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A Comparative Study: Discrepancies of an Upper and Lower Facial Index Between Gurkha and Kumauni Species of the Hilly Region of Uttarakhand India

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ABSTRACT
The individual evaluation of a person's ethnicity and identification is the key function of medical anthropometry. The aim of this study is to examine any variations in upper and lower facial parameters or facial index between the Gurkha and Kumauni ethnic species in the Indian state of Uttarakhand region of India. This study was conducted from 2019 to 2022 over two years. Two hundred subjects, fifty males and fifty females from each ethnic group of Garhwali and Kumauni, born and grown in the hilly region of Uttarakhand, aged between 20 years and older up to 35 years old, get chosen during this period. By this age, skeletal growth by ossification of mostly facial bones is complete. Subjects from Shri Guru Ram Rai University and some subjects from their remote areas were selected at random for the study samples. Informed agreement was used. Present study based computer-based programmers/SPSS software 24.0 version to generate the mean, median, standard deviation, p-values and regression test that were used to compare measurements for different parameters. According to the findings of the ANOVA/regression test applied. The facial index is a very crucial factor in identifying ethnic differences in a certain geographic area. All of the studies that evaluated face metrics showed a clear sexual dimorphism. The p-value in both ethnic groups of present study was less than 0.05, which shows that the correlation is substantially higher than the threshold value. It means that the results are statistically significant for both ethnic groups. Mesoprosopic (round) faces were more common among Kumauni communities, followed by Euryprosopic (broad) faces in the Gurkha ethnic group. On the basis of this study the conclusion is drawn that a person's identification and ethnicity might be determined on the basis of their facial index. Additionally, our data might serve as a starting point for future investigations into the identification of a person from Uttarakhand.

OPEN ACCESS

Key Words
Anthropology, phenotype-ethnicity, staanalysis, facial tistical indices

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INTRODUCTION

Anthropometry a very specific subject for the identification of human beings. We can always tell apart distinct ethnic groups by their differences in face features. In many medical laws and artistic endeavors, the measurements of the face have received particular attention. The length and breadth of the face (interzygomatic distance), which together make up complete facial index, are the most appropriate facial measurements. A population's variations in facial form are shown via facial morphometry. Additionally, it is helpful in allowing variations across sexes, ethnicities, and even within families[1]. A person's species is very important section in forensic and surgery works[2]. The study on affect of geographical and environmental factors such as meal, weather etc on body height and facial variability also done[3]. A study on face shape in North Indian is Mesoprosopic followed by Euryprosopic, Hypereuryprosopic[4]. The maximum concentration of species resides in Africa and then in India[5]. A study on the facial anthropometry, for sex determination, forensics uses, facial surgery and diagnostic purposes[6]. A study done by World Health Organization, states that health as a state of complete physical, mental, is universally accepted[7].

In the current situation, both man-made disasters (such as bombings, attackers and killers) and natural calamities (such as earth-quakes, land-slides and water floods) have dramatically increased[8]. Anthropometry deals with human body features in assessing the subject's ethnicity with their identification from remains[9]. Craniofacial anthropometry is important for individual's facial measurements[10]. It is essential to build framework for diverse ethnicities in order to determine the ethnicity and gender of human subjects. Once the crucial data has been gathered anthropometrically, further methods might be used to identify the person more precisely. Therefore, it is imperative to promote fresher research on craniofacial anthropometry from various global populations. We conducted a thorough search and discovered that numerous studies have utilized various parameters for determine human ethnicity with the help of their facial indices in all different ethnic groups in the past. Thus the main purpose of this study to measure the facial profile of the Uttarakhand people by using all the factors.

Aims and objectives: Aim of the present study to check discrepancies of upper and lower facial index among the Gurkha and Kumauni ethnic groups in uttarakhand population. Other aims are:

- Examines subject's face differences by gender and race in the Indian state of Uttarakhand
- Using a regression model, determination of the dimensions of such variation that are important for differentiating between individuals from various groups and ethnicity
- Face type classification for gender and ethnicity by using a morphological facial index formula

The objectives were to observe the differences of upper and lower facial index for Uttarakhand population by Anthropometric measurements along with statistical analysis.

Inclusion criteria: Subject more than eighteen years of age and less than thirty five years and also their parents belong to the Kumauni and Garhwali Tribe of Uttarakhand since from birth.

Exclusion criteria: Subject below eighteen years of age and less than thirty five years, individuals of Kumauni and Garhwali Tribe other than Uttarakhand. Any craniofacial dismorphology excluded from this study.

MATERIALS and METHODS

This present study is carried in the Anatomy Dept, SGRRIMS and HS and Dehradun. This study was conducted from 2019 to 2022 over two years. Two hundred subjects, fifty males and fifty females from each ethnic group of Garhwali and Kumauni, born and grown in the hilly region of Uttarakhand, aged between 20 years and older up to 35 years old, get chosen during this period. By this age, skeletal growth by ossification of long bones is complete. Subjects from Shri Guru Ram Rai University and some remote areas were selected at random for the study samples. Informed agreement was used.

Methodology: Measurements of the different facial parameters were taken with help of Anthropometric tool. Digital sliding vernier caliper in the present study, Fig. 1. Measurement of the maximum length of face was done by with help of Steel measuring tape, Fig. 2. The Prosopic/Facial index formula for observing statistical data of faces in Gurkha and Kumauni ethnic groups is given below:

$$\text{Prosopic Index (FI)} = \frac{\text{Facial Heigh}}{\text{Facial Widh}} \text{x100}$$

- Morphological facial length
- Width of interzygomatic distance
- Prosopic/Facial index

- Prosopic index (FI) Formulae:

$$\text{FI} = \frac{\text{Facial height (N' – Me')}}{\text{Bizygomatic face width}} \text{x100}$$

(Note: N- nasion point, Me-Mention point).

Anthropometric measurement Present parameters were used for all the subjects. Parameters and important facial bony landmarks images given in figure (3-7). Present study shows that the face of Kumauni female isround in shape or Mesoprosopic type, in this type of faces, subjects having somewhat longer faces as compasiron to Gurkha subjects, Fig. 3. As per according to study Gurkha subjects having broad type of faces or Euryprosopic type of face. It means that Gurkha having somewhat shorter face in comparison to the Kumauni subjects, Fig. 4. Measurements of upper facial length from nasion to mention with the help of digital sliding vernier caliper are given below in Fig. 5. Measurements of lower facial length from subnasale to mention with the help of digital sliding vernier caliper are given below in Fig. 6. The different important facial bony landmarks are given below in Fig. 7. Following below the various facial bony points used for facial parameters (Fig. 8):

- Trichion (Tr) Intersection at mod of the hairline
- Zygion (Zy) it is the most end point on the zygomatic arches
- Mention (Mn) Point on the lower margin of lower jaw
- Nasion (Ns) internasal suture in the midsagittal plane of face
- Subnasale (Sn) Nasal septum and the upper lip meet in the midsagittal plane

According to Banister's classification the facial index has been used explain the facial type into different categories. The Prosopic index gets measured according to anatomical descriptions, Table 1. The following are facial measurements taken on the subjects are given below (Fig. 8-10).

The morphological facial length is the length, which is measured from nasion point to mention of the face. Given below in Fig. 8. The total breath or transverse diameter of face is measured between two identical and most prominent points of face known as zygion or zygoma, which is the most posterior and lateral end of zygomatic arch of facial zygomatic bone. Given below in fig. 9. The important facial bony landmarks, which were used in present study, given below in Fig. 10.

Different facial parameters measured for present study:

- Morphological Facial length-(distance in between nasion and gnathion/mention)
- Morphological Upper Facial length-(distance in between nasion and subnasale)
- Morphological Lower Facial length-(distance in anterior nasal spine and gnathion)
- Diameter of interzygomatic distance-(between two zygion points)
- Physiognomic Facial length-(distance in between Trichion and mention)

The facial index formulas:

- Morphological Facial Index:

$$\frac{\text{Morphological Facial Height}}{\text{Breadth of Bizygomatic Arch}} \text{x100}$$

- Morphological Upper Facial Index:

$$\frac{\text{Morphological Upper Facial Height}}{\text{Breadth of Bizygomatic Arch}} \text{x100}$$

- Morphological lower Facial Index:

$$\frac{\text{Morphological lower Facial Height}}{\text{Breadth of Bizygomatic Arch}} \text{x100}$$

Statistics All the facial parametric measurements get collected is tabulated on an excel spread sheet by using SPSS of 24 versions present in our central library of our medical college. The level of statistical significance is determined at $p<0.05$. Regression/ANOVA equation was used.

RESULTS

There is statistically significant difference in facial height in both ethnic groups. It is found that the facial length maximum in Kumauni male and female genders in comparison to Gurkha females and males. Prosopic/Facial index range of the Gurkha and Kumauni ethnic groups in present study are mentioned below the Table 2.

The mean, standard deviations of upper facial length, lower facial length, bizygomatic width, facial indexes for both female's ethnic groups in present study, with their significance values are given below in Table 3.

The mean, standard deviations of upper facial length, lower facial length, bizygomatic width, facial indexes for both male's ethnic groups in present study, with their significance values are given below in Table 4.

Type of faces on the basis of upper facial index in Gurkha and Kumauni males ethnic groups are given below in Table 5.

Type of faces on the basis of upper facial index in Gurkha and Kumauni males ethnic groups are given below in Table 5.

The above Tables 5 and 6 indicate the comparison of different facial types in Gurkha and Kumauni males and females. Most of the Kumauni peoples were with Mesoprosopic/round face, (Facial index<(50-54.99). In Gurkha subjects followed by Europrosopic/broad face with Facial index.

Fig. 1: Image of digital sliding vernier caliper used to determine measurements of face

Fig. 2: Image of steel measuring tape used to determine measurements of face

Fig. 3: Images showing mesoprosopic face type in Kumauni ethnic populatio

Fig. 4: Images showing Euryprosopic face types in Gurkha ethnic population

The descriptive statistics (mean, standard deviations, range, significances) of males and females for each parameter among Gurkha ethnic groups are given below in Table 7.

The descriptive statistics (mean, standard deviations, range, significances) of males and females for each parameter among Kumauni ethnic groups are given below in Table 8. The above tables show various facial parameters with mean, standard deviations, range and p-values in Gurkha and Kumauni males and females respectively.

DISCUSSIONS

Within a same species, differences can be seen between populations that reside in various geographic regions. This results from a person's biological, social and other factors. Indian people were mostly categorized around the turn of the 20th century based

Table 1: Different Face types according to upper prosopic index/martin and Saller

Phenotype	Prosopic Index range
Hypereuriprosopic (very broad face) facial index	(≤44.99)
Euriprosopic (broad face) facial index	(45-49.99)
Mesoprosopic (round face) facial index	(50-54.99)
Leptoprosopic (long face) facial index	(55-59.99)
Hyperleptoprosopic (very long face) facial index	(≥60)

Fig. 5: Image showing upper facial length measurements in the study

Fig. 6: Image showing lower facial length measurements in the study

Fig. 7: Image showing various fcaial bony landmarks in the study. (Trichion (Tr), Zygion (Zy), Mention (Mn), Nasion (Na), Subnasale (Sn)

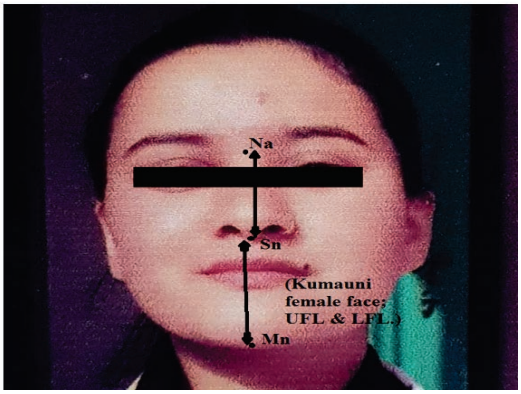

Fig. 8: Total facial height measurement Mention (Mn), Nasion (Na), Subnasale (Sn)

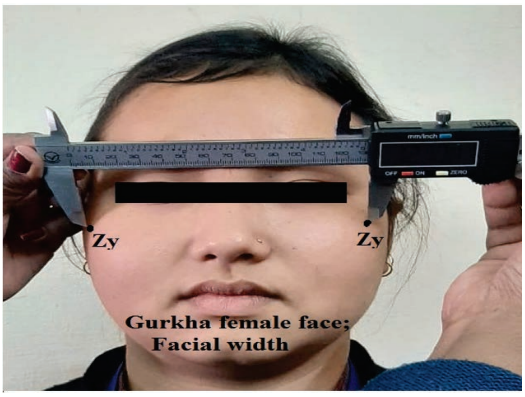

Fig. 9: Total facial width measurement Zygion (Zy)

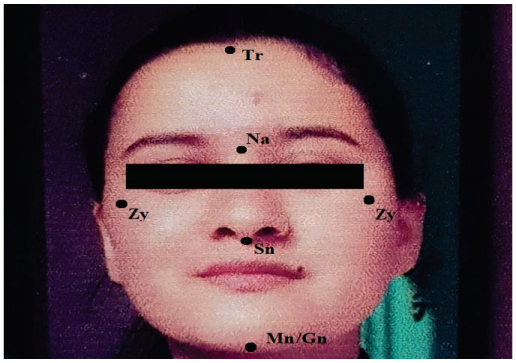

Fig. 10: Image showing facial bony landmarks. (Trichion (Tr), Zygion (Zy), Mention (Mn), Nasion (Na), Subnasale (Sn), Gnathion (Gn)

on physical and anthropometric traits. Environmental**,** biological, regional, racial, gender and age variables all have an impact on both intra-and inter-population variances. Anthropology is the study of the origins and evolution of people and their civilizations. It explores the full spectrum of human behavior and development, taking into account biological variety, geographic dispersion, and evolutionary history. The use of physical anthropology's scientific methods in a Medico legal setting is known as forensic anthropology[11]. Different statistics of upper and lower facial length from two ethnic groups and also in present study, are mentioned below in Table no 9. In the present study most dominant face type in Kumauni populations, this is followed by Mesoprosopic (Round face) facial index. In Gurkha populations followed by Euryprosopic/round face facial index). Present study carried with aim of measurements of Gurkha and Kumauni ethnic groups and to compare. In present study, mean distance of (UFH) were (50.97±6.67) mm in Gurkha male genders and (48.63±6.27) mm in Gurkha female genders. The mean distance of (UFH) was (46.72±4.61) mm in Kumauni male genders and (50.12±8.35) mm in Kumauni female genders. Farkas *et al*.[12] reported that, Indian population has mean UFH-47.2 mm in males and 43.7 mm in females. The mean length of (LFH) in present study was 50.78±5.26 mm and 48.13±6.72 mm in Gurkha male genders and female genders, sequencly. Mean distance of (LFH) in our study was 53.03±8.21 mm and 51.05±7.10 mm in

Table 2: Facial classification based on prosopic index

Phenotype	Range of prosopic index/ under bannister's classification	Range of prosopic index/classification under present study
Hypereuriprosopic	<79.9	none
Europrosopic	80-84.9	(47.72096 Gurkha Male)
Mesoprosopic	85-89.9	(48.15791 Gurkha Female)
Mesoprosopic	85-89.9	(48.26045 Kumauni Male)
Mesoprosopic	85-89.9	(52.2372 Kumauni Female)
Leptoprosopic	90-94.9	none
Hyperleptoprosopic	>95	none

Table 3: Descriptive statistics of variables in Gurkha and Kumauni females

Parameters	Gurkha Female Mean±Sd (mm)	Kumauni Female Mean±Sd (mm)	p-value of kumauni female	p-value of gurkha female
Upper Facial height	48.63±6.27	50.12 ± 8.35	0.06	0.03
Lower Facial height	48.13±6.72	51.05 ± 7.10	0.03	0.06
Bizygomatic width	100.98±13.30	95.95±8.24	0.03	0.04
Facial index of upper facial height	48.15	52.23	-	-
Facial index of lower facial height	47.66	53.20	-	-
Total morphological facial index	95.81	105.43	-	-

SD: Standard deviation, mm: millimeter

Table 4: Descriptive statistics of variables in gurkha and Kumauni males

Parameters	Gurkha male Mean±Sd (mm)	Kumauni male Mean±Sd (mm)	p-value of gurkha male	p-value of kumauni male
Upper Facial height	50.97±6.67	46.72± 4.61	0.04	0.03
Lower Facial height	50.78±5.26	53.03± 8.21	0.05	0.06
Bizygomatic width	106.81±6.06	96.81± 8.84	0.03	0.04
Facial index of Upper Facial height	47.72	48.26	-	-
Facial index of Lower Facial height	47.54	54.78	-	-
Total Morphological Facial index	95.26	103.04	-	-

SD: Standard deviation, mm: millimeter

Table 5: Table shows phenotype, upper facial index in gurkha and Kumauni females. UFL: Upper facial length, LFL: Lower facial length, N: number of subjects

	Gurkha Female (N = 50)		Kumauni Female(N = 50)	
Parameters	Parentage	Parentage	Parentage	Parentage
Europrosopic (broad face) Facial index		48.15 for UFL		
Mesoprosopic (round face) Facial index	47.66 for LFL		53.20 for LFL	52.23 for UFL

Table 6: Phenotype according to upper facial index in gurkha and Kumauni males. UFL: Upper facial length, LFL: Lower facial length, N: number of subjects

Parameters	Gurkha Male (N=50)		Kumauni Male(N=50)	
	Parameters	Parameters	Parameters	Parameters
Europrosopic (broad face) Facial index	47.54 for LFL	47.72 for UFL		
Mesoprosopic (round face) Facial index			54.78 for LFL	48.26 for UFL

Table 7: The Descriptive statistics of males and females for each parameter among gurkha ethnic group

	Mean±SD (mm)		Range (mm)			
Parameters	Males	Females	Males	Females	p-values M	p-values F
Width of face	106.81±6.06	100.98±13.30	19.89	42.22	0.03	0.03 (S)
Physiognomic facial length	19.18±0.82	17.25±2.40	2	9	0.06 NS	0.1(S)
Morphological upper facial length	50.97±6.67	48.63±6.27	23	21.15	0.04	0.06 NS
Morphological lower facial length	50.78±5.26	48.13±6.72	23.45	21.69	0.05	0.03
Morphological facial length	101.75±11.93	96.75±12.99	46.45	42.84	0.09(NS)	0.09(NS)
FI	95.26	85.90				

S: Significant, NS: Non significant, SD: Standard deviation, FI: Facial index, mm: millimeter, M: Male, F: Female, P: Probability

Table 8: The Descriptive statistics males and females for each parameter among kumauni ethnic group

	Mean0±SD (mm)		Range (mm)			
Parameters	Males	Females	Males	Females	p-values M	p-values F
Breath of face	96.81±8.84	95.95±8.24	28.91	24.82	0.04	0.04(S)
Physiognomic facial length	19.55±2.32	19.56±1.54	8.89	5.78	0.04	0.04(S)
Morphological upper facial length	46.72±4.61	50.12±8.35	15.243	24.24	0.03	0.03
Morphological lower facial length	53.03±8.21	51.05±7.10	26.098	23.11	0.06 NS	0.06 NS
Morphological facial length	99.75±11.93	96.76±12.99	41.33	47.35	0.09(NS)	0.09(NS)
FI	103.04	105.43				

S: Significant, NS: Non significant, SD: Standard deviation, FI: Facial index, mm: millimeter, M: Male, F: Female, P: Probability

Table 9: Descriptive statistics of upper and lower facial length from two ethnic groups and in present study

		UFH		LFH	
Different studies	N	Male	Females	Male	Females
Population of Hyderabad studied by Khanetal, 2012	40	1.19 cm	1.06 cm	-	-
Garhwali population studied by Hatwal, 2015	200 (100 male and100 female)	48.051 mm	45.864 mm	57.344 mm	54.8 mm
Nigerian population studied by Adamu 2016	283 (147 males and 136 females)	40.67 mm	45.61 mm	62.98 mm	58.05 mm
Study by Agnihotri 2011, Done in Indo-Mauritius population	150 (75 males and 75 females)	5.27 cm	5.20 cm	-	-
Indian population studied by Farkas 2005	60 (30 males and 30 females)	47.2 mm	43.7 mm	62.7 mm	57.2 mm
Bangladeshi females studied by Mostafa 2013	100 females	-	4.32 cm	-	-
Mangalore Subjects, studied by Jagadish Chandra 2012	100 (50 males and 50 females)	56.82 mm	58.58 mm	54.54 mm	59.12 mm
Onges group of Andaman and Nicobaris lands studied by Pandey, 2006	53 (27 male and 26 female)	1.50	1.30	-	-
Present study	100 (50 gurkha males and 50 grukha females)	50.97 mm	48.63 mm	50.78 mm	48.13 mm
	100 (50 kumauni males and 50 kumauni females)	46.72 mm	50.12 mm	53.03 mm	48.13 mm

UFL: Upper facial length, LFL: Lower facial length, N: number of subjects, mm: millimeter

Table 10: Descriptive statistics of morphological facial length, physiognomic facial length and facial index from ethnic populations and present study

		MFL		PFL		FI	
Different studies	No. of subject	Male	Females	Male	Females	Male	Females
Garhwali population studied by Hatwal *et al*.[15]	200 (100 male and 100 female)	105.395 mm	100.664 mm	-	-	-	-
Shetti studied on Indian subjects 2011	100 (66 males and 34 females)	11.08 cm	10.48 cm	-	-	87.19	86.75
Malaysian population studied by Shetti 2011	200 (96 males and 104 females)	11.14 cm	10.48 cm	-	-	85.72	87.71
Study by, 2011, done in Indo-Mauritius population	150 (75 males and 75 females)	11.58 cm	11.00 cm	17.85 cm	16.46 cm	-	-
Indian subjects studied by Farkas *et al*.[12]	60 (30 males and 30 females)	112.5 mm	101.5 mm	161.3 mm	163.0 mm	-	-
Bangladeshi females studied by Mostafa 2013	100 Females	-	10.59 cm	-	-	-	77.22
Haryanvi Banias studied by Kumar and Lone[13]	600 (300 of either sex)	11.07 cm	10.21 cm	-	-	86.0	84.84
North Indian subjects studied by Prasanna *et al*.[3]	100 (50 males and 50 females)	123.6 mm	117.0 mm	-	-	101.0	107.0
South Indian subjects studied by Prasanna *et al*.[3]	100 (50 males and 50 females)	119.7 mm	101.0 mm	-	-	100.28	85.39
Population of Mangalore studied by 2012	100 (50 males and 50 females)	119.98 mm	119.95 mm	-	-	101.59	107.41
Onges group of Andaman and Nicobar is lands studied by 2006	53 (27 male and 26 female)	10.18	9.31	16.17	15.06	77.98	75.29
Gujarati subjects studied by Shah 2016	901 (676 males and 225 females)	9.85 cm	8.54 cm	16.4 cm	14.76 cm	-	-
North Indian population studied by Kataria *et al*.[4]	400 (200 males and 200 females)	11.35 cm	10.376 cm	-	-	86.449	85.024
Bini ethnic group of Nigeria studied by Omotoso, 2011	450 (230 males and 220 females)	-	-	-	-	87.0	85.88
subjects of Central Serbia studied by Jeremic grukha females) 2013	700 (360 males and 340 females)	121.42 mm	110.84 mm	-	-	94.04	92.38
Present Study	100 (50 gurkha males and 50 100 (50 kumauni males and 50 kumauni females)	101.75 99.7	96.75 96.76	19.18 19.55	17.25 19.56	95.26 103.04	85.90 105.43

PFL: Physiognomic facial length, MFL: Morphological facial length, FI: Facial index

Kumauni males and females, respectively. The mean PFL in the present study was 19.18 in Gurkha males and 17.25 in Gurkha female Indian population has mean UFH-47.2 mm in males and 43.7 mm in females. The mean length of (LFH) in present study was 50.78±5.26 mm and 48.13±6.72 mm in Gurkha male genders and female genders, sequencly. Mean distance of (LFH) in our study was 53.03±8.21 mm and 51.05±7.10 mm in Kumauni males and females, respectively. The mean PFL in the present study was 19.18 in Gurkha males and 17.25 in Gurkha female genders, same as the PFL in the present study was 19.55 in Kumauni males and 19.56 in Kumauni females and study on Harvanyi Banias observed that the mean PFL in males and females was 11.07 cm and 10.21 cm, respectively Kumar and Lone[13]. In present study, uttarakhand subjects irrespective of their Species Gurkha and Kumauni. After comparing the facial features between male genders and female genders, facial parameter in our study indicates significant sexual dimorphism. Baral *et al* and Obaidi revealed that no any significant variations in facial length ratios between male genders and female genders in different ethnic groups. Hatwal *et al*.[14] reported the mean values of morphological facial length were more in male genders as compared to female genders in Garhwal ethnic groups. Nandini *et al*.[15]. Study on facial anthropometry in adult Jaunsari ethnic group of Uttarakhand[16]. Another study done by Ansari *et al*.[17]. The comparisons of descriptive statistics of morphological facial length, physiognomic facial length and facial index of all ethnic populations and present study are given in Table 10.

CONCLUSION

Male Kumauni had higher facial heights than Gurkha men, while female Kumauni had higher facial heights than Gurkha women. Mesoprosopic/round faces were more common in Kumauni communities followed by Europrosopic/broad faces in Gurkha populations. Study is important for forensic science, plastic surgery, facio-maxillary surgery and aesthetic surgery. Future research on the inhabitants of Uttarakhand will use this survey as a baseline for comparison. Given that all tribal societies are descended from various ethnic groupings, there may be a genetic component to the stark differences that exist between all of them. All other face characteristics, including FI and UFH, can be utilized to differentiate people based on gender. Therefore, for Uttarakhand, our statistics might serve as a reference. Hence conclusion from this present study is that the facial index parameter is appropriate for the personal identification and ethnicity in Uttarakhand population of India.

Limitation:

- Representation of a local population so it cannot get generalized
- Measurement of facial parameters 3. Emphasize the tribe of Gurkha and Kumauni only

Declaration of patient consent: The patients were aware while every attempt was made to keep their identities confidential.

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