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Research Article

Evaluation of Width and Thickness of the Attached Gingiva and Its Association with Age, Gender, and Arch Location in the Nepalese Population

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Purpose. The width and thickness of the attached gingiva are important clinical parameters. Considerable variations exist in the same as well as in different individuals. This study aimed to assess the width and thickness of the attached gingiva and its relationship with age, gender, and arch location in the Nepalese population. *Methods*. An observational cross-sectional study was conducted among 120 individuals visiting the periodontics department, who were categorized into three age groups with an equal distribution of gender in each group. The width of attached gingiva (WAG) was determined using the University of North Carolina-15 probe after locating the mucogingival junction. Data were gathered and entered in Excel sheet version 19, and SPSS version 20 was used for further analysis. The mean and standard deviations were calculated. The independent *t*-test and one-way ANOVA were used to find out the significant difference between variables. The correlation between dependent and independent variables was discovered with the help of the Pearson correlation test. The significance level was set at 5% with a 95% confidence level. *Results*. 120 individuals with 1440 teeth were examined to measure the WAG with an equal distribution of gender. The maximum WAG was found on the maxillary right lateral incisor and minimum width on the mandibular left first premolar. The average WAG was greater in the upper arch (3.19 mm) than in the lower arch (2.71 mm). The maximum thickness (1.728 mm) of the attached gingiva was found on the mandibular left first molars and minimum width (0.667 mm) on the mandibular left first premolars. *Conclusions*. As individuals age, there is a reduction in gingival thickness, accompanied by an increase in the WAG across both dental arches. In terms of gender differences, females exhibit a higher thickness of attached gingiva (TAH) than their male counterparts.

1. Introduction

Orban defined the "attached gingiva" as "The part of the gingiva which is firmly attached to the underlying tooth and bone and is stippled on the surface" [1]. WAG extends from the mucogingival junction (MGJ) and to the free gingival groove. It is characterized by firmness, density, stippling, and a tight connection to the periosteum, tooth, and osseous structure. This clinical parameter holds significance in dental assessments.

Seibert and Lindhe presented the term "periodontal biotype" to categorize the thickness of the gingiva as "thick flat" and "thin scalloped" [2]. The faciopalatal dimension of the gingiva has been used to describe the thickness (gingival biotype) in and is influenced by the genetic trait. The shape of the gingiva, thickness of the keratinized gingiva in the faciolingual direction, WAG, form and thickness of buccal bone, and crown shape are included within the term "periodontal biotype" [3]. Various techniques have been introduced to measure gingival biotypes: histological study on cadaver jaws [4], modified caliper [5], injection needle [6], direct measurements/bone sounding or transgingival probing [7], visual examination, probe transparency, and histological section [8], ultrasonic devices [9], and cone-beam computed tomography [6].

Differences in the clinical presentation of a healthy marginal periodontium are observed among various subjects and tooth morphologies. Numerous characteristics are inherited through genetics, while others appear to be shaped by factors such as tooth shape, size, and alignment. In addition, biological factors such as age, gender, and growth can also play a role in determining these features [10]. Typically, there are differences in the biotypes of the facial gingiva at both the intraindividual and interindividual levels [2, 11]. This suggests the possibility of different gingival phenotypes existing within any given adult population [12].

An adequate WAG helps in maintaining aesthetics and improved control of dental plaque [13]. In routine periodontal and plastic surgeries, it is very important to restore an adequate WAG. Desirable TAH is essential, as a thin gingival margin may result in recession following trauma, surgery, or inflammatory damage [14]. Many previous studies focused either on assessing the thickness of the palatal mucosa on the palate or on individuals who were edentulous [12]. Therefore, this study aimed to assess the width and thickness of the attached gingiva and its relationship with age, gender, and arch location in the Nepalese patients.

2. Materials and Methods

The descriptive cross-sectional study was conducted at Kantipur Dental College, Kathmandu, Nepal. The study population included patients attending the periodontics department, who fulfilled the inclusion and exclusion criteria. Individuals with all indexed teeth in both the jaws, maintained oral hygiene status, periodontal tissues that are clinically healthy, exhibiting no loss of attachment in the indexed teeth (16, 14, 12, 21, 24, 26, 36, 34, 32, 41, 44, and 46), and well-aligned teeth in both the arches were included in the present study. The individuals with gingival recession in indexed teeth, hospitalized patients, females with pregnancy and breast feeding, patients using any medications or hormonal replacement therapy possibly affecting the periodontal tissue, extensive restorations including cervical restoration and fixed partial denture, history of periodontal plastic surgery, patients with a history of or undergoing fixed or removable orthodontic therapy, and physically disabled and mentally unstable patients were not included in the study. The research proposal was submitted, and consent to conduct the study was obtained by the Institutional Review Committee (IRC No: 2018/Th-05), Kantipur Dental College. Before participating in the research, each participant provided informed consent in a written form.

The research sample was selected according to non-probability convenient sampling. The study population selected was between 16 and 50 years of age and was assured that the data collected from them will be kept confidential. The research took place from October 2018 to January 2021.

The calculation of the sample size was according to the findings from the research conducted by Shaju and Zade [15] by using the following formula:

$$n = \frac{Z_\alpha^2 s^2}{d^2}. \quad (1)$$

A minimum of 57 subjects in each group, i.e., 57 females and 57 males, so altogether 114 patients, were enrolled in the study. To obtain a rounded figure, the study included a total of 120 participants. The participants were subsequently categorized into three age groups. Equal gender distribution was maintained in each age group.

The presence of plaque was recorded using the Loe's modified plaque index [16]. The condition of the gingiva was assessed with the Silness and Loe's [17] gingival index (GI). Periodontal examinations included measurement of WAG, probing sulcus depth, TAH, and number of teeth present.

Gingival index and plaque index assessments were conducted prior to initiating the periodontal examination. Individuals with a healthy gingiva without bleeding on probing and with no visible plaque were included in the study. Further measurements were performed on those individuals.

A single examiner conducted the entire procedure to reduce the interobserver variability. Standardized instruments were used for the study. The clinical procedures followed along with the armamentarium used are shown in Figure 1.

All measurements were taken at the midbuccal area of the indexed tooth. The mucogingival junction was identified with the assistance of Lugol's solution, which was coated on the participant's gingiva and alveolar mucosa using a cotton pellet and a light-pressure burnishing technique. The measurement of the width of the keratinized gingiva was carried out by using a University of North Carolina-15 probe (HuFriedy Mfg. Co., LLC., Chicago, United States), extending from the gingival margin to the mucogingival junction. The probing depth was then measured using a UNC-15 periodontal probe. The reading was rounded off to the nearest 1 mm. To ascertain the WAG, the measurement involved determining the total width of keratinized tissue and reducing the probing depth from it.

For the measurement of gingival thickness, lignocaine spray (Nummit spray 100 ml—anesthetic lidocaine topical spray, ICPA, Mumbai, India) was applied on the midbuccal surface and dried with a cotton pellet. An endodontic spreader (number 25, Dentsply Sirona) fitted with a stopper was inserted perpendicular to the gingival surface. Then, reading was measured from the tip of the spreader to the point below the stopper with the help of a digital Vernier caliper (Digital Calipers 6 inch/150 mm—Electronic Vernier Caliper with Large LCD Screen, Inch and Millimeter Conversion Measurement, Arura Enterprise, Tamil Nadu, 600031, India). Three consecutive measurements were recorded in millimeter, and the average was calculated. The intraexaminer reliability was calculated by re-examining the WAG and TAH in 10% of the total patients after a 1-week interval and was 91%.

(a) (b) (c) (d) (e)

Figure 1: Photographs of clinical procedures and armamentarium. (a) Before staining with Lugol's solution. (b) After staining with Lugol's solution. (c) Measurement of the width of keratinized gingiva with a UNC-15 probe. (d) Measurement of thickness of the attached gingiva with an endodontic spreader fitted with a stopper. (e) Measurement of thickness of keratinized gingiva with a digital Vernier caliper.

2.1. Statistical Analysis. Data were gathered and entered in Microsoft Excel version 19. Further data analysis was conducted using the SPSS version 20. Frequencies, mean, standard deviation, and percentage were calculated. The independent *t*-test was employed to identify any statistical differences between the width and thickness of the attached gingiva and age, gender, and arch location. Likewise, one-way ANOVA was utilized to determine differences between continuous variables. The Pearson correlation test was employed to identify the correlation between the variables. The significance level was set at 5% with a 95% confidence level.

3. Results

In current study, 120 individuals were examined, with an equal distribution of 60 (50%) males and 60 (50%) females. The participants had a mean age of 31.9 ± 10.72 years. Participants were categorized into three age groups. Participants were equally distributed in each group, i.e., 40 in each group (20 males and 20 female). Considering the ethnicity, 82 (68.3%) were Aryan, 22 (18.3%) were Mongolian, and 16 (13.4%) were mixed.

1440 teeth were examined to measure the WAG. The overall mean width of the attached gingiva was 2.956 mm. The average WAG was greater in the maxilla (3.19 mm) than in the mandible (2.71 mm). Within the maxilla, the widest width of the attached gingiva (4.53 mm) was observed on the right lateral incisor (12), while the narrowest (2.22 mm) was noted on the left first premolar (24). In the mandible, maximum width (3.52 mm) was found on the right central incisor (41) and minimum width (1.84 mm) on the left first premolar (34). The average WAG per tooth is presented in Table 1.

The overall average thickness of the attached gingiva (GT-TGP) was 1.101 mm. Maximum thickness (1.728 mm) of the attached gingiva was found on the mandibular left first molars and minimum thickness (0.667 mm) on the mandibular left first premolars. The mean TAH was higher in the maxilla (1.131 mm) than in the mandible (1.070 mm). In the maxilla, maximum thickness of the attached gingiva (1.699 mm) was found on the left first molars (26), whereas minimum thickness (0.757 mm) was found on the right first premolars (14). In the mandible, maximum thickness (1.070 mm) was found on the right first molar (46) and minimum (0.667 mm) on the left first premolar (34). The mean thickness of the attached gingiva per tooth is shown in Table 2. Thickness was classified [18] as thick (≥1.5 mm) and thin (<1.5 mm), as presented in Table 2.

The evaluation of the mean WAG and TAG in males and females was conducted through an independent sample *t*-test. The outcomes are presented in Tables 3 and 4. Females had a higher mean WAG (3.00 mm) than males (2.91 mm). The mean WAG in the maxillary premolar region was significantly higher in females than in males, with a statistically significant difference (p value = 0.03). In all other areas, there was not any statistical significance (Table 3).

The total TAH was notably greater in females (1.13 mm) than in males (1.07 mm), with a statistical significance ($p = 0.04$, Table 4). Likewise, the statistically significant differences were observed in the mean TAH in the mandibular incisor area (p value = 0.002) and the molar area (p value = 0.01). The assessment of variation in TAH and WAG across various age groups was conducted using the one-way ANOVA test. The results are shown in Tables 5 and 6. A statistically significant difference in the mean TAH in the maxillary molar region among different age groups was observed (p value = 0.01).

The correlation between the mean TAH and WAG was not found to be statistically significant in the maxilla (p value = 0.09), mandible (p value = 0.65), and overall (both arches, p value = 0.29). The correlation was significant between the maxillary incisors (p value = 0.01) and was weak (Table 7). The width of the attached gingiva in the maxilla and mandible was positively correlated and was statistically significant (p value <0.001). The strength of correlation was moderate ($r = 0.501$). A positive correlation was identified between the thickness of the attached gingiva in the maxilla and mandible, and this correlation was statistically significant (p value = 0.008). The correlation strength was weak ($r = 0.240$).

4. Discussion

The designation "periodontal phenotype" was introduced by the "2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions" [19].

Table 1: Mean width of the attached gingiva in the maxillary and mandibular arches (mm).

	n	Mean ± SD
Overall	1140	2.956 ± 0.419
Maxillary teeth		
All teeth		3.19 ± 0.49
1.6	120	2.92 ± 0.724
1.4	120	2.31 ± 0.683
1.2	120	4.53 ± 0.934
2.1	120	4.27 ± 0.978
2.4	120	2.22 ± 0.679
2.6	120	2.89 ± 0.818
Mandibular teeth		
All teeth		2.7194 ± 0.47436
3.6	120	2.60 ± 0.814
3.4	120	1.84 ± 0.661
3.2	120	3.47 ± 0.907
4.1	120	3.52 ± 0.830
4.4	120	1.85 ± 0.603
4.6	120	3.04 ± 0.726

This designation is based on both the gingival phenotype and bone morphotype [19]. TAH, WAG, and bone morphotype were three crucial parameters utilized for categorizing biotypes, playing an important role in the development or progression of defects present in the mucogingival area [20]. According to its definition, the biotype is genetically determined and remains unalterable. It does not consider environmental factors or clinical interventions that might influence the profile of the periodontal tissue [19].

Researchers have explored the function of the keratinized gingiva in preserving periodontal health, serving to prevent gingivitis and stabilize the gingival margin [21, 22]. There is ongoing debate concerning the function of the attached gingiva in sustaining gingival health. Maintaining optimal plaque control in regions with minimal or no attached gingiva can contribute to the preservation of periodontal health. Some authors have documented inflammation in areas with at least two mm of the keratinized gingiva, even when all dental surfaces were free of plaque [21, 22]. Kennedy et al. [23] concluded that their study found no supporting evidence to suggest that a zone with a narrow attached gingiva is more susceptible to gingival inflammation compared with a wider area of the attached gingiva. When establishing esthetic margins, the existence of the attached gingiva is crucial to reduce the risk of gingival recession and facilitate oral hygiene procedures [24]. But Mehta and Lim [25] disagreed on this statement.

There is an ongoing debate regarding the quantity of the attached gingiva required to prevent subsequent recession and attachment loss. Bowers GM [14] mentioned that it is feasible to maintain a clinically healthy gingiva even with a very limited area of attachment (<1 mm). A thin periodontal biotype, nonexistence of the attached gingiva, and decreased alveolar bone thickness due to malaligned tooth positioning within the jaw are recognized as determinants for the development and progression of gingival recession. The safeguarding of gingival health is primarily contingent on the presence and upkeep of attached gingival tissue [22].

Table 2: Mean thickness of the attached gingiva in the maxillary and mandibular arches.

Teeth	N	Mean gingival thickness—transgingival probing (GT-TGP) (mm)	Gingival thickness—transgingival probing (GT-TGP) < 1.5 mm n (%)	Gingival thickness—transgingival probing (GT-TGP) > 1.5 mm n (%)
Overall teeth	1440	1.1010 ± 0.15982	1093 (75.90)	347 (24.1)
Maxillary arch				
All teeth	720	1.1317 ± 0.17611	550 (76.38)	170 (23.62)
1.6	120	1.545 ± 0.4632	66 (55)	54 (45)
1.4	120	0.757 ± 0.2941	116 (96.7)	4 (3.3)
1.1	120	0.999 ± 0.2906	109 (90.8)	11 (9.2)
2.1	120	1.022 ± 0.2817	113 (94.2)	7 (5.8)
2.4	120	0.768 ± 0.2602	117 (97.5)	3 (2.5)
2.6	120	1.699 ± 0.4101	29 (24.2)	91 (75.8)
Mandibular arch				
All teeth	720	1.0704 ± 0.22788	543 (75.41)	177 (24.59)
3.6	120	1.728 ± 1.1973	41 (34.2)	79 (65.8)
3.4	120	0.689 ± 0.3070	118 (98.3)	2 (1.7)
3.1	120	0.811 ± 0.1922	120 (100)	—
4.1	120	0.827 ± 0.1879	120 (100)	—
4.4	120	0.667 ± 0.1642	120 (100)	—
4.6	120	1.701 ± 0.17611	24 (20)	96 (80)

Table 3: Comparison of the mean width of the attached gingiva among males and females.

Teeth	Male ($n = 60$)	Female ($n = 60$)	p value
All	2.91 ± 0.36	3.00 ± 0.47	0.23
Maxillary			
All teeth	3.12 ± 0.39	3.26 ± 0.57	0.12
Incisor region	4.30 ± 0.62	4.51 ± 0.94	0.15
Premolar region	2.15 ± 0.52	2.38 ± 0.61	**0.03***
Molar region	2.92 ± 0.58	2.90 ± 0.60	0.88
Mandibular			
All teeth	2.69 ± 0.45	2.74 ± 0.50	0.61
Incisor region	3.51 ± 0.77	3.48 ± 0.77	0.81
Premolar region	1.79 ± 0.46	1.90 ± 0.56	0.25
Molar region	2.79 ± 0.62	2.85 ± 0.67	0.62

Independent samples t-test, p value <0.05, which is statistically significant*.

Table 4: Comparison of the mean thickness of the attached gingiva among males and females.

Teeth	Male ($n = 60$)	Female ($n = 60$)	p value
All	1.07 ± 0.13	1.13 ± 0.18	**0.04***
Maxillary			
All teeth	1.10 ± 0.18	1.16 ± 0.16	0.07
Incisor region	0.99 ± 0.23	1.03 ± 0.29	0.32
Premolar region	0.75 ± 0.21	0.78 ± 0.21	0.41
Molar region	1.58 ± 0.31	1.67 ± 0.37	0.14
Mandibular			
All teeth	1.04 ± 0.14	1.10 ± 0.29	0.15
Incisor region	0.87 ± 0.17	0.77 ± 0.17	**0.002***
Premolar region	0.68 ± 0.15	0.67 ± 0.23	0.76
Molar region	1.57 ± 0.28	1.86 ± 0.80	**0.01***

Independent samples t-test, p value <0.05, which is statistically significant*.

Table 5: Comparison of the mean width of the attached gingiva among different age groups.

Teeth	16–24 years ($n = 40$)	25–39 years ($n = 40$)	40 years and above ($n = 40$)	p value
All	2.70 ± 0.38	3.03 ± 0.44	3.14 ± 0.29	**<0.001***
Maxillary				
All teeth	2.96 ± 0.48	3.33 ± 0.52	3.29 ± 0.40	**0.001***
Incisor region	3.98 ± 0.89	4.61 ± 0.70	4.63 ± 0.61	**<0.001***
Premolar region	2.31 ± 0.64	2.29 ± 0.53	2.20 ± 0.55	0.66
Molar region	2.59 ± 0.53	3.09 ± 0.55	3.05 ± 0.56	**<0.001***
Mandibular				
All teeth	2.45 ± 0.47	2.72 ± 0.46	2.99 ± 0.32	**<0.001***
Incisor region	3.03 ± 0.78	3.60 ± 0.67	3.85 ± 0.61	**<0.001***
Premolar region	1.85 ± 0.47	1.75 ± 0.63	1.94 ± 0.41	0.27
Molar region	2.46 ± 0.59	2.81 ± 0.63	3.19 ± 0.49	**<0.001***

One-way ANOVA, p value <0.05, which is statistically significant*.

As per the 1989 World Workshop of Periodontology, various parameters should be taken into consideration when assessing the presence of a sufficient area of the attached gingiva and determining the minimum acceptable amount of the attached gingiva [26]. Thus, determining the width of attached gingiva before any periodontal surgical procedure mainly in perioplastic surgery is important.

WAG and TAH play a crucial role in influencing the indications and outcomes of various restorative, periodontal, surgical, and implant therapies. The response of a thick gingival biotype varies from that of a thin gingival biotype. Evaluating the gingival biotype prior to dental procedures is essential for attaining a consistent and stable gingival margin position.

Table 6: Comparison of the mean thickness of the attached gingiva among different age groups.

Teeth	16–24 years ($n = 40$)	25–39 years ($n = 40$)	40 years and above ($n = 40$)	p value
All teeth	1.11 ± 0.15	1.09 ± 0.12	1.09 ± 0.19	0.84
Maxillary				
All teeth	1.16 ± 0.21	1.15 ± 0.18	1.09 ± 0.12	0.23
Incisor region	1.04 ± 0.27	0.97 ± 0.23	1.03 ± 0.28	0.42
Premolar region	0.78 ± 0.24	0.75 ± 0.23	0.76 ± 0.15	0.86
Molar region	1.66 ± 0.38	1.72 ± 0.33	1.49 ± 0.28	**0.01***
Mandibular				
All teeth	1.07 ± 0.15	1.05 ± 0.13	1.09 ± 0.35	0.61
Incisor region	0.82 ± 0.19	0.79 ± 0.16	0.85 ± 0.18	0.45
Premolar region	0.71 ± 0.26	0.64 ± 0.11	0.68 ± 0.19	0.34
Molar region	1.68 ± 0.34	1.69 ± 0.28	1.76 ± 0.98	0.84

One-way ANOVA, p value <0.05, which is statistically significant*.

Table 7: Correlation between the mean width and the mean thickness of the attached gingiva.

Variables		Width of attached gingiva (mean ± SD)	Thickness of attached gingiva (mean ± SD)	Pearson correlation coefficient (r)	p value
Maxilla	Overall	3.19 ± 0.49	1.13 ± 0.18	0.155	0.09
	Incisor	4.40 ± 0.79	1.01 + 0.26	0.229	**0.01***
	Premolar	2.27 ± 0.57	0.76 ± 0.21	0.144	0.12
	Molar	2.91 ± 0.59	1.62 ± 0.35	−0.137	0.13
Mandible	Overall	2.72 ± 0.47	1.07 ± 0.23	0.042	0.65
	Incisor	3.49 ± 0.77	0.82 ± 0.18	0.153	0.09
	Premolar	1.85 ± 0.51	0.68 ± 0.19	0.024	0.79
	Molar	2.82 ± 0.64	1.71 ± 0.62	0.005	0.96
Overall (both arches)		2.96 ± 0.42	1.10 ± 0.16	0.097	0.29

Pearson correlation, p value <0.05, which is statistically significant*.

In this study, the thickness of attached gingiva was measured by transgingival probing [27] which was easy to perform, convenient, cheap, and accurate. The midbuccal region was selected as a standardized landmark, given that this region represents the minimal width of the gingiva and for the sake of convenience. Also, the gingival index and the plaque index were taken in the same teeth. For the patient's and clinician's convenience and to reduce the examination time, index teeth were selected which are the representative of the respective sextants. Due to the absence of distinction between the attached gingiva and palatal mucosa and lingual mucosa, measurements were not taken for the palatal and lingual zones of the attached gingiva.

The mean WAG was higher in the maxilla (3.19 mm) than in the mandible (2.71 mm), aligning with findings from previous studies conducted by Bowers [14], Pradhan and Shrestha [28], Adesola et al. [29], Saxena et al. [30], and Anand et al. [31].

In the current study, maximum WAG in the maxilla (4.53 mm) was found on the right lateral incisors, whereas minimum (2.22 mm) was found on the left first premolars. In the mandible, maximum width (3.52 mm) was found on the right permanent central incisor and minimum (1.84 mm) on the left first premolar. WAG ranged from 1 to 7 mm. According to Lee et al. [18] in the Chinese population, the maximum WAG was found on the maxillary central incisors (5.64 ± 1.40 mm), while the lowest width was noted on the mandibular first premolar (3.43 ± 0.89 mm). The mean WAG was larger in the maxilla (5.10 ± 1.41 mm) than in the mandible (4.09 ± 1.05 mm), consistent with the current study. Variations in measurements could be attributed to different techniques for determining the mucogingival junction (functional versus iodine) or potential ethnic differences.

In a study by Shaju and Zade [15], variations in the WAG were identified across various regions of the oral cavity, with the widest measurements in the upper central incisors and the narrowest in the lower molars. These outcomes align with the results of our study, and Subbaiah and Manohar [32], Adesola et al. [29], and Anand et al. [31] discovered that WAG varied widely, with the highest measurements typically present in the upper incisors and the lowest in the lower premolars. These findings are comparable to the findings of the present study. In research conducted by Chandulal et al. [33], variations in the WAG were noted across different oral cavity regions, with the maxillary incisors showing the widest dimension. In the present study, similar variations in WAG were observed in both the arches. Variations in WAG in various studies might be due to different methods used to locate mucogingival junctions (functional versus staining) or possible true ethnical differences [10, 15, 18, 33].

In this study, participants were categorized into three age groups, and the WAG was measured and compared among these groups. The statistically significant difference in the average WAG among the three age groups was noticed (p value <0.001). The average WAG in each group was 2.70 ± 0.38 mm in the 16–24 years group, 3.03 ± 0.44 mm in the 25–39 years group, and 3.14 ± 0.29 mm in the >40 years group. There was a notable increase in the overall WAG in the group aged >40 years compared with the other age groups. Kolte et al. [12], Bhatia et al. [34], Pradhan and Shrestha [28], and Jennes et al. [35] suggested an increase in the WAG with age, while Adesola et al. [29] observed no association between the WAG and age. In a study by Shaju and Zade [15] in the Indian population, the maximum WAG was in the middle years age group and lowest in the older years age group. In contrast to this study, there was a progressive increase in the WAG with an increase in age in the current study.

In the present study, female participants had a higher mean WAG (3.00 mm) than males (2.91 mm). The average WAG in the maxillary premolar area was significantly higher in females than in males, with a significant difference statistically (p value = 0.03). In all other areas, no statistical significance was seen (Table 3). These results were similar to the studies conducted by Chandulal et al. [33], Shaju and Zade [15], Pradhan and Shrestha [28], and Alhajj [36]. But in the research by Kolte et al. [12], De Rouck et al. [37], and Jennes et al. [35], females had less WAG.

In the present study, the mean TAH was higher in the maxilla (1.131 mm) than in the mandible (1.070 mm), aligning with the results of the research conducted by Agarwal et al. [38].

In the study carried out by Lee et al. [18], the average TAH in the upper incisor, premolar, and molar regions was reported as 1.55 ± 0.30 mm, 1.38 ± 0.37 mm, and 2.20 ± 0.64 mm, respectively. Similarly, the average TAH in the mandibular incisor, premolar, and molar regions was reported to be 1.01 ± 0.31 mm, 1.11 ± 0.36 mm, and 2.07 ± 0.40 mm, respectively. These measurements exceed those observed in the current study. The general anatomical trend of increasing thickness of the attached gingiva was consistent in all studies [18, 27, 39], whereas there was a decrease in thickness from the incisor to the premolar, which increased in molars in the current study.

Unlike the current study, Vandana and Savitha [13] and Kolte et al. [12] found that the TAH was greater in the lower arch than in the upper arch.

Our findings indicate that gingival thickness was greater in the young adult group and decreased in the older adult group. These observations align with the findings reported by Vandana and Savitha [13]; such alterations in the oral epithelium could be attributed to age-dependent thinning and reduced keratinization. Our study specifically concentrated on measuring the gingival biotype (thickness) on the midfacial aspect, which is considered to be the most appropriate approach. This is because variations may exist between midfacial and interdental measurements due to differences in alveolar bone contours, which could potentially affect soft tissue thickness [13].

The overall TAH was greater in females (1.13 mm) than in males (1.07 mm), with a statistical significance ($p = 0.04$, Table 4). Comparable results were suggested by Agarwal et al. [38]. In contrast to the current study, females had a thinner attached gingiva than males in the research conducted by Vandana and Savitha [13], Kolte et al. [12], Manjunath et al. [40], and Anand et al. [31].

Different researchers have established arbitrary thresholds to distinguish between thick and thin tissues. Few studies utilized one mm, while others suggested one and half mm as the ceiling for thin gingival tissue due to variations in tissue responses to the periodontal therapy [5, 41, 42]. Using this threshold of 1.5 mm, 75% participants had a thin gingiva and 24.9% had a thick gingiva. In the maxillary arch, 76.38% participants had thin gingival biotypes and 23.62% had thick gingival biotypes, whereas 75.41% had thin gingival biotypes and 24.59% thick gingival biotypes in the mandibular arch. Lee et al. [18] concluded that overall, 64.6% had thin gingival biotypes and 35.4% had thick gingival biotypes, which is comparable with the result obtained in the current study. A similar prevalence of gingival biotypes (75.6% thin, 24.6% thick) was obtained in the mandibular arch, but a higher prevalence (53.2% thin, 46.8% thick) was discovered in the research conducted by Lee et al. [18], as compared to the current study. In contrast, Shao et al. [43], Shah et al. [44], and Rijal et al. [45] discovered a greater prevalence of thick gingival phenotypes. This difference in gingival thickness in different populations may be due to racial variation where Asians usually have a thin gingiva compared to Caucasians [18, 43, 46, 47].

The correlation between the mean WAG and TAH was not seen statistically significant in the upper arch (p value = 0.09), lower arch (p value = 0.65), and overall (both arches, p value = 0.29). These findings are consistent with those of the research carried out by Lee et al. [18], Collins et al. [48], Alkan et al. [49], Park et al. [50], Singh et al. [51], Khattak et al. [52], and Adesola et al. [29], whereas they contradict the study by Kolte et al. [12]. Similarly, there is an association between gingival width and gingival phenotype. The thick gingival biotype has a more pronounced width of the keratinized gingiva [20, 43, 53, 54]. The correlation was significant between the maxillary incisors (p value = 0.01); however, the correlation is weak.

5. Conclusion

As age increases, there is a nonstatistically significant decrease in gingival thickness, while the WAG increases in both the upper and lower dental arches. In terms of gender differences, females exhibited a greater TAH than males. While, the other tooth-related components such as tooth position, shape of the arch, genetic factors of the individual, and religion factors are also likely to affect the measurement, which may be an important parameter for future clinical trials. Additional research is required on periodontally healthy individuals in various population in Nepal to establish baseline values for WAG.

5.1. Limitations. Since this is a cross-sectional study, the level of evidence provided by this study is less compared to case-control and cohort studies. All the measurements were performed with the help of a hand periodontal probe, in which the standardization of probing force and probing angulations could not be possible compared to automated probes. The precision of reading was 1 mm when the UNC-15 probe was used. Measurement errors may have resulted from differences in the angulation of the spreader, changes in tissue volume due to infiltration of anesthetic, and difficulty in accessibility/visibility, especially in the posterior regions. The findings of the current research may not be generalizable to all the Nepali citizens because of ethnic and cultural differences. This sample consisted only of patients visiting a dental college located in Kathmandu, Nepal. Hence, the result cannot be generalized for the entire Nepalese population.

5.2. Recommendations. Further studies should be conducted in various populations in Nepal to get reference values for WAG. Variations due to ethnicity should be studied. A sample size with a large population should be considered to explore the correlation among age, gender, and gingival biotype (width and thickness). Automated probes with high precision should be used in the future studies. Noninvasive methods such as cone-beam computed tomography (CBCT) and ultrasonography (USG) should also be used to measure TAH.

Data Availability

The data used to support the findings of this study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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