.59
79	47	48.41	1.41
80	42	48.41	6.41
81	57	48.41	-8.59
82	35	34.3	-0.7
83	51	48.41	-2.59
84	31	34.3	3.3
85	56	48.41	-7.59
86	32	34.3	2.3
87	60	62.52	2.52
88	40	34.3	-5.7
89	40	34.3	-5.7
90	60	48.41	-11.59
91	32	34.3	2.3
92	58	62.52	4.52
93	35	34.3	-0.7
94	35	34.3	-0.7
95	32	34.3	2.3

S No.	Actual Age	Age using Root Resorption factor	Difference
96	42	34.3	-7.7
97	47	62.52	15.52
98	60	62.52	2.52
99	40	34.3	-5.7
100	38	34.3	-3.7

Table showing mean calculated age and standard deviation using various physiological factors

S No	Factors	Range (yrs)	Mean (yrs)	Standard Deviation
1	Attrition	30.58 – 64.36	41.22	± 8.04
2	Peridontal disease	32.32 – 45.70	41.21	± 3.30
3	Secondary Dentine Deposition	22.43 – 55.99	41.22	± 9.01
4	Cementum Apposition	31.63 – 47.89	41.22	± 8.03
5	Root Translucency	34.30 – 62.52	41.21	± 9.92
6	Root Resorption	34.17 – 59.79	41.21	± 8.21

Table showing mean age calculated using regression formula derived from each individual factor taken alone and their standard deviation. It was seen that all factor had almost same mean age although maximum and minimum deviation from the actual age was very large.

TABLE 22

Table showing Minimum and maximum difference of the age calculated from that of actual age

S.No.	Factors	Minimum difference (yrs)	Maximum difference (yrs)
I	**All factors**	- 4.24	+ 3.26
II	**Attrition**	- 17.53	+ 22.47
III	Peridontal Disease	- 20.99	+ 19.7
IV	Secondary Dentine Deposition	- 15.79	+ 14.21
V	Cementum Apposition	- 17.11	+ 17.89
VI	Root Translucency	- 14.70	+ 15.52
VII	Root Resorption	- 25.83	+ 17.92

Table showing maximum difference and minimum difference of actual age of the person and calculated age from all factors taken together and each individual physiological factor taken alone. It was seen that although range of age difference between actual age and calculated age from each factors taken alone was very large still secondary dentine deposition and root translucency were the factor giving least range of deviation amongst all the factors.

TABLE 23

Table showing comparison of actual age with the age calculated by individual physiological factor taken alone

S.No.	Factors	Range	Mean ± S.D.	Diff.	t	p	S
I	Actual Age	25 - 65	41.23 ± 11.65	-	-	-	-
II	**Attrition**	30.58 – 64.36	41.22 ± 8.54	0.01	0.006	>0.05	NS
III	Peridontal Disease	32.32 – 45.70	41.21 ± 3.30	0.01	0.01	>0.05	NS
IV	Secondary Dentine Deposition	22.43 – 55.99	41.22 ± 9.01	0.01	0.004	>0.05	NS
V	Cementum Apposition	31.63 – 47.89	41.22 ± 8.03	0.01	0.004	>0.05	NS
VI	Root Translucency	34.30 – 62.52	41.21 ± 9.92	0.02	0.004	>0.05	NS
VII	Root Resorption	34.17 – 59.79	41.21 ± 8.21	0.02	0.004	>0.05	NS

Table showing the mean age calculated using regression formula derived taking each factor individually. It was found that mean age calculated using regression formula individual factors were almost same as actual age with slight difference and this difference statistically was non-significant.

TABLE 24

Table showing comparison of calculated age with the age calculated by individual physiological factor taken alone

S.No.	Factors	Range	Mean ± S.D.	Diff.	t	p	S
I	Calculated Age	2.76 – 66.06	41.33 ± 11.36	-	-	-	-
II	**Attrition**	30.58 – 64.36	41.22 ± 8.54	0.11	0.26	>0.05	NS
III	Peridontal Disease	32.32 – 45.70	41.21 ± 3.30	0.11	0.33	>0.05	NS
IV	Secondary Dentine Deposition	22.43 – 55.99	41.22 ± 9.01	0.11	0.26	>0.05	NS
V	Cementum Apposition	31.63 – 47.89	41.22 ± 8.03	0.11	0.27	>0.05	NS
VI	Root Translucency	34.30 – 62.52	41.21 ± 9.92	0.12	0.25	>0.05	NS
VII	Root Resorption	34.17 – 59.79	41.21 ± 8.21	0.12	0.25	>0.05	NS

Table showing the mean calculated age using total score of all factors together and comparison with calculated using individual factor taken separately. It was found that mean calculated age using regression formula individual factors were almost same as calculated age using all factors together with slight difference and this difference statistically was non-significant.

TABLE 25

Table showing calculated age using regression equation derived by scoring Two physiological factor: Attrition & Peridontal Disease (Formula: y = 10.18 x + 11.09)

S No.	Actual Age	Attrition Score	Peridontal Ds. Score	Total of these two factor	Age calculated using score of two factors	Difference
1	27	1	1	2	31.09	4.09
2	34	1	1	2	31.09	-2.91
3	35	2	1	3	41.09	6.09
4	29	1	1	2	31.09	2.09
5	58	2	1	3	41.09	-16.91
6	60	2	2	4	51.09	-8.91
7	38	1	1	2	31.09	-6.91
8	50	2	1	3	41.09	-8.91
9	40	2	1	3	41.09	1.09
10	28	1	0	1	21.09	-6.91
11	30	1	1	2	31.09	1.09
12	55	2	2	4	51.09	-3.91
13	62	2	2	4	51.09	-10.91
14	49	2	1	3	41.09	-7.91
15	32	2	1	3	41.09	9.09
16	46	2	1	3	41.09	-4.91
17	25	1	1	2	31.09	6.09
18	42	2	1	3	41.09	-0.91
19	52	2	1	3	41.09	-10.91
20	28	1	1	2	31.09	3.09
21	50	2	1	3	41.09	-8.91
22	47	2	2	4	51.09	4.09
23	35	1	1	2	31.09	-3.91
24	28	1	2	3	41.09	13.09
25	40	2	1	3	41.09	1.09
26	50	2	2	4	51.09	1.09
27	57	2	1	3	41.09	-15.91
28	29	1	1	2	31.09	2.09
29	30	1	2	3	41.09	11.09
30	45	2	1	3	41.09	-3.91
31	26	1	2	3	41.09	15.09

32	27	1	1	2	31.09	4.09
33	30	1	2	3	41.09	11.09
34	40	2	1	3	41.09	1.09
35	55	2	2	4	51.09	-3.91
36	48	2	1	3	41.09	-6.91
37	30	1	1	2	31.09	1.09
38	28	1	2	3	41.09	13.09
39	25	1	1	2	31.09	6.09
40	37	1	1	2	31.09	-5.91
41	45	2	1	3	41.09	-3.91
42	48	2	1	3	41.09	-6.91
43	37	1	2	3	41.09	4.09
44	65	2	2	4	51.09	-13.91
45	29	1	2	3	41.09	12.09
46	25	1	1	2	31.09	6.09
47	30	1	1	2	31.09	1.09
48	40	2	1	3	41.09	1.09
49	65	3	2	5	61.09	-3.91
50	32	1	1	2	31.09	-0.91
51	26	1	1	2	31.09	5.09
52	33	2	1	3	41.09	8.09
53	65	2	2	4	51.09	-13.91
54	37	1	1	2	31.09	-5.91
55	52	2	2	4	51.09	-0.91
56	32	2	1	3	41.09	9.09
57	25	2	1	3	41.09	16.09
58	32	2	1	3	41.09	9.09
59	27	1	1	2	31.09	4.09
60	45	2	1	3	41.09	-3.91
61	55	2	2	4	51.09	-3.91
62	28	1	2	3	41.09	13.09
63	35	1	1	2	31.09	-3.91
64	28	1	1	2	31.09	3.09

65	50	2	2	4	51.09	1.09
66	42	2	1	3	41.09	-0.91
67	32	2	1	3	41.09	9.09
68	40	2	1	3	41.09	1.09
69	34	1	1	2	31.09	-2.91
70	36	2	2	4	51.09	15.09
71	45	2	2	4	51.09	6.09
72	60	2	1	3	41.09	-18.91
73	54	2	2	4	51.09	-2.91
74	27	1	1	2	31.09	4.09
75	60	2	1	3	41.09	-18.91
76	55	2	2	4	51.09	-3.91
77	55	2	1	3	41.09	-13.91
78	50	2	2	4	51.09	1.09
79	47	2	2	4	51.09	4.09
80	42	2	1	3	41.09	-0.91
81	57	2	2	4	51.09	-5.91
82	35	1	1	2	31.09	-3.91
83	51	2	2	4	51.09	0.09
84	31	2	1	3	41.09	10.09
85	56	2	2	4	51.09	-4.91
86	32	1	2	3	41.09	9.09
87	60	2	1	3	41.09	-18.91
88	40	2	2	4	51.09	11.09
89	40	2	2	4	51.09	11.09
90	60	2	1	3	41.09	-18.91
91	32	1	1	2	31.09	-0.91
92	58	2	1	3	41.09	-16.91
93	35	1	2	3	41.09	6.09
94	35	2	2	4	51.09	16.09
95	32	1	1	2	31.09	-0.91
96	42	2	1	3	41.09	-0.91
97	47	2	1	3	41.09	-5.91

98	60	2	1	3	41.09	-18.91
99	40	2	1	3	41.09	1.09
100	38	1	1	2	31.09	-6.91

Mean = 40.69 ± 7.64 years

Maximum deviation = +16.09 years

Minimum deviation = - 18.91 years

Table showing the age calculated using the regression equation derived by plotting score of attrition and peridontal disease on x axis and actual age on y axis. These two factors can be used in living person also as no extensive maneuver is required in scoring these two factors. 46% of the cases had less than ± 5 years deviation from the actual age.

Fig.1 Regression Curve depicting relation of calculated Attrition score to Actual age and its regression formula

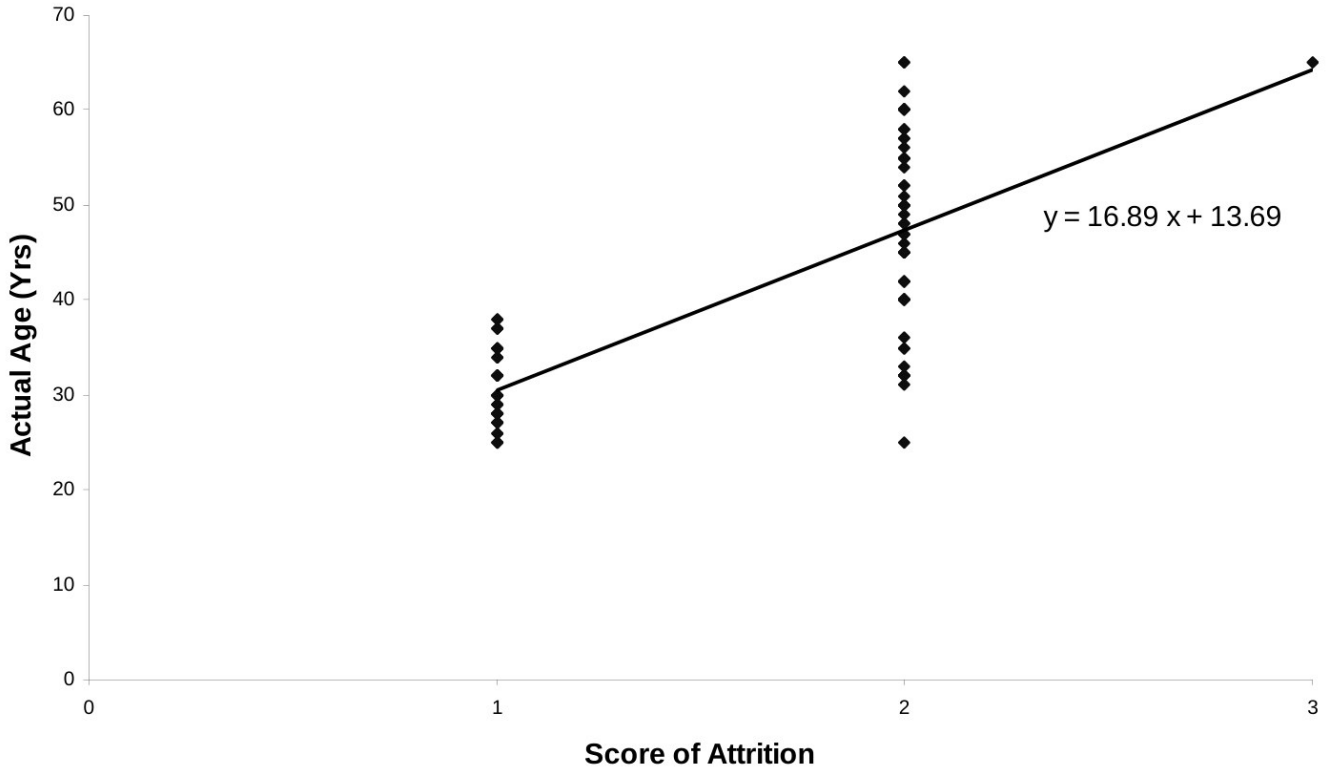


Fig.1 Regression Curve depicting relation of calculated Attrition score to Actual age and its regression formula

Fig.2 Regression Curve depicting relation of calculated Peridontal Disease score to Actual age and its regression formula

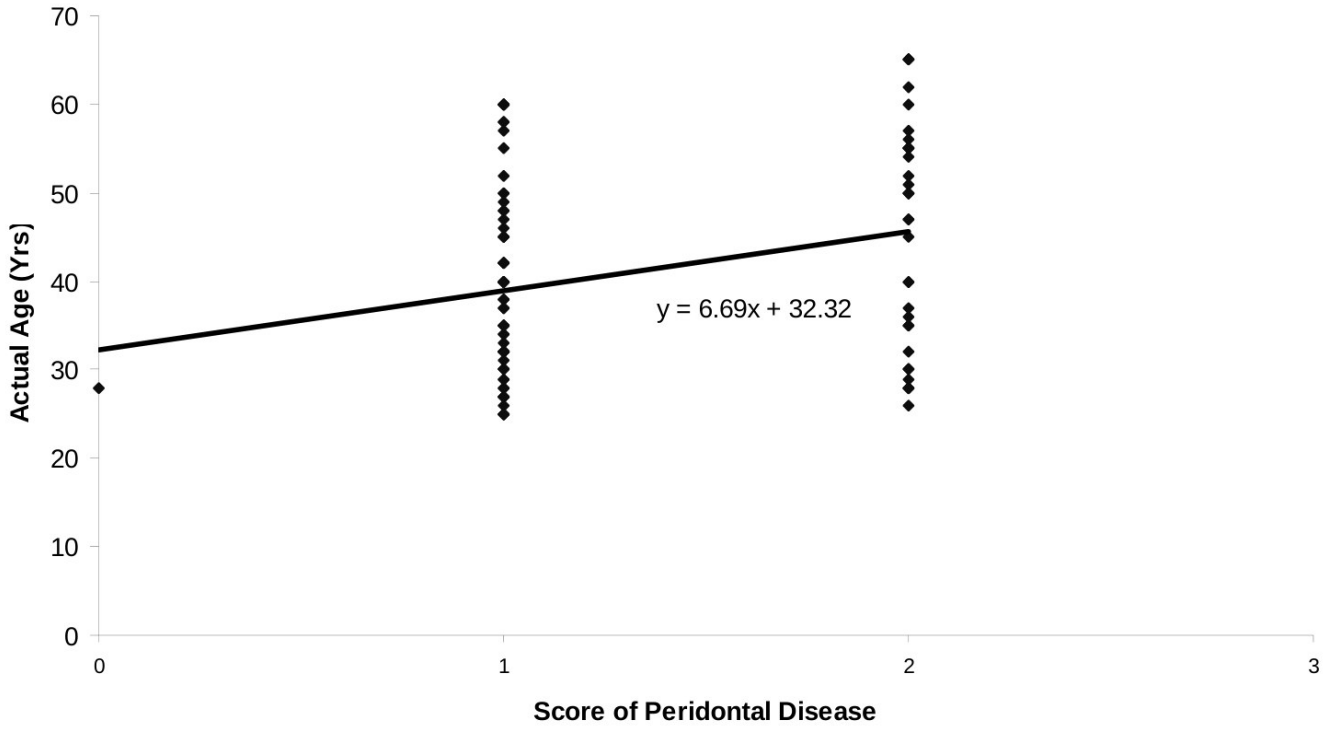


Fig.2 Regression Curve depicting relation of calculated Peridontal Disease score to Actual age and its regression formula

Fig.3 Regression Curve depicting relation of calculated Secondary Dentine Deposition score to Actual age and its regression formula

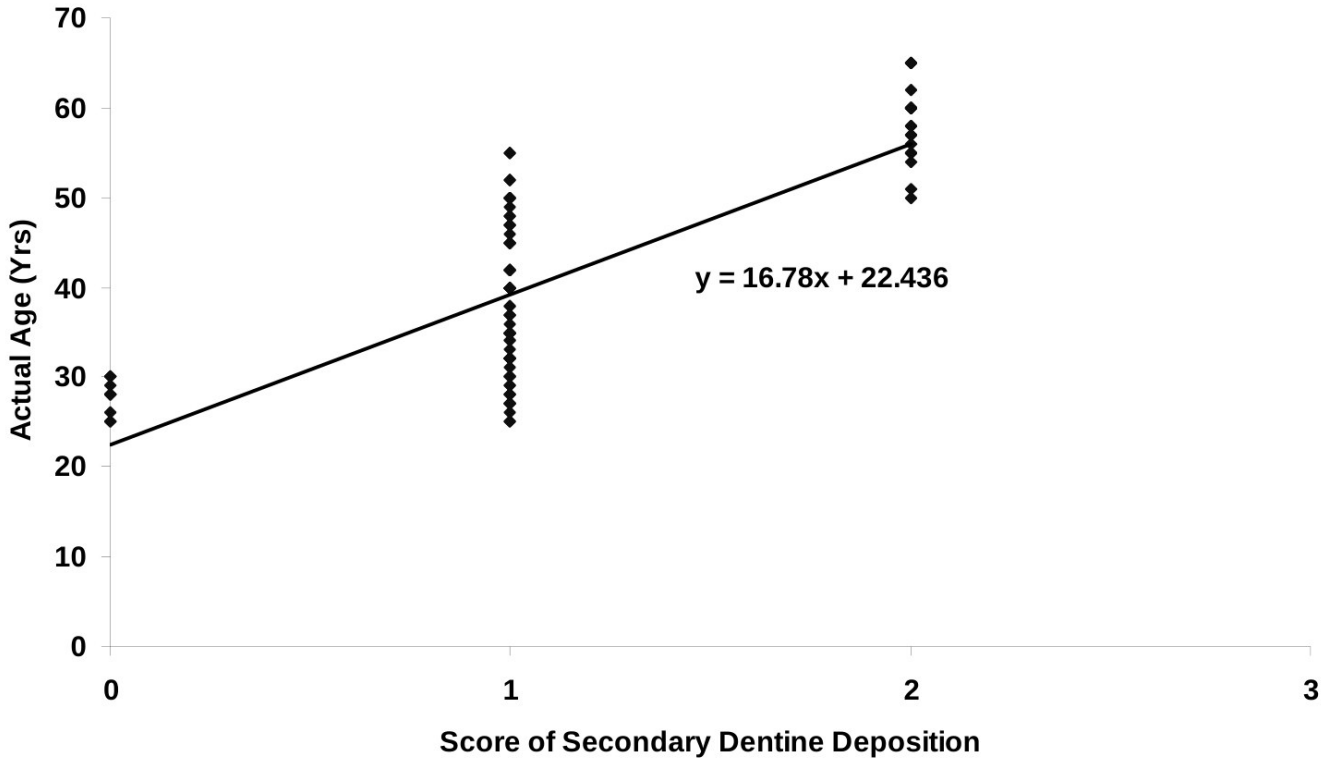


Fig.3 Regression Curve depicting relation of calculated Secondary Dentine Deposition score to Actual age and its regression formula

Fig.4 Regression Curve depicting relation of calculated Cementum Apposition score to Actual age and its regression formula

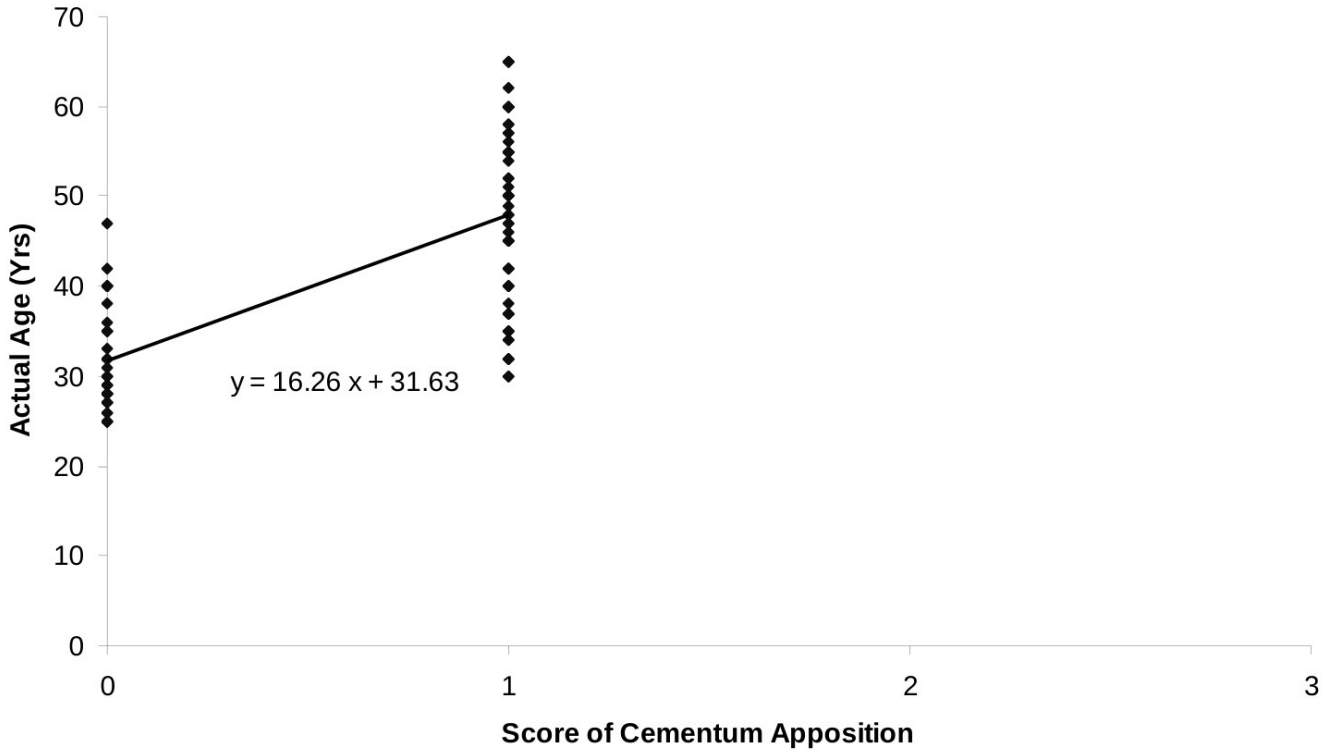


Fig.4 Regression Curve depicting relation of calculated Cementum Apposition score to Actual age and its regression formula

Fig. 5 Regression Curve depicting relation of calculated Root Translucency score to Actual age and its regression formula

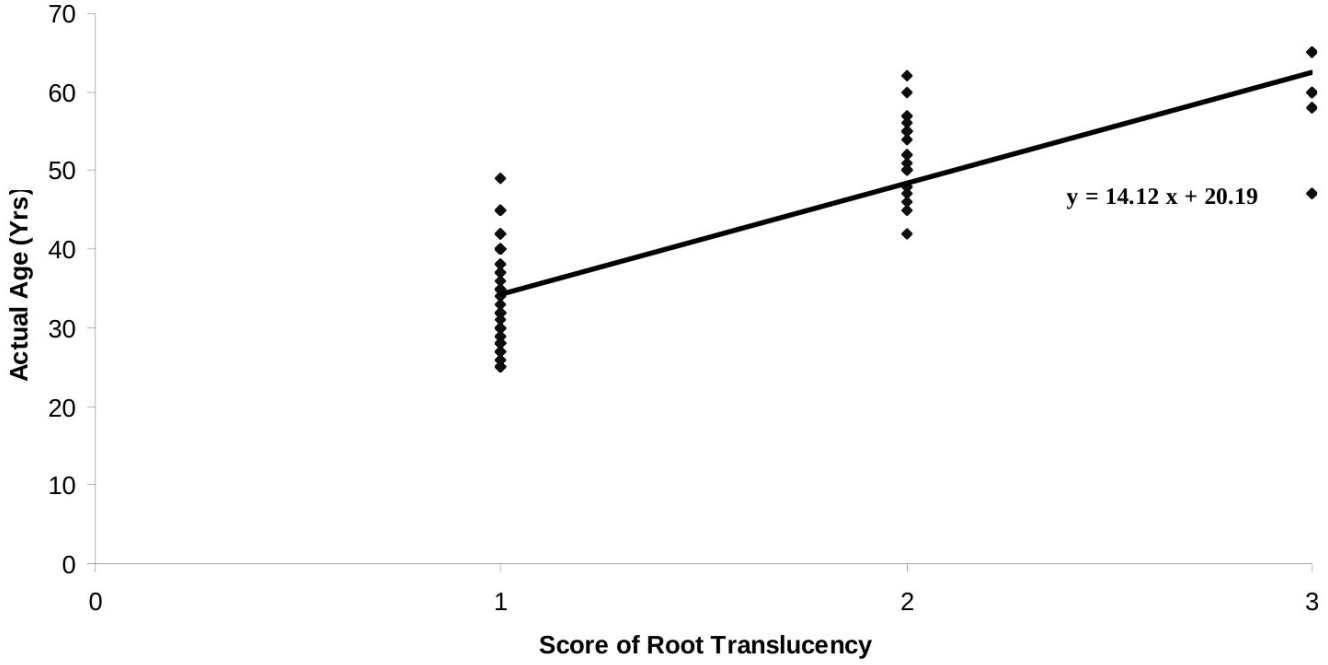


Fig. 5 Regression Curve depicting relation of calculated Root Translucency score to Actual age and its regression formula

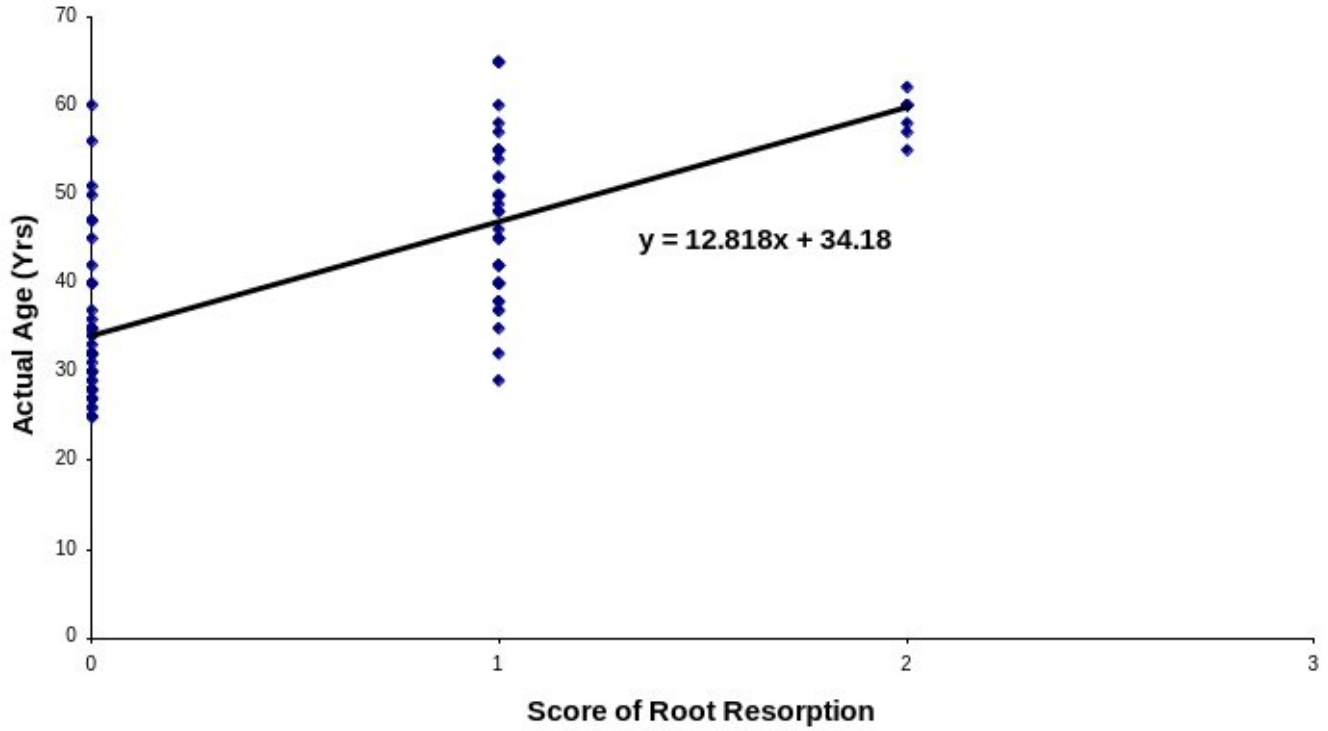


Fig. 6 Regression Curve depicting relation of calculated Root Resorption score to Actual age and its regression formula

Fig. 7 Regression Curve depicting relation of calculated Total Score to Actual age and its regression formula

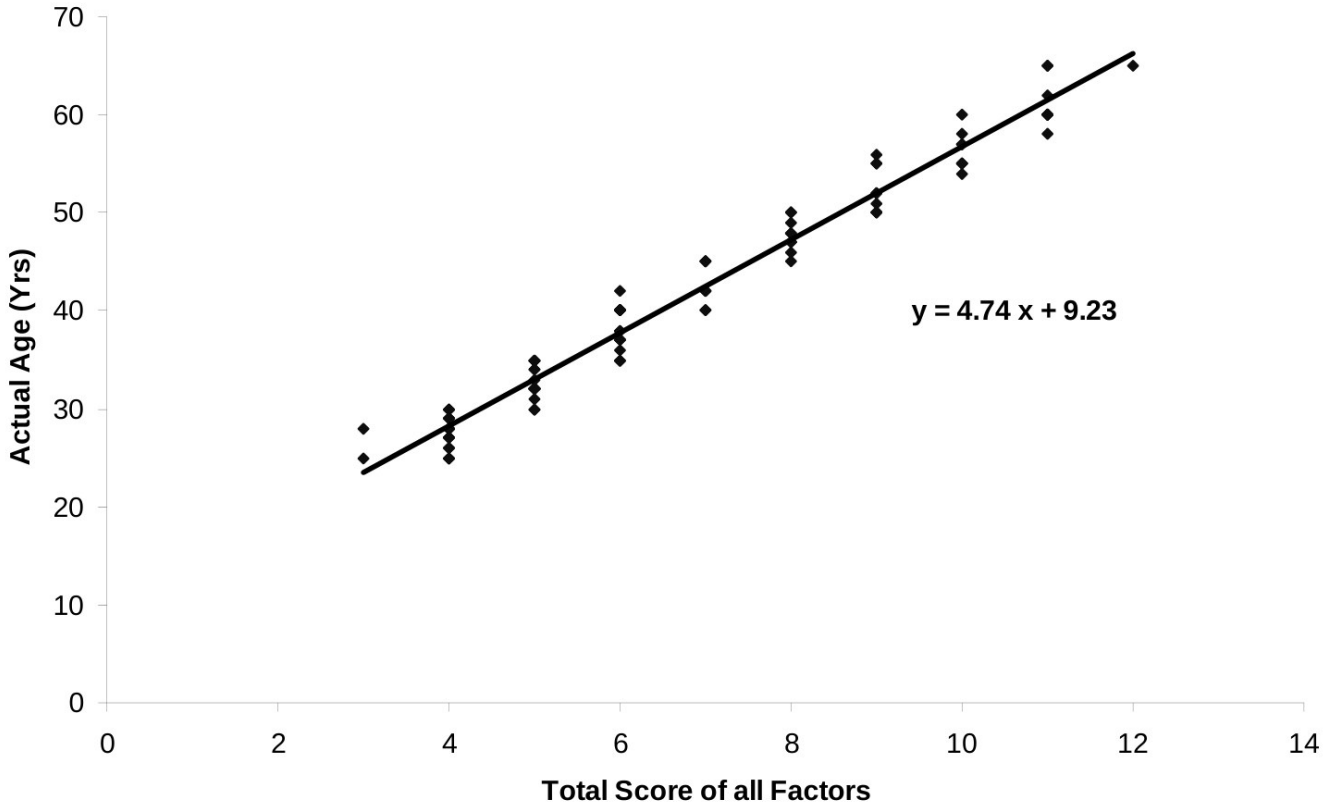
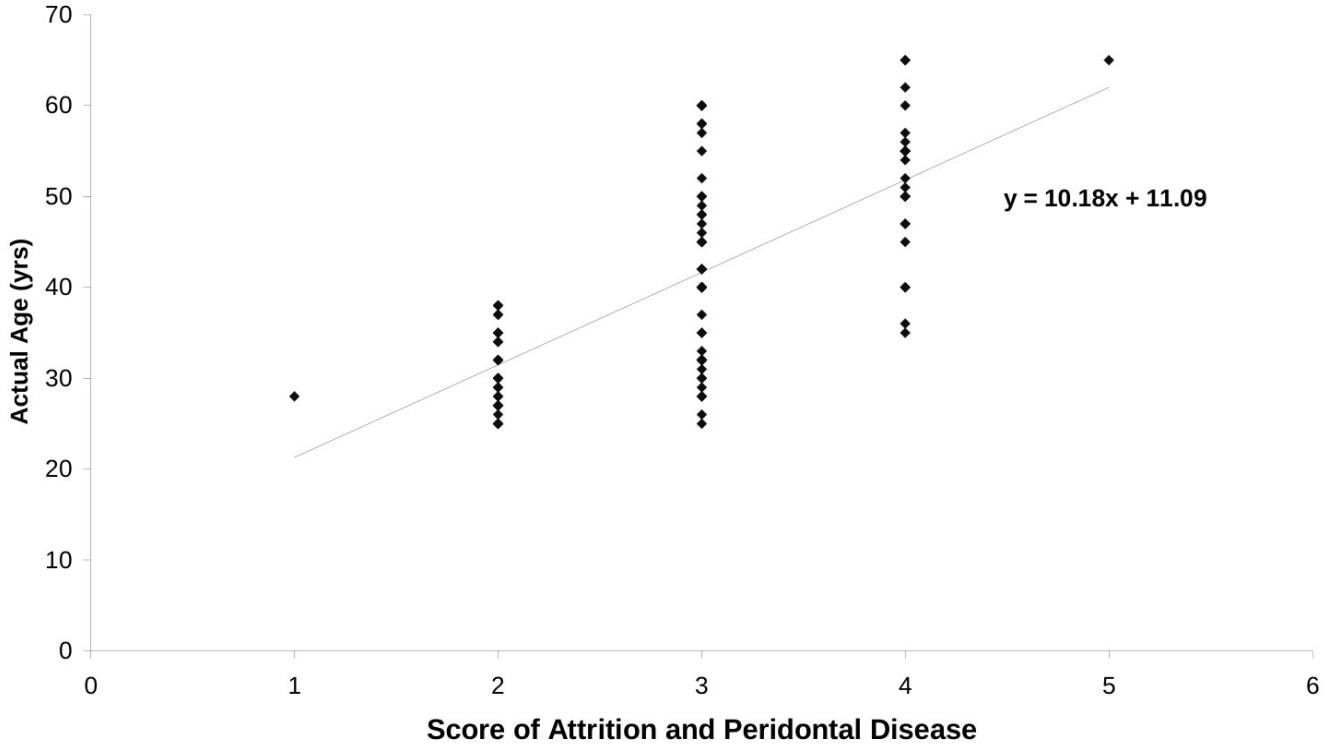


Fig. 7 Regression Curve depicting relation of calculated Total Score to Actual age and its regression formula

FiFig. 8 Regression Curve depicting relation of scores of attrition and peridontal factor's together to actual age and its regression formula



FiFig. 8 Regression Curve depicting relation of scores of attrition and peridontal factor's together to actual age and its regression formula

DISCUSSION

A total of 100 cases were taken in this study and six physiological factors were recorded. The teeth selected in this study were first premolars. Incisors although having maximum affect of attrition were not taken as these were having less thickness and thus get broken while making their ground section which is necessary to score four physiological factors. Premolars were selected for the study as these are known to give best coefficient as compared to other teeth as per study of Kvaal and Solheim (1994).

Molars on the other hand also having greater effect of diet as they are used in mastication of food but they are very strong and hard and it is difficult to make their ground section. Also first molars were found to get attritional very early (Santini, Land and Raab 1990) and we in our study were to include only the normal teeth. Third molars too were very variable in eruption and usually not present in all individual. Premolars were thus best in this respect i.e. having optimum strength and are less brittle as compared to incisors.

Cases were divided into different age groups and maximum number of cases in the study belonged to age group of 25 to 30 years, next being 35 to 40 years. This age group was largest as this is the most active age group and most of the postmortem done in the hospital are from this age group.

In each age group score was given to every physiological factor and total score was calculated. It was seen that total score increased with the increasing age. It was 4.0 ± 0.41 in the age group of 25 to 30 years increasing to mean total score 11.25 ± 0.50 in the age group of above 60 years. This increase was statistically analyzed and was found out to be significant. This finding was similar to

the finding of Pillai and Bhaskar (1974) that also noted and scored these six physiological factors in their study.

In our study, 63 were males and 37 females. We found that mean total score in males were slightly higher (6.92 ± 2.41) than that in females (6.43 ± 2.43) but statistically this difference was non-significant. This finding was consistent with the finding of Pillai and Bhaskar (1974).

Diet of the persons was also noted. Person taking any kind of meat were taken as non-vegetarian while persons having vegetables and eggs were kept in the group of vegetarians. It was seen that in the study group, vegetarian were more as compared to non-vegetarian. The mean total score of the vegetarian was compared to that with the mean total score of non-vegetarian. Mean total score in non-vegetarians was 7.16 ± 2.21 and slightly more as compared to mean total scores in vegetarians (6.60 ± 2.17). But statistically this difference was non significant similar to the finding of Pillai and Bhaskar (1974) study. As the selected premolars are less frequently used in routine mastication, the attrition factors and others factors usually are very less effected with type of diet and habits of the person.

In the study group rural and urban population was equal in number but mean total score of the various physiological factors was higher in the urban population (6.78 ± 2.48) as compared rural population (6.70 ± 2.40). Statistical this difference was also non-significant being consistent with the results of study of Pillai and Bhaskar (1974).

Socioeconomic status of all cases was calculated using modified Kuppuswamy socioeconomic status chart. Highest number i.e. 46% of cases of the study group belonged to lower socioeconomic status and were having mean total score 6.43 ± 2.39 for all physiological factors of their teeth. Highest value of mean total score was found in the Lower Middle socioeconomic status persons (7.30 ± 2.52) and lowest mean total score was seen in upper socioeconomic status group (6.20 ± 2.94). Statistically it was seen that the difference of mean total score of various socioeconomic status groups was non-significant.

In the present study, the regression line obtained by plotting total score allotted against the actual age of the person. This regression line was used to derive the regression formula and it came out as Formula A: y= 4.7 x + 9.66, where y is calculated age and x is total score allotted.

The values of total scores allotted by macroscopic and microscopic examination of teeth, was used in the regression formulae derived in previous studies like that of Pillai and Bhaskar (Formula B: y= 5.34 x – 4.08) and the age was calculated and difference of calculated age from that of actual age was noted. Formula derived by Gustafson (Formula C: y = 4.56 x + 11.43) was also used and Table 12 shows calculated age and also its difference from the actual age. Similarly formula derived by Maple and Rice (Formula D: y = 4.26 x + 13.45) was used and Table 13 shows calculated age and difference of ages. Table 14 shows calculated age using formula derived by Singh and Mukerjee (Formula E: y = 6.26 x – 6), Table 15 showing the calculated and difference using same score in formula derived by Tomaru et al (Formula F: y = 8.50 A + 26.073). Kwak and Kim's multiple regression formula (Formula G: y = 6.37 T +4.63 P + 2.70 S + 2.40 C + 3.08 A + 1.34 R + 8.57) was also used and age calculated and difference was noted from actual age in Table 16. Lastly, Table 17 shows the calculated age obtained by using values of total score allotted in the newly derived regression equation (Formula A: y= 4.7 x + 9.66).

The comparison of the mean actual age and mean calculated age, using the newly derived regression equation was done. It was found that mean calculated age (41.33 ± 11.38) was slightly

higher as compared to the mean actual age (41.23 ± 11.65) but statistically this difference was non-significant.

Maximum and Minimum deviation was calculated from each of the six formulae and it was seen that newly derived regression formula (Formula A) gave least deviation of the calculated age from the actual age (- 4.24 to + 3.26 years) which was similar to that calculate using Gustafson's (- 3.53 to + 4.67 years) as well as Maple and Rice's formula (- 4.69 to + 5.49). Rest of the formulae gave large range of deviation. The reason could be different study group as well as due to use of multiple regression equation as in the method of Kwak and Kim.

In the present study, regression curve were also derived by plotting score of individual factor against the actual age of the person and age was calculated.

The six formulae derived were

1. Attrition: y = 16.89 x + 13.69
2. Peridontal Disease: y = 6.69 x + 32.32
3. Sec. Dentine Deposition: y = 16.78 x + 22.43
4. Cementum Apposition: y = 16.26 x + 31.63
5. Root Translucency: y = 14.11x + 20.19
6. Root Resorption: y = 14.11x + 20.19

(y is calculated age and x is individual score)

These six equation derived was used in each case and age was calculated by putting the values in the regression equation. The difference of calculated age and actual age of the person using these factors alone were also calculated.

Mean calculated age of three out six factors was 41.22 and rest of the three was 41.21 which were quite near to the actual age but on calculating the maximum and minimum deviation of calculated age from the actual age it was found that there was large range of negative as well positive deviation.

Out of the all the factors, secondary dentine deposition and root translucency showed least deviation. These findings were same as to the finding of Solheim (1992) who also found stronger correlation of these two factors with the age as compared to other factors.

The comparison of actual age and calculated age using all factors together, with age calculated from the individual factor separately was done. The mean age was found almost the same with slight difference which was found to be non- significant statistically.

All the factors taken together and total score used for calculating age gave less deviation as compared when each factor was taken alone. Deviation of calculated age from the actual age was ± 4 years (range - 4.24 to + 3.26 years) which was better than that found by Maple and Rice i.e. ± 7 years but more as compared to that found by Bang and Ramm in their study (± 3.6 years).

Two factors i.e. attrition and peridontal disease can be studied in situ that is without removal of the teeth from the socket thus these two factors can even be studied in living person as well. In our study, we used the scores allotted to these two factors and plotted graph with scores of these two on x axis and actual age on y axis as shown in Fig 8 and thus got a regression curve and a regression

equation. This equation was thus used to calculate the age for the individual case. It was found that mean calculated age using these two factors came out to be 40.69 ± 7.64 years which was quite near the mean actual age [41.23 ± 11.65 years]. No similar study was found in the literature to compare these finding.

By using the attrition and peridontal disease factor only, although the deviation was large i.e. maximum deviation + 16.09 years and minimum was - 18.91 years, but in 46% of the total cases had a deviation of only ± 5 years which was near to when all the six factors are taken together. Thus these two factors which can recorded in a living person can also help in age estimation.

Thus in our study we found that physiological factor studied gave the best result when all the six factors were scored and used collectively together top find the age of the person.

SUMMARY AND CONCLUSION

1. Six physiological factors were noted in this study that could help in the age estimation. These were attrition, peridontal disease, secondary dentine deposition, cementum apposition, root translucency/transparency and root resorption.
2. Physiological factors of teeth that could help in age estimation had no significant correlation with the sex of the person.
3. Diet whether vegetarian or non-vegetarian had no effect on physiological factors of teeth which help in age estimation.
4. Socio-economic status of person had no significant effect on the physiological factors of teeth.
5. Regression formula was derived from the graph obtained by plotting total score against actual age.
6. Regression formulae were also derived from the graph obtained by plotting score of individual physiological factor alone against actual age.
7. Previous regression formulae were used to calculate the age using total score recorded from the physiological factors of teeth.
8. Previous regression formulae were evaluated and Gustafson's and Maple & Rice's formulae were found to give least range of deviation from actual age.
9. Formula A (newly derived formula) derived from the regression curve obtained by plotting total score against actual age was $y = 4.7 x + 9.66$ where y is calculated age and x is total score.
10. Mean calculated age when total scores of all the physiological factors were taken together was 41.33 ± 11.38 while mean actual age was 41.23 ± 11.65.
11. Mean calculated age with all physiological factors taken together had a deviation of about ± 4 years (- 4.24 to +3.26 years)
12. Age calculated using all the six factors had less deviation from the actual age as compared when individual factor was taken alone.
13. All the six physiological factors showed large deviation when they were taken separately. Least deviation of calculated age from actual age was seen with the secondary dentine deposition and root translucency factors.

14. Two physiological factors i.e. attrition and peridontal disease, which could be recorded in living person were also studied together. Using these two physiological factors, in 46 % cases deviation of calculated age from the actual age was ± 5 years.

MASTER CHART

ABBREVIATION USED IN MASTER CHART

S. No. : Serial Number

AA: Actual Age

M: Male

F: Female

V: Vegetarian

NV: Non-vegetarian

R: Rural

U: Urban

Att. Sc: Attrition Score

P D.: Peridontal Disease Score

SDD: Secondary Dentine Deposition Score

C A: Cementum Apposition Score

R T: Root Translucency/ Root Transparency Score

R R: Root resorption Score

Tot. Sc.: Total Score

Cal. Ag A: Age calculated using Formula A

Cal. Ag B: Age calculated using Formula B

Cal. Ag C: Age calculated using Formula C

Cal. Ag D: Age calculated using Formula D

Cal. Ag E: Age calculated using Formula E

Cal. Ag F: Age calculated using Formula F

Cal. Ag G: Age calculated using Formula G

Diff. in Age: Difference of calculated age from actual Age

S No.	Name	Sex	AA	Diet	Resi	AttS	PD	SDD	CA	RT	RR	TotSc	CalAgA	Diff.inAge	CalAgB	Diff.inAge	CalAgC	Diff.inAge	CalAgD	Diff.inAge	CalAgE	Diff.inAge
1	Sandeep Sharma	M	27	V	U	1	1	1	0	1	0	4	28.46	1.46	17.28	-9.72	29.67	2.67	30.49	3.49	19.04	-7.96
2	Sahab Singh	M	34	V	R	1	1	1	1	1	0	5	33.16	-0.84	22.62	-11.38	34.23	0.23	34.75	0.75	25.3	-8.7
3	Suman	F	35	NV	U	2	1	1	0	1	1	6	37.86	2.86	27.96	-7.04	38.79	3.79	39.01	4.01	31.56	-3.44
4	Dharampal	M	29	V	R	1	1	1	0	1	1	4	28.46	-0.54	17.28	-11.72	29.67	0.67	30.49	1.49	19.04	-9.96
5	Gurjant Singh	M	58	V	U	2	1	2	1	3	2	11	61.36	3.36	54.66	-3.34	61.59	3.59	60.31	2.31	62.86	4.86
6	Tarachand	M	60	V	R	2	2	2	1	3	1	11	61.36	1.36	54.66	-5.34	61.59	1.59	60.31	0.31	62.86	2.86
7	Ashwani Kumar	M	38	V	R	1	1	1	0	1	1	6	37.86	-0.14	27.96	-10.04	38.79	0.79	39.01	1.01	31.56	-6.44
8	Surjeet Singh	M	50	V	U	2	1	1	1	2	1	8	47.26	-2.74	38.64	-11.36	47.91	-2.09	47.53	-2.47	44.08	-5.92
9	Om Parkash	M	40	NV	R	2	1	1	0	1	1	6	37.86	-2.14	27.96	-12.04	38.79	-1.21	39.01	-0.99	31.56	-8.44
10	Mandeep Kaur	F	28	V	U	1	0	1	0	1	0	3	23.76	-4.24	11.94	-16.06	25.11	-2.89	26.23	-1.77	12.78	-15.22
11	Akbar Ali	M	30	V	R	1	1	1	1	1	0	5	33.16	3.16	22.62	-7.38	34.23	4.23	34.75	4.75	25.3	-4.7
12	Krishanawati	F	55	V	R	2	2	1	1	2	1	9	51.96	-3.04	43.98	-11.02	52.47	-2.53	51.79	-3.21	50.34	-4.66
13	Kashmir Singh	M	62	NV	R	2	2	2	1	2	2	11	61.36	-0.64	54.66	-7.34	61.59	-0.41	60.31	-1.69	62.86	0.86
14	Joginder singh	M	49	NV	U	2	1	1	1	1	1	8	47.26	-1.74	38.64	-10.36	47.91	-1.09	47.53	-1.47	44.08	-4.92
15	Jai Bant	F	32	V	R	2	1	1	0	1	1	5	33.16	1.16	22.62	-9.38	34.23	2.23	34.75	2.75	25.3	-6.7
16	Sarujal Islam	M	46	V	U	2	1	1	1	2	1	8	47.26	1.26	38.64	-7.36	47.91	1.91	47.53	1.53	44.08	-1.92
17	Jatinder Kaur	F	25	V	R	1	1	1	0	1	0	4	28.46	3.46	17.28	-7.72	29.67	4.67	30.49	5.49	19.04	-5.96

S No.	Name	Sex	AA	Diet	Resi	Att S	PD	SDD	CA	RT	RR	TotSc	CalAg A	Diff.inAge	CalAg B	Diff.inAge	CalAgC	Diff.inAge	CalAgD	Diff.inAge	CalAgE	Diff.inAge
18	Surinder Singh	M	42	V	U	2	1	1	1	1	1	7	42.56	0.56	33.3	-8.7	43.35	1.35	43.27	1.27	37.82	-4.18
19	Kishan Lal	M	52	NV	U	2	1	1	1	2	1	9	51.96	-0.04	43.98	-8.02	52.47	0.47	51.79	-0.21	50.34	-1.66
20	Jatinder Singh	M	28	V	U	1	1	1	0	1	0	4	28.46	0.46	17.28	-10.72	29.67	1.67	30.49	2.49	19.04	-8.96
21	Darshan singh	M	50	V	R	2	1	1	1	2	1	8	47.26	-2.74	38.64	-11.36	47.91	-2.09	47.53	-2.47	44.08	-5.92
22	Harpreet Kaur	F	47	NV	U	2	2	1	0	3	0	8	47.26	0.26	38.64	-8.36	47.91	0.91	47.53	0.53	44.08	-2.92
23	Deeela Ram	M	35	V	R	1	1	1	1	1	0	5	33.16	-1.84	22.62	-12.38	34.23	-0.77	34.75	-0.25	25.3	-9.7
24	Ram Singh	M	28	V	U	1	2	0	0	1	0	4	28.46	0.46	17.28	-10.72	29.67	1.67	30.49	2.49	19.04	-8.96
25	Surinderpal S	M	40	V	U	2	1	1	0	1	1	6	37.86	-2.14	27.96	-12.04	38.79	-1.21	39.01	-0.99	31.56	-8.44
26	Ranjit Paswan	M	50	V	R	2	2	1	1	2	1	9	51.96	1.96	43.98	-6.02	52.47	2.47	51.79	1.79	50.34	0.34
27	Shanti kumari	F	57	V	U	2	1	2	1	2	2	10	56.66	-0.34	49.32	-7.68	57.03	0.03	56.05	-0.95	56.6	-0.4
28	Jai Parkash	M	29	NV	R	1	1	1	0	1	0	4	28.46	-0.54	17.28	-11.72	29.67	0.67	30.49	1.49	19.04	-9.96
29	Seema Goel	F	30	NV	R	1	2	0	0	1	0	4	28.46	-1.54	17.28	-12.72	29.67	-0.33	30.49	0.49	19.04	-10.96
30	Rajinder kaur	F	45	V	U	2	1	1	1	1	1	7	42.56	-2.44	33.3	-11.7	43.35	-1.65	43.27	-1.73	37.82	-7.18
31	Balwinder kaur	F	26	V	U	1	2	0	0	1	0	4	28.46	2.46	17.28	-8.72	29.67	3.67	30.49	4.49	19.04	-6.96
32	Om Parkash	M	27	V	U	1	1	1	0	1	0	4	28.46	1.46	17.28	-9.72	29.67	2.67	30.49	3.49	19.04	-7.96
33	Surjit Kumar	M	30	V	R	1	2	0	0	1	0	4	28.46	-1.54	17.28	-12.72	29.67	-0.33	30.49	0.49	19.04	-10.96
34		M	40	V	U	2	1	1	0	1	1	6	37.86	-2.14	27.96	-12.04	38.79	-1.21	39.01	-0.99	31.56	-8.44

S No.	Name	Sex	AA	Diet	Resi	Atts	PD	SDD	CA	RT	RR	TotSc	CalAgA	Diff.inAge	CalAgB	Diff.inAge	CalAgC	Diff.inAge	CalAgD	Diff.inAge	CalAgE	Diff.inAge
	Surinderpal S																					
35	Raja Ram	M	55	NV	R	2	2	1	1	2	1	9	51.96	-3.04	43.98	-11.02	52.47	-2.53	51.79	-3.21	50.34	-4.66
36	Jawahar Lal	M	48	V	U	2	1	1	1	2	1	8	47.26	-0.74	38.64	-9.36	47.91	-0.09	47.53	-0.47	44.08	-3.92
37	Pankaj	M	30	V	U	1	1	1	1	1	0	5	33.16	3.16	22.62	-7.38	34.23	4.23	34.75	4.75	25.3	-4.7
38	Ranjit Singh	M	28	NV	R	1	2	0	0	1	0	4	28.46	0.46	17.28	-10.72	29.67	1.67	30.49	2.49	19.04	-8.96
39	Gurmail Singh	M	25	NV	R	1	1	1	0	1	0	4	28.46	3.46	17.28	-7.72	29.67	4.67	30.49	5.49	19.04	-5.96
40	Charanjeet Verma	M	37	V	U	1	1	1	1	1	1	6	37.86	0.86	27.96	-9.04	38.79	1.79	39.01	2.01	31.56	-5.44
41	Mohinder Singh	M	45	NV	R	2	1	1	1	1	1	7	42.56	-2.44	33.3	-11.7	43.35	-1.65	43.27	-1.73	37.82	-7.18
42	Mehma Singh	M	48	V	R	2	1	1	1	2	1	8	47.26	-0.74	38.64	-9.36	47.91	-0.09	47.53	-0.47	44.08	-3.92
43	Paramjeet Sngh	M	37	V	R	1	2	1	1	1	0	6	37.86	0.86	27.96	-9.04	38.79	1.79	39.01	2.01	31.56	-5.44
44	Bachan Singh	M	65	V	R	2	2	2	1	3	1	11	61.36	-3.64	54.66	-10.34	61.59	-3.41	60.31	-4.69	62.86	-2.14
45	Hirommay Ghosh	M	29	NV	U	1	2	0	0	1	0	4	28.46	-0.54	17.28	-11.72	29.67	0.67	30.49	1.49	19.04	-9.96
46	Jasmail Kaur	F	25	V	U	1	1	0	0	1	0	3	23.76	-1.24	11.94	-13.06	25.11	0.11	26.23	1.23	12.78	-12.22
47	Sukhwinder Kaur	F	30	V	R	1	1	1	0	1	0	4	28.46	-1.54	17.28	-12.72	29.67	-0.33	30.49	0.49	19.04	-10.96
48	Shinder Kaur	F	40	NV	U	2	1	1	1	1	1	7	42.56	2.56	33.3	-6.7	43.35	3.35	43.27	3.27	37.82	-2.18
49	Sarwan Singh	M	65	V	U	3	2	2	1	3	1	12	66.06	1.06	60	-5	66.15	1.15	64.57	-0.43	69.12	4.12

S No.	Name	Sex	AA	Diet	Resi	Atts	PD	SDD	CA	RT	RR	TotSc	CalAgA	Diff.inAge	CalAgB	Diff.inAge	CalAgC	Diff.inAge	CalAgD	Diff.inAge	CalAgE	Diff.inAge
50	Darshan Kaur	F	32	V	R	1	1	1	1	1	0	5	33.16	1.16	22.62	-9.38	34.23	2.23	34.75	2.75	25.3	-6.7
51	Gurinder Kaur	F	26	V	U	1	1	1	0	1	0	4	28.46	2.46	17.28	-8.72	29.67	3.67	30.49	4.49	19.04	-6.96
52	Narain Dass	M	33	NV	U	2	1	1	0	1	0	5	33.16	0.16	22.62	-10.38	34.23	1.23	34.75	1.75	25.3	-7.7
53	Naranjan	M	65	V	U	2	2	2	1	3	1	11	61.36	-3.64	54.66	-10.34	61.59	-3.41	60.31	-4.69	62.86	-2.14
54	Kamlesh Rani	F	37	V	R	1	1	1	1	1	1	6	37.86	0.86	27.96	-9.04	38.79	1.79	39.01	2.01	31.56	-5.44
55	Amarjit Singh	M	52	NV	R	2	2	1	1	2	1	9	51.96	-0.04	43.98	-8.02	52.47	0.47	51.79	-0.21	50.34	-1.66
56	Amit Sharma	M	32	V	R	2	1	1	0	1	0	5	33.16	1.16	22.62	-9.38	34.23	2.23	34.75	2.75	25.3	-6.7
57	Baljit Kaur	F	25	V	R	2	1	0	0	1	0	4	28.46	3.46	17.28	-7.72	29.67	4.67	30.49	5.49	19.04	-5.96
58	Sant Ram	M	32	V	U	2	1	1	0	1	0	5	33.16	1.16	22.62	-9.38	34.23	2.23	34.75	2.75	25.3	-6.7
59	Baldev Singh	M	27	V	U	1	1	1	0	1	0	4	28.46	1.46	17.28	-9.72	29.67	2.67	30.49	3.49	19.04	-7.96
60	Reenu Bala	F	45	NV	U	2	1	1	1	1	1	7	42.56	-2.44	33.3	-11.7	43.35	-1.65	43.27	-1.73	37.82	-7.18
61	Pushpa Kumari	F	55	V	U	2	2	2	1	2	1	10	56.66	1.66	49.32	-5.68	57.03	2.03	56.05	1.05	56.6	1.6
62	Jaswinder Kaur	F	28	V	R	1	2	0	0	1	0	4	28.46	0.46	17.28	-10.72	29.67	1.67	30.49	2.49	19.04	-8.96
63	Karmi	F	35	V	R	1	1	1	1	1	0	5	33.16	-1.84	22.62	-12.38	34.23	-0.77	34.75	-0.25	25.3	-9.7
64	Rulda Singh	M	28	V	R	1	1	1	0	1	0	4	28.46	0.46	17.28	-10.72	29.67	1.67	30.49	2.49	19.04	-8.96
65	Seeta	F	50	V	U	2	2	1	1	2	1	9	51.96	1.96	43.98	-6.02	52.47	2.47	51.79	1.79	50.34	0.34
66	Dharm Singh	M	42	V	U	2	1	1	0	1	1	6	37.86	-4.14	27.96	-14.04	38.79	-3.21	39.01	-2.99	31.56	-10.44
67	Satnam Kaur	F	32	V	U	2	1	1	0	1	0	5	33.16	1.16	22.62	-9.38	34.23	2.23	34.75	2.75	25.3	-6.7
68		F	40	V	R	2	1	1	1	1	1	7	42.56	2.56	33.3	-6.7	43.35	3.35	43.27	3.27	37.82	-2.18

S No.	Name	Sex	AA	Diet	Resi	Atts	PD	SDD	CA	RT	RR	TotSc	CalAgA	Diff.inAge	CalAgB	Diff.inAge	CalAgC	Diff.inAge	CalAgD	Diff.inAge	CalAgE	Diff.inAge
	Charanjeet Kaur																					
69	Ighraj Dutt	M	34	NV	U	1	1	1	1	1	0	5	33.16	-0.84	22.62	-11.38	34.23	0.23	34.75	0.75	25.3	-8.7
70	Harbhajan Singh	M	36	V	R	2	2	1	0	1	0	6	37.86	1.86	27.96	-8.04	38.79	2.79	39.01	3.01	31.56	-4.44
71	Tulsi Ram	M	45	V	U	2	2	1	1	2	0	8	47.26	2.26	38.64	-6.36	47.91	2.91	47.53	2.53	44.08	-0.92
72	Parmanand	M	60	V	U	2	1	2	1	3	2	11	61.36	1.36	54.66	-5.34	61.59	1.59	60.31	0.31	62.86	2.86
73	Kartar Singh	M	54	V	R	2	2	2	1	2	1	10	56.66	2.66	49.32	-4.68	57.03	3.03	56.05	2.05	56.6	2.6
74	Manju Bala	F	27	V	U	1	1	1	0	1	0	4	28.46	1.46	17.28	-9.72	29.67	2.67	30.49	3.49	19.04	-7.96
75	Saita Dei	F	60	NV	R	2	1	2	1	3	0	11	61.36	1.36	54.66	-5.34	61.59	1.59	60.31	0.31	62.86	2.86
76	Wazira Ram	M	55	V	R	2	2	2	1	2	1	10	56.66	1.66	49.32	-5.68	57.03	2.03	56.05	1.05	56.6	1.6
77	Amar Singh	M	55	V	R	2	1	2	1	2	2	10	56.66	1.66	49.32	-5.68	57.03	2.03	56.05	1.05	56.6	1.6
78	Tej Kaur	F	50	V	U	2	2	2	1	2	0	9	51.96	1.96	43.98	-6.02	52.47	2.47	51.79	1.79	50.34	0.34
79	Gagan Singh	M	47	V	R	2	2	1	1	2	0	8	47.26	0.26	38.64	-8.36	47.91	0.91	47.53	0.53	44.08	-2.92
80	Karnail Singh	M	42	V	R	2	1	1	1	2	0	7	42.56	0.56	33.3	-8.7	43.35	1.35	43.27	1.27	37.82	-4.18
81	Ashok Singh	M	57	NV	U	2	2	2	1	2	1	10	56.66	-0.34	49.32	-7.68	57.03	0.03	56.05	-0.95	56.6	-0.4
82	Gurmeet Kaur	F	35	V	U	1	1	1	1	1	0	5	33.16	-1.84	22.62	-12.38	34.23	-0.77	34.75	-0.25	25.3	-9.7
83	Darshpal Singh	M	51	V	U	2	2	2	1	2	0	9	51.96	0.96	43.98	-7.02	52.47	1.47	51.79	0.79	50.34	-0.66
84	Parnam Singh	M	31	V	R	2	1	1	0	1	0	5	33.16	2.16	22.62	-8.38	34.23	3.23	34.75	3.75	25.3	-5.7
85	Balwinder Singh	M	56	V	R	2	2	2	1	2	0	9	51.96	-4.04	43.98	-12.02	52.47	-3.53	51.79	-4.21	50.34	-5.66

S No.	Name	Sex	AA	Diet	Resi	AttS	PD	SDD	CA	RT	RR	TotSc	CalAgA	Diff.inAge	CalAgB	Diff.inAge	CalAgC	Diff.inAge	CalAgD	Diff.inAge	CalAgE	Diff.inAge
86	Nirmal Singh	M	32	NV	R	1	2	1	0	1	0	5	33.16	1.16	22.62	-9.38	34.23	2.23	34.75	2.75	25.3	-6.7
87	Surjit Kaur	F	60	V	U	2	1	2	1	3	2	11	61.36	1.36	54.66	-5.34	61.59	1.59	60.31	0.31	62.86	2.86
88	Karam Singh	M	40	V	R	2	2	1	0	1	0	6	37.86	-2.14	27.96	-12.04	38.79	-1.21	39.01	-0.99	31.56	-8.44
89	Manjeet Kaur	F	40	V	U	2	2	1	0	1	0	6	37.86	-2.14	27.96	-12.04	38.79	-1.21	39.01	-0.99	31.56	-8.44
90	Buli Devi	F	60	V	U	2	1	2	1	2	2	10	56.66	-3.34	49.32	-10.68	57.03	-2.97	56.05	-3.95	56.6	-3.4
91	Bhagwan Singh	M	32	V	R	1	1	1	1	1	0	5	33.16	1.16	22.62	-9.38	34.23	2.23	34.75	2.75	25.3	-6.7
92	Gurnam Singh	M	58	NV	R	2	1	2	1	3	1	10	56.66	-1.34	49.32	-8.68	57.03	-0.97	56.05	-1.95	56.6	-1.4
93	Seema	F	35	V	U	1	2	1	0	1	0	5	33.16	-1.84	22.62	-12.38	34.23	-0.77	34.75	-0.25	25.3	-9.7
94	Manjit Singh	M	35	NV	U	2	2	1	0	1	0	6	37.86	2.86	27.96	-7.04	38.79	3.79	39.01	4.01	31.56	-3.44
95	Geeta Rani	F	32	V	U	1	1	1	1	1	0	5	33.16	1.16	22.62	-9.38	34.23	2.23	34.75	2.75	25.3	-6.7
96	Suman Sharma	F	42	V	U	2	1	1	1	1	1	7	42.56	0.56	33.3	-8.7	43.35	1.35	43.27	1.27	37.82	-4.18
97	Surjeet Kaur	F	47	NV	R	2	1	1	1	3	0	8	47.26	0.26	38.64	-8.36	47.91	0.91	47.53	0.53	44.08	-2.92
98	Sampuran Kaur	F	60	V	R	2	1	2	1	3	2	11	61.36	1.36	54.66	-5.34	61.59	1.59	60.31	0.31	62.86	2.86
99	Ram Bhadur	M	40	V	R	2	1	1	1	1	0	6	37.86	-2.14	27.96	-12.04	38.79	-1.21	39.01	-0.99	31.56	-8.44
100	Satpaul Kaur	F	38	V	R	1	1	1	1	1	1	6	37.86	-0.14	27.96	-10.04	38.79	0.79	39.01	1.01	31.56	-6.44

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