

A Study of Cephalometric Norms of Kodava and Kerala Population for McNamara Analysis

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ABSTRACT

Aim: This study was carried out to establish cephalometric norms of Kodava and Kerala population for McNamara analysis.

Materials and Methods: 60 kodava and 60 Kerala adults (30 males and 30 females) were taken with an age group between 18-30 years having class I molar relationship on both sides with minimal or no crowding /spacing, normal growth pattern and no history of orthodontic treatment or orthognathic surgery. Lateral cephalograms in occlusion were taken with natural head position and no lip strain. The head films were traced and analyzed, landmarks and cephalometric parameters used in McNamara analysis were followed.

Results: It has shown significant difference in mandible to cranial base relation (pog-Np), maxilla to mandible relation (Ans-Menton). Our study findings were similar to McNamara norms.

Conclusion: Despite reduced chin prominence and lower anterior facial height in Kodava and Kerala population rest all the parameters are similar to Caucasian standards. McNamara analysis can be applied for Kerala and Kodava population.

Keywords: Lateral cephalogram, cephalometric norms, McNamara analysis, Kodava population, Kerala population.

INTRODUCTION

For centuries, facial esthetics has been a subject of interest to people of all cultures. The world is full of evidence of human achievements since antiquity to make themselves more graceful and attractive. As far as orthodontics is concerned, harmonious facial aesthetics and functional occlusion have long been recognized as the two important goals of orthodontic treatment.¹

The goal of the orthodontic treatment is to improve the patient's life by enhancing the dental and jaw

function and dentofacial esthetics. The greatest trust to this direction evolved with the advent of cephalometrics and its application to clinical orthodontics. A radiographic head image could be measured in two dimensions, thereby making possible the accurate study of craniofacial growth and development. Cephalometrics has now established itself as one of the pillars of orthodontic diagnosis. One of the major applications of cephalometrics is that it helps in the classification of the skeletal and dental abnormalities and also helps to establish facial types. It also helps in

Received: Jan. 21, 2018; Accepted: Apr. 3, 2018

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orthodontic diagnosis by enabling the study of skeletal, dental and soft tissue structures of the craniofacial region.

The human face is a complex mosaic of lines, angles, planes, shapes, textures and colours. The interplay of these elements produces an infinite variety of facial forms from near perfect symmetry to extreme disproportion. To establish a concept of facial balance or proportion, imaginary lines are drawn through various facial landmarks and the various features are measured in relation to the rest of the face. The morphologic relationship and proportions of the nose, lips and chin determine the facial harmony in orthodontics. The soft tissue components of the face grow at different times with varying velocities, just as the dentofacial components do. Although facial morphology is to a large extent influenced by the skeletal and dental scaffolding, the ultimate esthetic appearance resides in the soft tissue drapes. Since the advent of Roentgenographic cephalometry and its application in orthodontics, several analyses have been put forward for the evaluation of dentofacial structures with norms and ranges. Racial differences produce subtle differences in a given feature that can produce quite a noticeable difference in the overall facial form, which is, of relevant importance in orthodontic diagnosis and treatment planning. Thus it is logical to individualize norms for different races.

Pioneers in Orthodontics who have paved way for racial studies, have elicited demons trouble in cephalometric norms within race and ethnic groups.² In principle, McNamara's analysis combines the anterior reference plane (a plane perpendicular to the Frankfort Horizontal through the nasion) described by Burstone, and the description of the length of the jaws and their relationship as given by Harvold. This specific innovative cephalometric analysis was introduced because 'a need had arisen for a method of cephalometric analysis that is sensitive not only to the position of teeth within a given bone, but also to the relationship of jaw elements and makes the actual analysis most suitable for diagnosis, treatment planning and treatment evaluation, not only of conventional orthodontic patients, but also for patients with skeletal discrepancies who are candidates for dentofacial orthopedics and

orthognathic surgery.³ Similar studies have also been carried out by many Indian authors on different racial and ethnic population found in the Indian subcontinent. The conclusion of these studies stimulated the present investigation to study the skeletodental and soft tissue patterns in Kodava and Kerala population.

The Kodavas are a community of 100,000 inhabiting the district of Coorg with a population of 500,000 in Karnataka. Coorg was reduced from statehood to a status of district in 1956. Kodavas are of unknown origin, are ethnically distinct and have unique facial and physical characteristics, with distinct language (Kodava), dress, unique life style and culture of their own.

Kerala, a state on India's tropical Malabar Coast, has nearly 600km of Arabian Sea shoreline. It's known for its palm-lined beaches and backwaters, a network of canals. Inland are the Western Ghats, mountains whose slopes support tea, coffee and spice plantations as well as wildlife. Kerala has the lowest positive population growth rate in India. As clinicians in this country, there is a need to setup cephalometric norms of the Kodava and Kerala population for McNamara analysis in order to facilitate proper treatment planning to serve the aesthetic needs of the community.

OBJECTIVES - This study was conducted with the following objectives:

To establish cephalometric norms of kodava and kerala population for McNamara analysis

MATERIALS AND METHODS

The present study was conducted in department of orthodontics and dentofacial orthopaedics, coorg institute of dental sciences, virajpet. The subjects were individuals from kerala and kodva population reporting to coorg institute of dental sciences.

Sample constituted 60 kodava and 60 kerala individuals which included 30 males and 30 females in both population. (Figure1 A,B, and 2 A,B) Lateral cephalogram were taken for each subject included in study with their consent. A prestructured proforma was used to collect the relevant information and record cephalometric measurements for each subject.



Fig 1a: Extra oral frontal photograph of the female subject.



Fig 1b: Extra oral profile photograph of the female subject.



Fig 2a: Extra oral frontal photograph of the male subject.



Fig 2b: Extra oral profile photograph of the male subject.



Fig 3a: Intraoral photographs of the subjects.



Fig 3b: Intraoral photographs of the subjects.



Fig 3c: Intraoral photographs of the subjects.



Fig 3d: Maxillary occlusal intraoral photographs of the subjects.



Fig 3e: Mandibular occlusal intraoral photographs of the subjects.

INCLUSION CRITERIA FOR SAMPLE SELECTION

1. Age range 18-30 years
2. Class I molar relationship on both sides with no or minimal crowding
3. Competent lips

4. Acceptable ,pleasing profile
5. Normal growth pattern

EXCLUSION CRITERIA FOR SAMPLE SELECTION

1. History of previous orthognathic surgery
2. Presence of craniofacial anomalies
3. History of previous orthodontic treatment
4. Presence of gross abnormality or severe crowding
5. Missing teeth except third molars
6. Presence of gross facial asymmetry or deformity
7. Pregnant woman

After examining each subject for his/her dental occlusion, (Figure3 A, B, C, D, E) lateral cephalograms in occlusion were taken with a natural head position with no lip strain .The lateral cephalometric radiographs were taken using the digital cephalostat (SIRONA ORTHOPHOS XG 5 DS). The head films were traced on acetate matt paper (8 x 10 inches) using 3H pencil. The tracings were analysed, landmarks and cephalometric parameters used in McNamara analysis were followed. The results were statically determined using SPSS (17.0) Software-

- 1) Descriptive analysis
- 2) t-test

MEASUREMENTS USED IN MCNAMARA'S ANALYSIS

MANDIBLE TO CRANIAL BASE

Pogonion to nasion perpendicular - Distance between point A and the line NP

MAXILLA TO CRANIAL BASE

Point A-NP (mm) - Distance between point A and the line N Perpendicular

SOFT TISSUE

Nasolabial angle (degrees) - Angle formed between upper lip and nasal base

Reference lines

MAXILLA TO MANDIBLE

- Co-A (mm) Effective Midfacial length: - distance between condylion and point A
- Co-Gn (mm) Effective Mandibular length: - distance between condylion and gnathion anatomic.
- Maxillomandibular differential (mm) - Difference between mandible length and midfacial length.
- ANS-Me (mm) - Height of lower anterior facial
- MP-FH (degrees) - Mandibular plane with Frankfort horizontal plane
- Facial axis angle (degrees) - Angle formed between the perpendicular on N-Ba and the facial plane

DENTITION

Upper incisor – Point A (mm) - Distance between front upper incisor point to the nasion perpendicular

Lower incisor – A Pog (mm) - Distance between front lower incisor point to the line A-pog

AIRWAYS

- Upper airway (mm) - Width of upper pharynx
- Lower airway (mm) - Width of lower pharynx

RESULTS

- Descriptive statistics for the cephalometric measurements for adult Kodava Population in this study are presented in Table 1 for the sexes combined.
- Descriptive statistics for the cephalometric measurements for adult Kerala Population in this study are presented in Table 2 for the sexes combined.

DISCUSSION

Roentgenographic cephalometry was first introduced by Broadbent in 1931, mainly as a tool to study craniofacial growth and development³. McNamara analysis can be used as an aid in diagnosis of skeletal and dental defects which when tempered with good clinical judgement can establish an appropriate treatment plan.^{4, 5, 6}

There are numerous cephalometric analysis that have been developed to establish norms for ideal facial proportions and occlusion, with ranges for skeletal or dental patterns. Since well-established Indian ethnic norms are lacking, norms derived for Caucasian population are routinely used for investigation which show a great degree of variation when applied to different populations. Thus it became necessary to establish norms for every ethnic group.

Coorg is a small district situated on the slopes of the Western Ghats. The Kodavas are natives of Coorg and they represent a small number in this part of the state, while Kerala is the state on India's tropical Malabar Coast with the lowest positive population growth rate in India. Racial mixing has been limited to this population due to strong family bonds and firm religious and cultural heritage, based on ethnic belief and traditions. Hence, as clinicians in this country, there is a need to setup cephalometric norms for the Kodava and Kerala population for McNamara analysis in order to facilitate proper treatment planning to serve the esthetic needs of both the community.

60 Kodava and 60 Kerala adults (30 males and 30 females) with an age group between 18-30 years having class I molar relationship on both sides with minimal or no crowding/spacing, normal growth pattern and no history of orthodontic treatment /orthognathic surgery were included in this study.

The lateral cephalometric radiographs were taken using the digital cephalostat [SIRONA ORTHOPHOS XG 5 DS]. The head films were traced on acetate matt paper (8 x 10 inches) using 3H pencil. The tracings were analysed for landmarks and cephalometric parameters used in McNamara analysis. In this study we have taken into consideration the 5 major sections i.e. mandible to cranial base, maxilla to cranial base, soft tissue, maxilla to mandible, dentition and airway [table 1 and table 2].

The overall mean values with various parameters as per McNamara analysis were taken up as this method depends primarily upon linear measurements than angles, so that treatment planning is made easier especially for orthognathic surgery. This method is more sensitive to vertical changes than Steiner's analysis (ANB angle),

Table 1: Descriptive statistics for the cephalometric measurements for adult Kodava Population in this study for the sexes combined.

PARAMETERS	RANGE	MEAN	STANDARD DEVIATION
MANDIBLE TO CRANIAL BASE			
Pog – NP (in mm)	-10 to 1	-5.9667	2.80415
MAXILLA TO CRANIAL BASE			
Point A to NP (in mm)	-8 to 4	-1.9667	2.85210
SOFT TISSUE			
Nasolabial Angle (in degrees)	89 to 111	96.4833	4.63769
MAXILLA TO MANDIBLE			
Co-Point A (in mm)	80 to 94	87.1833	4.31588
Co-Gn (in mm)	100 to 122	113.2500	5.97913
Max and Mand Diff (in mm)	20 to 31	26.3833	3.10872
ANS-Me (in mm)	54 to 68	59.3500	2.87494
MP-FH angle (in degrees)	20 to 29	23.1167	2.26313
Facial Axis angle (in degrees)	90 to 97	93.3833	1.94929
DENTITION			
Up inc-Point A (in mm)	3 to 7	5.4333	1.07934
Lower inc-A-Pog (in mm)	1 to 6	3.1833	1.24181
AIRWAY			
Upper airway (in mm)	12 to 21	16.2333	2.33156
Lower airway (in mm)	9 to 15	11.9333	1.40056

Table 2: Descriptive statistics for the cephalometric measurements for adult Kerala Population in this study are presented in Table 2 for the sexes combined.

PARAMETERS	RANGE	MEAN	STANDARD DEVIATION
MANDIBLE TO CRANIAL BASE			
Pog – NP (in mm)	-10 to 2	-6.6000	3.06539
MAXILLA TO CRANIAL BASE			
Point A to NP (in mm)	-5 to 3	-0.9500	2.01204
SOFT TISSUE			

Nasolabial Angle (in degrees)	90 to 110	97.2167	6.08998
MAXILLA TO MANDIBLE			
Co-Point A (in mm)	82 to 98	87.8333	3.73788
Co-Gn (in mm)	105 to 120	111.9500	4.08978
Max and Mand Diff (in mm)	18 to 32	24.7667	3.07735
ANS-Me (in mm)	54 to 70	60.9500	4.08978
MP-FH angle (in degrees)	19 to 30	24.0667	2.89867
Facial Axis angle (in degrees)	85 to 97	91.6667	2.78414
DENTITION			
Upper inc-Point A (in mm)	2 to 7	4.1667	1.35505
Lower inc-A-Pog (in mm)	1 to 5	3.0000	1.11993
AIRWAY			
Upper airway (in mm)	11 to 19	14.9333	1.95601
Lower airway (in mm)	10 to 15	11.7000	1.38148

thereby providing guidelines with respect to normally occurring growth increments.

MANDIBLE TO CRANIAL BASE RELATION- (POGONION TO NASION PERPENDICULAR)

The distance from Pogonion to Nasion Perpendicular determines the relationship of mandible mainly chin to cranial base. A decrease will indicate anterior positioning and an increase will indicate posterior positioning.⁷

The mean of pogonion to nasion perpendicular for kodava population is -5.9667 with a standard deviation of 2.80415 and for kerala population is -6.6000 with a standard deviation of 3.06539. The male and female values within kodava population showed high statistically significant difference while in kerala population the value seems to be statistically significant indicating **reduced chin prominence**.

MAXILLA TO CRANIAL BASE RELATION (POINT A TO NASION PERPENDICULAR)

It usually indicates the antero-posterior position of maxilla relative to nasion perpendicular with an ideal value of +/- 1.62 and 2.11 +/- 0.72 .¹⁴

In a well-balanced face point A should be on or slightly ahead of this line. An increase will indicate maxillary prognathism and decrease will indicate maxillary retrognathism.

The mean of point A to nasion perpendicular for kodava population is -1.9667 with a standard deviation of 2.85210 and for kerala population is -0.9500 with a standard deviation of 2.01204. The male and female values within kodava population showed high statistically significant difference while in kerala population it showed statistically significant difference indicating **orthognathic maxilla**.

SOFT TISSUE (NASOLABIAL ANGLE)

Nasolabial angle is defined as the angle between the line drawn through the midpoint of nostril aperture and a line drawn perpendicular to Frankfurt horizontal while intersecting subnasle.⁸ The mean angle for women was 93.4 to 98.5 degrees for men

and 95.5 to 100.1 degrees for women and an arbitrary range 90 to 120 degree.³

The mean of nasolabial angle for kodava population is 96.4833 with a standard deviation of 4.63769 and Kerala population is 97.2167 with a standard deviation of 6.08998. The male and female values within kodava population showed statistically significant difference while within Kerala population showed high statistically significant difference **indicating normally placed upper lip in both the population.**

MAXILLA TO MANDIBLE RELATION

Condylion to Point A determines the most effective midfacial lengths (not the actual anatomic length of maxilla) with an ideal value of 85mm in length ⁹. The mean of condylion to point A for kodava population is 87.1833 with a standard deviation of 4.31588 and Kerala population is 87.1833 with a standard deviation of 3.73788. The male and female values within kodava population showed statistically no significant difference while Kerala population showed high statistically significant difference which indicates **average mid facial length.**

The most effective mandibular length is derived by constructing a line from condylion to gnathion (the most anteroinferior aspect of mandibular symphysis) with an ideal value ranging from 105 to 108mm in length. The mean of condylion to gnathion for kodava population is 113.2500 with a standard deviation of 5.97913 and Kerala population is 111.9500 with a standard deviation of 4.08978. The male and female values within kodava population showed statistically significant difference while Kerala population showed high statistically significant difference which indicates **average effective mandibular length in both the population.**

Maxillomandibular differential is the difference between maxillary and mandibular growth lengths. Average measurement reported by McNamara in ideal cases 20mm (small), 25-27mm (medium) 30-33mm (large), this falls into higher values for south Indian community according to Thomas and valiathan. The mean of maxillomandibular differential for kodava population is 26.3833 with a standard deviation of 3.10872 and kerala

population being 24.7667 with a standard deviation of 3.07735. The male and female values within kodava population showed high statistically significant difference while within Kerala population it showed statistically no significant difference which **indicates medium size facial pattern.**

Anterior nasal spine to menton represents the height of lower anterior face.¹⁰ Average measurements according to McNamara were, the lower anterior facial height should be 65mm and upper facial height 53mm with ratio being approximately 5:6 for a well-balanced face. An increase will indicate long faced individual and a decrease shows short face individuals.³ The mean of anterior nasal spine to menton for kodava population is 59.3500 with a standard deviation of 2.87494 and Kerala population is 60.9500 with a standard deviation of 4.08978. The male and female values within kodava population showed statistically no significant difference while within Kerala population showed high statistically significant difference **indicating slightly short face individual.**

Mandibular plane angle is related to the steepness of mandibular plane when compared to the cranial base represented by Frankfort plane which averages about 25+/- 3.0. Higher angles indicate a vertical or downward growth whereas lower angle indicates horizontal or forward growth. The mean of MP-HP angle for kodava population is 23.1167 with a standard deviation of 2.26313 and Kerala population is 24.0667 with a standard deviation of 2.89867. The male and female values within kodava population showed statistically no significant difference while within Kerala population showed high statistically significant difference which indicates **normodivergent growth pattern.**

Facial axis angle expresses the ratio of facial height to depth thus indicating the direction of growth of chin.¹¹ This angle averages about 90+/- 3.5. Higher angle indicates anticlockwise growth whereas lower value indicates clockwise growth of the chin. Thomas and valiathan showed facial axis to be 90.65+/- 3.33 and 89.64+/- 5.06 for adult south Indian. The mean of facial axis angle for Kodava population is 93.3833 with a standard deviation of 1.94929 and Kerala population is 91.6667 with a

standard deviation of 2.78414. The male and female values within kodava population showed statistically no significant difference and the Kerala population showed high statistically significant difference which indicates **normal growth of chin**.

DENTITION

Upper incisor – point A relates the relationship of upper incisors to the maxilla.¹² The average value is around 4-6 mm. An increase will indicate proclined incisors and decrease will indicate retroclined incisors. The mean of upper incisor to point A for kodava population is 5.4333 with a standard deviation of 1.07934 and Kerala population is 4.1667 with a standard deviation of 1.35505. The male and female values within kodava population showed statistically significant difference and Kerala population showed statistically no significant difference which indicates **normally placed upper incisors**.

Lower incisor – A pog relates the position of lower incisors to A-pog line. The average value is around 1-3mm where in an increase indicates proclination and decrease retroclination. It also indicates balanced position of lower incisors to A-pog line which could be due to normal effective mandibular length, maxillomandibular differential and relative stable position of lower incisors to A-pogline during growth. The mean of lower incisor to A-pog for kodava population is 3.1833 with a standard deviation of 1.24181 and Kerala population is 3.0000 with a standard deviation of 1.11993. The male and female values within kodava population showed statistically no significant difference and within Kerala population showed high statistically significant difference which indicates **normally placed lower incisors**.

AIRWAY

Upper airway represents the width of upper pharyngeal space.¹³ Average measurements given by McNamara said to be about 12mm which increases by age. An airway opening of 5mm or less in the upper pharyngeal measurement is indicator of possible airway impairment.³ The mean of upper airway for kodava population is 16.2333 with a standard deviation of 2.33156 and Kerala population is 14.9333 with a standard deviation of 1.95601. The male and female values within kodava

population showed high statistically significant difference and within Kerala population showed statistically no significant difference which indicates **average upper airway measurements**.

Lower airway represents the width of lower pharyngeal space.¹⁴ Average value is 12mm+/-2mm and does not change appreciably with age. An increase is suggestive of tonsillar enlargement and decrease is rarely seen. The mean of lower airway for kodava population is 11.9333 with a standard deviation of 1.40056 and Kerala population is 11.7000 with a standard deviation of 1.381148. The male and female values within kodava population showed statistically no significant difference while within Kerala population showed statistically significant difference which indicates **average lower airway measurements**.

COMPARISON WITH OTHER STUDIES

Our study was in agreement with a study done on Iranian population¹², cephalograms of 75 Iranian adults (18-35yrs) including 36 males and 39 females that represented Class I skeletal relationship, normal vertical pattern and space deficiency less than 3 mm were selected eleven indexes of McNamara Analysis were manually traced and analyzed. It was shown that there is significant difference in effective length of mid face, mandibular length and lower one third height between men and women ($p < 0.05$). The findings were very similar to McNamara's norms. Despite the larger jaw dimensions in Caucasian compared to Iranian ethnic group. McNamara analysis can be applied for Iranian population.

In present study standardised norms for Kodava and Kerala population have been derived in which almost all the parameter values are similar to established values of McNamara analysis in European American population, only difference found was that the Kodava and Kerala adult population have a reduced chin prominence and are short face individuals.

FUTURE SCOPE OF STUDY

Similar study can be carried out using a larger sample size, the landmark identification error can be minimized by averaging multiple measurements done by a user, and advent of cone beam computed

tomography allows 3D reconstruction of dentofacial structures hence norms for ethnic population could be derived in the 3 dimensional plane of space.

CONCLUSION

From the present study following conclusions can be made:-

- ❖ The mandible to cranial base relation (Pog-Np) in Kodava and Kerala population which indicates reduced chin prominence among the adult individuals.
- ❖ The maxilla to cranial relation (Point A -Np) in Kodava and Kerala population which indicates slightly orthognathic maxilla among the adult individuals.
- ❖ Soft tissue factor (nasolabial angle) is within the average range for Kodava and Kerala population which indicates normally placed upper incisors.
- ❖ The Kodava and Kerala adult population had an average mid facial lengths (Co-point A).
- ❖ The Kodava and Kerala adult population had an average effective mandibular length (Co-Gn).
- ❖ The maxilla mandibular differential in Kerala and Kodava population indicates a medium size facial pattern among the adult individuals.
- ❖ The Kodava and Kerala population have a reduced lower anterior facial height (ANS-MENTON) which indicates more adult individuals have a slight short face.
- ❖ The mandibular plane angle values in the Kodava and Kerala population indicates a normodivergent growth pattern.
- ❖ The facial axis angle values in the Kodava and Kerala population indicates normal growth pattern of the chin.
- ❖ The upper incisor to Point A values in Kodava and Kerala population indicates normally placed upper incisors in adult individuals.
- ❖ The lower incisor to A-pog values in Kodava and Kerala population indicates

normally placed lower incisors in adult individuals.

- ❖ The Kodava and Kerala population have average upper and lower airway measurements.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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