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Transgenerational Changes in Oro-Facial Features among Malekudiya Tribes Native to Dakshina Kannada District of Karnataka: An Anthropological/Epidemiological Study

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Abstract

Introduction: The Malekudiya tribe, indigenous to the Dakshina Kannada district of Karnataka, represents a unique cultural and genetic population. The study of transgenerational changes in orofacial features within this community provides valuable insights into the influence of genetics, environment, lifestyle, and cultural practices on oral health.

Objective: To document and analyze transgenerational orofacial changes across three generations of the Malekudiya tribe, using a combination of oral health assessments and facio-anthropometric scales.

Methods: A descriptive cross-sectional study was conducted involving three successive generations of the Malekudiya tribe. A total of 435 families were invited, with 400 triads (three generations each) ultimately participating, achieving a response rate of 91.95%. Orofacial characteristics were recorded using a modified WHO oral health assessment form and facio-anthropometric scales. Data were analyzed using SPSS Version 27, employing descriptive statistics, chi-square tests, independent t-tests, and ANOVA, with a significance level set at $p < 0.05$.

Results: The socio-demographic analysis revealed that the mean ages of the three generations were 63.40 ± 2.3, 48.23 ± 4.2, and 32.8 ± 12.5 years, with a higher female representation across all generations. While intra-tribe matrimony was predominant in the first two generations, a shift towards diverse marriage practices was noted in the third generation. Regarding orofacial features, no significant generational differences were observed in body build, head shapes, facial shapes, facial symmetry, nose characteristics, or lip features, indicating strong genetic continuity within the tribe. However, oral health

assessments showed a consistent increase in dental caries (DMFT scores) across generations, likely reflecting changes in dietary habits and access to dental care. Additionally, significant intergenerational variations in periodontal health were observed, with a decrease in gingival enlargement, gingival recession, and periodontal pockets from the first to the third generation.

Conclusion: This study highlights the genetic stability of orofacial features among the Malekudiya tribe, alongside emerging trends in oral health influenced by modern dietary and healthcare practices. The findings underscore the need for culturally sensitive public health strategies that integrate traditional knowledge and address evolving health challenges within indigenous communities.

Keywords: Transgenerational changes, orofacial features, Malekudiya tribe, Dakshina Kannada, Karnataka, oral health, anthropology, epidemiology.

Introduction

India is a vast, culturally diverse country, with numerous ethnic groups, often referred to as 'indigenous,' 'tribal,' or 'adivasi,' adding to its rich social fabric.[1] These include 705 officially recognized groups of various ethnicity accounting to 104 million people known as Scheduled Tribes, dispersed across various regions making up 8.6% of the country's population.[2,3] A significant portion of these tribes, about 10.4 million, live in urban areas, while the rest are spread across rural regions, where they make up 11.3% of the rural population.[4]

Karnataka is home to 50 different tribes officially recognized by the Government of India. Among these, 14 tribes, including two primitive groups, are primarily native to the state. The tribal population in Karnataka totals 4,248,987 people, with 50,870 belonging to primitive groups. Although these tribes make up only 6.95 percent of the state's population, they represent a significant cultural and demographic presence.[5, 6] Many of these tribes reside in the lush Western Ghats and possess extensive knowledge of medicinal plants, contributing significantly to traditional medicine and being the focus of many scientific studies.[7]Significance of studying these tribes extends beyond immediate research goals, contributing to broader anthropological and epidemiological knowledge. It also highlights the importance of considering cultural and geographical contexts in health studies, particularly for indigenous communities.[8]

In Dakshina Kannada district of Karnataka, an indigenous tribal community known as the Malekudiyas (also called Kudiya or Melakudi in different locations) resides. This community, numbering around 11,405 people, speaks Kannada, Tulu, and Malayalam.[9] They are spread across districts like Kodagu, Dakshina Kannada, Udupi and Chickmagaluru. Despite efforts from various organizations, there is a notable lack of detailed literature on the health status of this tribe.[10]

Transgenerational changes refer to variations that occur across multiple generations within a population, influenced by genetics, environmental conditions, lifestyle, and cultural practices. In indigenous tribes like Malekudiya tribe, examining these changes provides insights into how these factors shape health and physical characteristics over time.[11] Orofacial changes, which include variations in structure and health of face and mouth, are particularly significant as they reflect broader health trends. These changes can result from shifts in diet, access to healthcare, and cultural practices.[12] For instance, traditional diets and oral health practices may protect against dental issues, but as modern lifestyles are adopted, oral health may decline, leading to noticeable differences in facial bone structure and dental health across generations.

Study of transgenerational orofacial changes is crucial for understanding the impact of genetic inheritance, environmental conditions, lifestyle, and cultural practices on oral health. Genetic factors influence susceptibility to dental conditions like malocclusion and periodontal diseases. Environmental conditions, such as the availability of clean water and exposure to pollutants, also significantly affect oral health, influencing the prevalence of dental caries and developmental issues in facial structures. Analyzing these factors across generations provides valuable insights for public health interventions.

Lifestyle and cultural practices, including traditional dietary habits and oral hygiene methods, play a critical role in shaping orofacial characteristics. However, modernization often leads to the adoption of processed foods and the loss of beneficial traditional practices, impacting oral health. Socio-economic changes further influence access to healthcare and education, affecting oral health outcomes. Documenting these transitions helps identify areas needing targeted interventions. Additionally, the intergenerational transmission of traditional knowledge is vital for maintaining oral health, but this knowledge risks being lost as younger generations move away from these practices. Understanding these dynamics is essential for developing culturally sensitive healthcare strategies for the Malekudiya tribe.

Therefore the aim of our study is to document orofacial changes across three generations within the Malekudiya community, using a modified oral health assessment form and facio-anthropometric scales. This approach will provide a comprehensive evaluation of oral and facial health, capturing the evolution of these characteristics over time. Understanding these transgenerational orofacial changes is crucial for developing culturally sensitive healthcare strategies that incorporate traditional knowledge and address emerging health challenges.

Methodology

A descriptive Cross-sectional study involving three successive generations was conducted upon Malekudiya tribe native to the forests and foot hills of Dakshina kannada district in southern Karnataka. Necessary permissions and clearances were obtained from relevant authorities, including the Taluk Health Office, the Directorate of Scheduled Tribes, and the Taluk Girijana Unit. Ethical clearance was obtained from the Institutional Ethics Committee (IECKVGDCH/SS15/2023-24), Informed consent was obtained from all participants prior to the study.

An initial visit to the Social welfare department was conducted to gather essential data needed to plan and implement the survey/ clinical examination (no. of settlements/colonies, no. of households, family size, structure, time to visit the colonies etc.). Data were collected on a specially designed and validated proforma which contained three parts. Part A recorded socio-demographic details, along with details of general examination. Part B recorded facial features in detail as per a pilot study by Mane DR et al.[14] Part C included a clinical examination of both soft and hard tissues of the oral cavity, additionally in depth examination of dental hard tissues and the periodontium was recorded using a modified WHO oral assessment form for Adults 2013.[15]

A type III clinical examination was carried out under adequate illumination using plane mouth mirrors and a standard WHO/CPI probe.

A list of the geographic distribution of Malekudiya population was obtained from Social welfare department and data regarding the total number of families and individuals within their jurisdiction was gathered. Tribal

areas were randomly selected from this list. A sample proportionate to the size of each area was drawn using the WHO's Pathfinder methodology, ensuring a representative sample of the population. An adult Malekudiya tribal willing to participate in the study and having at least one surviving parent and an adult offspring representing three generations constituted one sample unit in our study (triad). Any member of the participating triad with a history of craniofacial trauma or surgery, currently undergoing orthodontic treatment, with complete edentulism, and those needing immediate emergency treatment were excluded.

Sample size required for the study was calculated for a reported prevalence of 57%.[16] 95% confidence level accepting an error of 5%. Calculated sample size was 361, 10% of the calculated sample size was added to compensate for sample loss if any, thus accounting to 397 and rounded off to 400 samples.

Investigator was trained and calibrated in recording all parameters involved in the study at the department of public health dentistry of the institute. Investigator along with a recorder personally visited the included households with prior permission to collect necessary data and perform clinical examination. Further, duplicate examinations were performed upon two percent of the triads examined each day. Data were analyzed using SPSS version 27. Descriptive measures and chi-square tests were conducted separately for each variable. Independent t-tests and ANOVA were performed with a 95% confidence interval, setting the P-value at < 0.05 level of significance.

Results

In this study a total of 435 families meeting the inclusion and exclusion criteria were invited to participate, 35 of them declined citing reasons such as lack of time, lack of interest and a perceived lack of necessity. Thus reporting a response rate of 91.95%. Analysis of socio-demographic characteristics revealed mean age of 63.40 ± 2.3, 48.23 ± 4.2 and 32.8 ± 12.5 among three generations and significantly higher representation from females (1 :1.27, 1:1.38, 1:1.63). Predominantly, within tribe matrimony was observed in the all the three generations. Analysis of general physical examination revealed no significant differences in body build ($p = 0.468$), with the majority classified as ectomorphic across all generations. Similarly, the distribution of head shapes ($p = 0.627$) showed consistent patterns across generations, with brachycephalic being the most prevalent head shape. (Table No. 1)

Analysis of extra oral characteristics showed no significant differences in face shape ($p = 0.853$), facial angle ($p = 0.436$), and facial profile ($p = 0.719$), with straight profiles and angles being most common. Facial symmetry was unequivocally consistent across generations ($p = 0.824$). No significant differences were observed in nose size ($p = 0.637$) or nose shape ($p = 0.735$), with a predominant pattern of big noses and bulbous shapes. Lip examination showed no significant differences in lip competency ($p = 0.649$), lip length ($p = 0.736$), high lip line ($p = 0.347$), low lip line ($p = 0.268$), nasolabial angle ($p = 0.349$), and mentolabial sulcus ($p = 0.575$). (Table No. 2) Intra oral characteristics showed similarity in terms of color of oral mucosa ($p = 0.643$), dental arch shape ($p = 0.721$), Hard palate shape ($p = 0.684$), Degree of soft palate classification ($p = 0.786$), occlusal relation ($p = 0.639$). Analysis of dental caries experience ($p = 0.687$) reveled a consistent increase in average DMFT values across three generations (2.66 ± 0.57, 3.33 ± 0.36, 4.17 ± 0.98). Edited analysis of the components revealed the differences in both missing and filled teeth however the decayed component remained consistent across three generations. Periodontal health as

assessed through gingival were found in missing teeth ($p < 0.05$) and filled teeth ($p < 0.05$), indicating a decrease in missing teeth and an increase in filled teeth from Generation 1 to Generation 3. Gingival enlargement ($p < 0.05$) and gingival recession ($p < 0.05$) demonstrated significant intergenerational variations, with a decrease in prevalence observed from Generation 1 to Generation 3. Periodontal findings revealed a significant decrease in periodontal pockets reveled a statistically significantly higher values for the first generation compared to the second and third counterparts (> 6mm) ($p < 0.001$) across generations. (Table No.3)

Table 1: Transgenerational differences in Socio- Demographic Characteristics

S.No	Variables	Generation 1	Generation 2	Generation 3	p value
1.	Age range				
a.	18-34	0	0	296(74%)	<0.001
b.	35-44	0	128(32%)	104(26%)	
c.	45-64	152(38%)	272(68%)	0	
d.	65-74	248(62%)	0	0	
e.	Mean Age				
		63.40 ± 2.3	48.23 ± 4.2	32.8 ± 12.5	<0.001
2.	Gender				
a.	Male	176(44%)	168(42%)	152(38%)	0.357
b.	Female	224(56%)	232(58%)	248(62%)	
3.	Marital status				
A.	Married				
a.	Within the family	104(26%)	72(18%)	24(9%)	
b.	Within the Tribe	280(70%)	296(74%)	222(81%)	<0.05
c.	With other tribe	16(4%)	32(8%)	26(10%)	
B.	Unmarried				
a.		-	-	128(32%)	-
General Examination					
1.	Body Build				
a.	Ectomorphic	336(84%)	312(78%)	360(90%)	0.468
b.	Mesomorphic	40(10%)	56(14%)	32(8%)	
c.	Endomorphic	24(6%)	32(8%)	8(2%)	
2.	Shape of the head				
a.	Diliocephalic	56(14%)	48(12%)	64(16%)	0.627
b.	Mesocephalic	152(38%)	128(32%)	136(34%)	
c.	Brachycephalic	176(44%)	216(54%)	176(44%)	
d.	Hyper Brachycephalic	16(4%)	8(2%)	24(6%)	

Table 2: Transgenerational differences in Extra Oral Characteristics

S.No	Variables	Generation 1	Generation 2	Generation 3	p value
Facial Examination					
1.	Face Shape				
a.	Mesoprosopic	7(1.75%)	5(1.25%)	6(1.5%)	0.853
b.	Euryprosopic	57(14.25%)	43(10.75%)	49(12.25%)	
c.	Hypereuryprosopic	32(8%)	29(7.25)	12(3%)	
d.	Leptoprosopic	289(72.25)	311(77.75%)	323(80.75)	
e.	Hyperleptoprosopic	15(3.75%)	12(3%)	10(2.5%)	
2.	Facial Angle				
a.	Straight	297(74.25%)	327(81.75%)	331(82.75%)	0.436
b.	Retrognathic	89(22.25%)	40(10%)	37(9.25%)	
c.	Prognathic	14(3.5%)	33(8.25%)	32(8%)	
3.	Facial Profile				
a.	Straight	281(70.25%)	317(79.25%)	323(80.75%)	0.719
b.	Convex	25(6.25%)	47(11.75%)	39(9.75%)	
c.	Concave	94(9.75%)	36(9%)	36(9%)	
4.	Facial symmetry				
a.	Symmetrical	376(94%)	389(97.25%)	391(97.75%)	0.824
b.	Asymmetrical	24(6%)	11(2.75%)	9(2.25%)	
Nose Examination					
1.	Nose Size				
a.	Small	7(1.75%)	9(2.25%)	11(2.75%)	0.637
b.	Long	18(4.5%)	7(1.75%)	18(4.5%)	
c.	Big	375(93.75%)	384(96%)	371(92.75%)	
2.	Nose Shape				
a.	Bulbous	371(92.75%)	379(94.75%)	365(91.25%)	0.735
b.	Straight	5(1.25%)	2(0.5%)	8(2%)	
c.	Broad	24(6%)	19(4.75%)	27(6.75%)	
Lip Examination					
1.	Lip Competency				
a.	Competent	379(94.75%)	382(95.5%)	391(97.75%)	0.649
b.	Incompetent	18(4.5%)	14(3.5%)	5(1.25%)	
c.	Potentially Competent	2(0.5%)	4(1%)	3(0.75%)	
d.	Everted Lips	1(0.25%)	0	1(0.25%)	

2.	Lip Length				
a.	Short	5(1.25%)	1(0.25%)	2(0.5%)	0.736
b.	Long	17(4.25%)	12(3%)	15(3.75%)	
c.	Medium	378(94.5%)	387(96.75%)	383(95.75%)	
3.	High Lip Line				
a.	Only teeth	386(96.5%)	391(97.75%)	393(98.25%)	0.347
b.	Gingival third	3(0.75%)	4(1%)	6(1.5%)	
c.	Gummy	11(2.27%)	5(1.25%)	1(0.25%)	
4.	Low Lip Line				
d.	No incisal show	386(96.5%)	389(97.25%)	391(97.75%)	0.268
e.	Incisal show	14(3.5%)	11(2.75%)	9(2.25%)	
5.	Nasolabial angle				
a.	Acute	10(2.5%)	8(2%)	5(1.25%)	0.349
b.	Normal (110^0)	384(%)	387(96.75%)	392(98%)	
c.	Obtuse	6(1.5%)	5(1.25%)	3(0.75%)	
6.	Mentolabial sulcus				
a.	Deep	29(7.25%)	21(5.25%)	17(4.25%)	0.575
b.	Shallow	371(92.75%)	379(94.75%)	383(95.75%)	

Table 3: Transgenerational differences in Intra Oral Characteristics

S.No	Variables	Generation 1	Generation 2	Generation 3	p value
Intra-Oral Examination					
1.	Color of mucosa				
a.	Pink	378(94.5%)	383(95.75%)	390(97.5%)	0.643
b.	Whitish pale	6(1.5%)	7(1.75%)	3(0.75%)	
c.	Reddish	16(4%)	10(2.5%)	7(1.75%)	
2.	Arch Shape				
a.	Squarish	246(61.5%)	224(56%)	235(58.75%)	0.721
b.	Ovoid	154(38.5%)	176(44%)	165(41.25%)	
3.	Palatal Region				
a.	U- Shape	384(%)	388(%)	389(%)	0.684
b.	V- Shape	16(%)	12(%)	11(%)	
4.	Soft Palate (House Classification)*				
a.	Class I	382(95.5%)	380(95%)	390(97.5%)	0.786
b.	Class II	12(3%)	15(3.75%)	7(1.75%)	

c.	Class III	6(1.5%)	5(1.25%)	3(0.75%)	
5.	Occlusal Analysis				
a.	Normal	383(95.75%)	381(95.25%)	390(97.5%)	0.639
b.	Overjet	12(3%)	13(3.25%)	7(1.75%)	
c.	Overbite	5(1.25%)	6(1.5%)	3(0.75%)	
6.	DMF				
a.	Decayed teeth	3.92 ± 1.06	3.20±1.57	3.64±1.57	0.734
b.	Missing teeth	4.15 ± 2.49	1.07 ± 0.70	2.50±0.37	**<0.05**
c.	Filled teeth	1.46 ± 0.77	3.21 ± 1.05	5.73±0.62	**<0.05**
d.	Caries experience	2.66 ± 0.57	3.33 ± 0.36	4.17 ± 0.98	**<0.05**
7.	Gingival enlargement				
a.	Yes	231(57.75%)	187(46.75%)	123(30.75%)	**<0.05**
8.	Gingival Recession				
a.	Generalized	157(39.25%)	56(14%)	14(3.5%)	**<0.05**
b.	Localized	196(49%)	138(34.5%)	39(9.75%)	
3.	Periodontal findings				
a.	Periodontal pockets < 6mm	183(45.75%)	79(19.75%)	27(6.75%)	**<0.001**
b.	Periodontal pockets > 6mm	117(29.25%)	46(11.5%)	11(2.75%)	

Discussion

To the best of our knowledge, this study is first of its kind to understand transgenerational changes in the orofacial regions within a tribal community in India. A Cautionary approach is thus advised to interpret and discuss our findings. Findings of our study provide valuable insights into the socio-demographic and physical characteristics of the Malekudiya Tribe in Sullia Taluk, highlighting a few transgenerational differences and trends.

The study achieved a high response rate of 91.95%, which is commendable and suggests a strong engagement with the community. This contrasts with many population-based studies where response rates are significantly lower possibly due to the effects of urbanization, privacy concerns and lack of perceived benefit from participation.[17]

Gender distribution across generations revealed a higher representation of females, a significant finding in our study. This contrasts with the 2011 census data, which reported a total gender ratio of 943 females per 1,000 males in India and a population composition in Karnataka of 50.9% males and 49.1% females.[18] This gender pattern may reflect cultural or social factors influencing gender roles and survival rates. In comparison, the general population often shows a slight female predominance due to higher male mortality rates.[19] Various tribal groups display differing gender ratios influenced by factors such as migration, employment opportunities, and cultural practices. Among local tribes like Soliga, Jenu Kuruba, and Kadu

Kuruba, the number of females is slightly lower than that of males.[20] These variations highlight the diverse factors impacting gender distribution among different tribal communities as shown in the study by Malji A. et al.(2021)[21]

Marrying within the bloodline or within the tribe was a common practice in the first and second generations of this study, consistent with the findings of Fortes M. et al.(2015)[22] These practices suggest inbreeding within the tribal population and the preservation of their unique cultural and genetic heritage in the older generations. However, in third generation, a trend towards more diverse marriage practices was observed. This shift mirrors patterns seen in other tribal groups undergoing social transitions, where traditional practices evolve with increased interaction with mainstream society. For instance, A regional Siddi tribe has shown a shift from traditional endogamous marriages to more exogamous practices due to increased social integration and economic opportunities, as highlighted in the study by Almeida F.J et al.(2023)[23] Similarly, local Hakki Pikki tribe is undergoing a shift towards more diverse marriage practices as younger generations pursue education and employment outside their communities. This change aligns with their cultural belief that marriage between worshippers of the same deity is strictly prohibited, as noted in research by Guruprasad S.L. et al.(2015)[24] These developments reflect broader social and cultural transformations among various tribal communities in India, illustrating how increased exposure to mainstream society and economic opportunities can influence and alter traditional marital practices.

The general physical examination of the Malekudiya Tribe revealed no significant differences in body build or head shapes across generations, with most individuals classified as ectomorphic and brachycephalic, respectively. These consistent physical traits suggest a strong genetic stability within the tribe, likely due to endogamy and limited gene flow from outside populations. In contrast, the general population displays a wider spectrum of body types and head shapes due to greater genetic diversity and diverse lifestyles. Similar patterns of physical trait consistency are also observed among other tribal populations, such as those studied by B. Karmakar et al.(2005)[25] including the Lodha tribe. These tribes exhibit homogeneity in physical traits influenced by shared genetic and environmental factors. However, there are no specific studies available for tribes in Karnataka that provide similar detailed analysis. These findings underscore how genetic heritage and cultural practices shape physical characteristics across diverse tribal communities in India.

Similarly, no significant generational differences were observed in face shape, facial angle, and facial profile within the Malekudiya Tribe, where straight profiles and angles were the most common. This consistency suggests a robust genetic continuity within the tribe. In contrast, non-tribal populations often exhibit greater variability in face shape and profiles due to their diverse genetic backgrounds and mixed ancestry. Similar stable facial characteristics are observed in other tribal groups with endogamous practices, as noted in the study by Sengupta M. et al.(2004)[26], which includes the Santhal tribe. These findings underscore the role of genetic isolation and cultural practices in maintaining consistent facial traits across various tribal communities in India. However, there is a lack of literature specifically addressing tribal populations in Karnataka, which limits detailed comparative analyses within the region.

Facial symmetry remained consistently high across all generations within the Malekudiya Tribe, suggesting

genetic stability. High facial symmetry is often correlated with genetic fitness and attractiveness in anthropological research. In contrast, the general population exhibits greater variability in facial symmetry, influenced by diverse genetic backgrounds and environmental factors. Similar levels of facial symmetry are observed in other tribal populations, as highlighted in the study by B. Karmakar et al.(2005)[25], among five endogamous tribal populations, where the Lodha tribe showed the highest contribution to population variation. This consistency in facial symmetry underscores the impact of genetic and cultural factors on physical traits across diverse tribal communities in India. However, there is a notable lack of detailed studies focusing on tribal populations in Karnataka, which limits comparisons and further understanding of these characteristics within the region.

A predominant pattern of large and bulbous noses was observed, which can be attributed to the specific genetic factors of the Malekudiya Tribe. In contrast, the general population shows a wide variety of nasal shapes and sizes due to diverse genetic influences. Similarly, other tribal groups often exhibit distinctive nasal characteristics that set them apart from the broader population. For instance, the local tribes such as Kadu Kuruba and Siddi tribes in karnataka are known for their broad nasal bridges, while the Santhal tribe typically features straight and narrow noses.[27] These unique nasal traits in various tribal communities are shaped by a combination of genetic and environmental factors.

The examination of lips showed no significant differences in lip competency, lip length, high lip line, low lip line, nasolabial angle, and mentolabial sulcus within the Malekudiya Tribe, indicating stable lip features across generations. In contrast, the general population exhibits significant variability in lip characteristics, influenced by ethnic background and genetic diversity. Other tribal groups in Karnataka, such as the Koraga and Jenu Kuruba tribes, also display consistent lip features within their populations.[28] These observations underscore the impact of genetic continuity and cultural practices on the preservation of specific physical characteristics among tribal communities.

Our study found no significant differences in the color of the oral mucosa, dental arch shape, hard palate region, soft palate classification, occlusal analysis, and caries experience within the Malekudiya Tribe. This consistency suggests a stable oral health environment and genetic continuity within the tribe. In contrast, the general population displays significant variability in these characteristics due to diverse genetic backgrounds and dietary habits. Similarly, other endogamous tribal groups, like the Bhil tribes of Rajasthan and the Iruliga tribes of Karnataka, also show stable intra-oral traits, indicative of limited external genetic influence, as documented in the study by Valsan I. et al.(2016)[29]. These findings highlight the role of genetic isolation and cultural practices in maintaining consistent oral health characteristics among various tribal communities.

Our study observed a consistent increase in dental caries experience among the Malekudiya Tribe, indicating changes in dietary and environmental practices. The mean scores for the first and second generations were significantly lower than the reported national and regional averages. For instance, the first generation's DMFT scores were much lower than the national average of 14.6 and the Karnataka average of 11 for the 65-74 age groups. Similarly, the second generation's scores were below the national average of 5.2 and the Karnataka average of 3 for the 35-44 age group. However, the third generation's DMFT scores were slightly higher than the national average of 2.3 and the

Karnataka average of 3 for the 35-44 age group.[30] This trend reflects an increase in caries experience, likely due to changes in dietary habits and environmental factors. Additionally, the DMFT components revealed that the missing and filled components were higher among the third generation, indicating improved access to dental care and services. There were significant differences in the number of missing and filled teeth, with a notable decrease in missing teeth and an increase in filled teeth from the first to the third generation. This shift underscores improvements in dental care and access over time. Overall, while the Malekudiya Tribe shows a similar positive trend in dental health compared to other tribal population, which has benefited from better awareness and access to dental care, their experience highlights the impact of evolving practices and access to services on oral health within the tribe.

Significant intergenerational variations were found in gingival enlargement and gingival recession, with a decreasing prevalence from first generation to third generation, suggesting a higher prevalence of periodontal diseases among the older population. This trend could also be attributed to improved access to and affordability of dental care among younger generations. Periodontal pockets were more common in older generations, indicating an age-related association with periodontal diseases. Similar trends is observed in other local tribal groups, such as Irulas, Mudugas and Kurumbas tribes, where older generations show a higher prevalence of periodontal issues compared to younger, Gopalankutty N et al.(2020)[31] document these findings, highlighting the impact of increased access to dental care and better oral hygiene practices among younger tribal populations. These observations underscore the influence of age and improved dental care on the prevalence of periodontal diseases across various tribal communities.

This study on transgenerational changes among the Malekudiya Tribe in Sullia Taluk, India, stands out for several strengths. Firstly, it pioneers in its focus, being the first of its kind to comprehensively assess generational shifts within this tribal community. The high response rate of 91.95% underscores robust community engagement and enhances the study's credibility, a notable achievement compared to lower response rates typically seen in urban settings or with non-tribal populations. The study's findings on gender distribution, highlighting a higher representation of females compared to broader national and regional demographics, provide crucial insights into gender dynamics within tribal societies, potentially influenced by unique cultural and social factors. Moreover, the study's longitudinal approach reveals continuity in physical characteristics such as body build, head shapes, and facial features across generations, suggesting strong genetic stability within the tribe. This genetic resilience is further supported by consistent findings in oral health and dental metrics, indicating a stable oral health environment despite changing dietary and environmental influences over time. Overall, this study not only enriches our understanding of tribal health and demographics but also serves as a benchmark for future research on transgenerational changes in similar communities globally.

While this study on transgenerational changes among the Malekudiya Tribe in Sullia Taluk provides valuable insights, it also faces several limitations. Firstly, the study's focus on a single tribal community restricts the generalizability of its findings to other tribal groups or broader populations. The high response rate of 91.95% suggests strong community engagement but may also

introduce response bias, as those who chose to participate may differ systematically from those who did not. Additionally, the reliance on self-reported data for certain socio-demographic and health indicators, such as marital practices, oral health behaviors, and dietary habits, introduces potential recall bias and may not capture the full spectrum of behaviors accurately.

Furthermore, the study's cross-sectional design limits its ability to establish causal relationships between observed changes and potential influencing factors over time. Longitudinal studies would be necessary to better understand the dynamics and evolution of these characteristics within the Malekudiya Tribe. Moreover, while efforts were made to ensure consistency in measurement techniques, variations in observer interpretations or equipment limitations in physical and dental examinations could affect the reliability of the results.

Finally, the study's findings on gender representation and cultural practices may be influenced by evolving societal norms and external influences, which were not fully explored in this study. Future research could benefit from broader contextual analyses and comparative studies across different tribal communities to better elucidate these dynamics.

Conclusion

This pioneering study sheds light on the unique socio-demographic and physical characteristics of the Malekudiya Tribe, offering unprecedented insights into their transgenerational changes. The high response rate underscores strong community engagement, contrasting with lower rates seen in urbanized settings. Gender dynamics, marriage practices, and physical traits reflect a blend of cultural preservation and adaptation to modern influences. The tribe's genetic stability, evidenced by consistent physical features and oral health traits across generations, highlights the impact of endogamy and limited gene flow.[23,24] As the Malekudiya Tribe navigates societal transitions, improvements in dental health underscore broader advancements in healthcare access.[29] This study not only enriches our understanding of tribal communities in India but also underscores the need for culturally sensitive approaches in healthcare and research, ensuring the preservation of their distinct heritage amidst evolving global landscapes.

Author Contribution:

The study was conceptualized and supervised by Dr Suman B, who also played a key role in the original draft preparation. Mr. Aashif Zaid secured funding and contributed significantly through data curation, formal analysis, and visualization, while also participating in the review and editing process. Dr. Nusrath Fareed led the investigation and managed resources, overseeing project administration and contributing to the review and editing of the manuscript. Lastly, Dr Supriya H provided essential resources, guiding the research with supervision and contributing to the final manuscript through thoughtful review and editing. Together, these contributions ensured the study's successful completion and the production of a comprehensive and insightful manuscript.

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Patient Consent

All participants provided written informed consent before data collection.

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