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Original Article

ISSN (P): 2307-3748
ISSN (E): 2310 -3841

Citation:
Faisal SS, et al. Frequency of different mandibular arch forms among patients attending a Tertiary Care Hospital in Karachi. Int. j. endorsing health sci. res. 2025;13(4):188-192.

Corresponding Author Email:
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Funding:
The authors received no external funding for this study.

Conflicts of Interests:
The authors have declared that no competing interests exist.

Data Sharing Statement:
The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

Received 12/02/2025
Accepted 27/05/2025
First Published 01/12/2025

Frequency of different mandibular arch forms among patients attending a Tertiary Care Hospital in Karachi.

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DOI: https://doi.org/10.29052/IJEHSR.v13.i4.2025.188-192

Abstract

Background:
The morphology of the mandibular dental arch varies across individuals and populations, influenced by factors such as gender, ethnicity, and malocclusion. Recognizing arch form differences is essential for achieving functional stability and esthetic balance in orthodontic treatment. This study aimed to determine the frequency and distribution of different mandibular arch forms tapered, square, and ovoid among orthodontic patients visiting Karachi Medical and Dental College (KMDC), and to evaluate the association between arch form and gender.

Methodology:
A descriptive cross-sectional study was conducted at the Department of Orthodontics, KMDC, Karachi, from January to June 2024. A total of 220 patients aged 12–35 years were selected through convenience sampling. Mandibular arch forms were assessed on dental casts using 3M Unitek preformed templates (tapered, square, and ovoid). Data were analyzed using SPSS version 20.0. Frequencies and percentages were calculated for categorical variables, and mean ± SD for age. The Chi-square test was applied to assess the association between gender and arch form, with $p \leq 0.05$ considered statistically significant.

Results:
Of the 220 participants, 52 (23.6%) were males and 168 (76.4%) females, with a mean age of 19.33 ± 4.45 years. The ovoid arch form was most prevalent (39.1%), followed by the tapered (33.6%) and square (27.3%) forms. Gender-based differences were significant, as males predominantly exhibited tapered arches (46.2%) while females showed a higher frequency of ovoid arches (44.0%) ($p = 0.019$).

Conclusion:
The ovoid arch form was the most common among orthodontic patients, with significant gender differences observed. These findings provide valuable reference data for orthodontic diagnosis, archwire selection, and population-based treatment planning in Pakistani patients.

Keywords:
Mandibular Arch Form, Orthodontics, Tapered, Square, Ovoid, Gender Differences

Introduction

In orthodontics, achieving an esthetic, functional, and stable arch form is a fundamental treatment objective. The pre-treatment dental arch morphology serves as a critical guide for ensuring long-term post-treatment stability, as the dental arch tends to return to its original shape after appliance removal if excessive alteration occurs [1]. Evaluating arch form before treatment helps orthodontists design individualized treatment plans that respect the patient's inherent morphology and minimize relapse tendencies [2].

The dental arch reflects the spatial relationship of teeth within the jaw and results from the interplay of skeletal structure, soft-tissue dynamics, and environmental factors [3,4]. Historically, human arch forms have been classified into geometric patterns such as parabolic, elliptical, and catenary shapes, while clinically, they are categorized as tapered, square, and ovoid [5–7]. Numerous studies have examined the relationship between arch form and factors such as gender, malocclusion type, and ethnicity, but no universal pattern has been established [8,9].

Previous research conducted in Turkey revealed that the tapered arch form was the most prevalent (62.5%), followed by ovoid (27.3%) and square (10.2%), with gender-related variations noted [10–13]. Similarly, comparative studies between Caucasian and Japanese populations demonstrated significant differences in arch width and depth, although no single arch form could be attributed to a specific ethnic group [14–16]. In Pakistan, limited data exist on the frequency of mandibular arch forms across diverse populations. Studies from Lahore and Karachi have shown ovoid arches to be the most common, though methodological variations make direct comparisons difficult [17].

Understanding the frequency and pattern of mandibular arch forms in the local population is essential for optimizing archwire selection, improving treatment outcomes, and ensuring post-treatment stability. Therefore, this study was designed to evaluate the distribution of mandibular arch forms, tapered, square, and ovoid among orthodontic patients attending a tertiary care dental hospital in Karachi, and to analyze their association with gender.

Methodology

Study Design

This was a descriptive cross-sectional study conducted to determine the frequency and distribution of different mandibular arch forms tapered, square, and ovoid among orthodontic patients. The study was carried out in the Department of Orthodontics, Karachi Medical and Dental College (KMDC), Karachi, Pakistan, over a six-month period from January to June 2024.

Ethics

The research proposal was reviewed and approved by the Research Evaluation Unit, Registration and Research Cell, College of Physicians and Surgeons Pakistan (CPSP) (Ref. No. CPSP/REU/DSG-2015-174-1506, dated September 5, 2017). The study adhered to the ethical standards outlined in the Declaration of Helsinki and the ethical policies of CPSP. Written informed consent was obtained from each participant before enrollment, and for minors under 18 years of age, consent was obtained from a parent or legal guardian. All data were anonymized to ensure confidentiality and privacy.

Setting

The study was conducted at the Department of Orthodontics, KMDC, which functions as a tertiary care center providing comprehensive orthodontic services.

Participants

The study population comprised patients aged 12 to 35 years who presented to the Orthodontics Department for consultation or treatment. Convenience sampling was employed to recruit participants fulfilling the inclusion criteria until the target sample size of 220 was reached. Patients with full permanent dentition (excluding third molars), no history of orthodontic treatment, and availability of good-quality dental casts suitable for evaluation were included in the study. While those with craniofacial anomalies such as cleft lip or palate, severe crowding or spacing that distorted the natural arch form, missing anterior or posterior teeth (other than third molars), or a history of trauma or restorative work that altered the natural arch configuration were kept in the exclusion criteria.

Variables

The primary dependent variable was the type of mandibular arch form, categorized as ovoid, tapered, or square. Independent variables included gender and age, which were analyzed to assess their relationship with arch form distribution.

Data Sources and Measurement

After informed consent, alginate impressions of the mandibular arch were taken for each participant and immediately poured using Plaster of Paris to create accurate dental casts. The arch form of each cast was evaluated using 3M Unitek preformed arch-form templates (3M Unitek, Monrovia, California, USA). The template was positioned to align with the cusp tips of canines and buccal cusps of premolars and molars. The arch form providing the best fit along the buccal curvature was classified as the participant's mandibular arch type.

To ensure measurement precision, examiner calibration was performed on 20 randomly selected study models, which were re-evaluated after one week. Intra-examiner reliability was assessed using the Kappa coefficient ($\kappa = 0.87$), indicating excellent agreement. All subsequent evaluations were carried out by the same examiner under the supervision of an orthodontic specialist to minimize inter-observer variability.

Bias

Several measures were taken to reduce potential bias. Examiner calibration minimized measurement bias, while the use of standardized 3M Unitek templates ensured procedural uniformity. Selection bias was reduced by consecutively enrolling all eligible patients during the study period, and inter-observer bias was avoided by having a single trained examiner perform all measurements. Confidential handling of data further prevented information bias.

Study Size

The sample size of 220 participants was determined to achieve sufficient statistical power to detect a meaningful difference in arch form frequency across genders, based on previous regional studies. Sampling continued until this number was achieved, ensuring adequate representation for comparative analysis.

Quantitative Variables

Quantitative data such as age were summarized using mean and standard deviation, while categorical variables like gender and arch form were expressed as frequencies and percentages. The relationship

between arch form and gender was examined as the primary quantitative outcome.

Statistical Methods

All data were entered and analyzed using SPSS version 20.0. Descriptive statistics were computed for demographic variables, while inferential statistics were applied to test associations. The Chi-square test was employed to evaluate the relationship between arch form and gender, with a p-value ≤ 0.05 considered statistically significant. Post-stratification Chi-square analysis was also performed to control for potential effect modifiers such as age and malocclusion type.

Results

Participants

A total of 220 participants were included in this study, comprising 52 males (23.6%) and 168 females (76.4%). The participants' age ranged from 12 to 35 years, with a mean age of 19.33 ± 4.45 years. All participants met the inclusion criteria of having complete permanent dentition (excluding third molars) and no prior orthodontic treatment.

Descriptive Data

The mean age distribution suggested that most patients seeking orthodontic treatment at KMDC were young adults in their late teens. The sample demonstrated a gender imbalance, with a higher proportion of female patients, consistent with trends observed in other orthodontic outpatient populations.

Outcome Data

Among the three mandibular arch forms evaluated, the ovoid type was found to be the most prevalent, followed by the tapered and square forms. Specifically, 86 participants (39.1%) exhibited an ovoid arch, 74 (33.6%) showed a tapered form, and 60 (27.3%) displayed a square form.

Main Results

When analyzed by gender, notable variations in arch form frequency were observed. Among male participants, the tapered arch form was most common, recorded in 24 individuals (46.2%), followed by the square (30.8%) and ovoid (23.0%) types. In contrast, the ovoid arch form predominated among females, found in 74 individuals (44.0%), while tapered (29.8%) and square (26.2%) forms were less frequent.

Statistical analysis using the Chi-square test revealed a significant association between gender and arch form ($\chi^2 = 7.97$, $p = 0.019$), indicating that the distribution of mandibular arch forms varied significantly between males and females.

Overall, these results suggest that gender plays a role in determining mandibular arch morphology, with females tending toward ovoid arches and males showing a higher frequency of tapered forms. The ovoid arch, however, remains the most prevalent overall, reinforcing its clinical relevance in orthodontic diagnosis, wire selection, and treatment planning for achieving stable post-treatment outcomes.

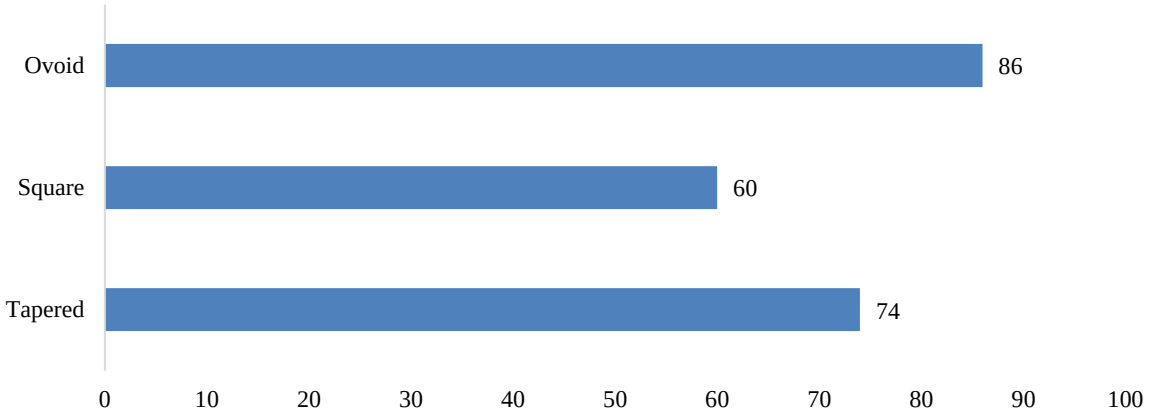

Figure 1: Frequency of Arch form.

Table 1: Gender wise comparison of Arch form among the enrolled patients.

Arch form	Male	Female	p-value
Tapered	24	50	
Square	16	44	0.019*
Ovoid	12	74	

*p ≤ 0.05 indicates statistically significant association based on Chi-square test.

Discussion

Complete accumulation, correlation, and evaluation of each patient's biomechanical and morphological characteristics allowed the dentist to determine the frequency of mandibular arch forms in the study population [18, 19]. Multiple studies have investigated the distribution of arch forms in different populations, and these findings provide important context for interpreting the results of the present study.

One study reported that the tapered arch form was the most prevalent, followed by the ovoid type, while the square form was the least common [20]. A similar pattern was observed in a 2011 study conducted on a Turkish population comprising 600 participants (362 females and 238 males). In that study, the tapered form was most frequent (62.5%), followed by the ovoid (27.3%) and square forms (10.2%) [21]. Gender-related differences in arch morphology were also noted, suggesting that biological sex may influence dental arch dimensions.

In contrast to these findings, the present study found the ovoid arch form to be the most common, followed by tapered and square forms. This is consistent with data from a Pakistani study evaluating 250 patients at Lahore Medical and Dental College, where the distribution based on Noroozi's mathematical model also showed the ovoid form as most frequent (82%), square as the second most common (64%), and tapered as the least prevalent (11.2%) [22].

Another investigation conducted in 2012 on 200 randomly selected outpatients from CSMSS Dental College, Aurangabad, India, also supports these findings. That study reported that the ovoid arch form was most common (50%), followed by tapered (32.5%), with square being the least frequent (17.5%) [1]. These results align well with the present study, reaffirming that the ovoid arch form appears to dominate in South Asian populations.

Ethnic variation may contribute substantially to differences in dental arch morphology. Research has shown that populations of different ethnic backgrounds may exhibit distinct arch characteristics [23,24]. For example, a comparative study conducted in 2001 assessed Caucasian and Japanese individuals to examine morphological differences in mandibular arch form. The study found that the Caucasian population tended to have significantly narrower arch widths and greater arch depth compared with the Japanese sample [16]. Interestingly, when the groups were reorganized based on arch form categories, rather than ethnicity, no statistically significant differences in arch dimensions were observed between the two populations. This suggests that while craniofacial morphology may vary among ethnic groups, arch form categories themselves are not strictly tied to ethnicity or Angle's classification. Instead, the frequency of specific arch forms varies across populations, influenced by both genetic and environmental factors.

Limitations

The present study was limited by its single-center design and the use of a convenience sampling method, which may restrict the generalizability of results to the wider Pakistani population. The study sample, although adequately powered, primarily represented patients attending an urban tertiary care facility, and hence may not reflect rural or ethnically diverse groups. Furthermore, only mandibular arches were analyzed, while maxillary arch forms were not included for comparison. Future research should employ a multi-center approach with a larger and more diverse sample size to validate these findings across different regions and ethnicities. Additionally, incorporating digital 3D scanning and morphometric analysis could enhance measurement precision and allow for more robust comparisons of arch dimensions and shape variability.

Conclusion

This study identified the ovoid mandibular arch form as the most prevalent pattern among orthodontic patients attending a tertiary care hospital in Karachi, followed by the tapered and square forms. A significant association between gender and arch form was observed, with males exhibiting a higher frequency of tapered arches and females demonstrating a predominance of ovoid arches. These findings highlight the importance of recognizing gender-based variations and population-specific arch form characteristics during orthodontic diagnosis and treatment planning. Understanding the natural arch morphology not only facilitates appropriate archwire selection but also contributes to improved treatment stability and post-treatment outcomes. Future multi-center studies with larger and more diverse samples, as well as incorporation of advanced digital measurement tools, are recommended to further validate and expand upon these results within the Pakistani population.

Acknowledgement

The authors of this study would like to thank all the participants for their cooperation.

References

1. Tajik I, Mushtaq N, Khan M. Arch Form among Different Angle Classifications A-Study. Pak Oral Dental J 2011;31(1):90-3
2. Khatri JM, Madaan JB. Evaluation of arch form among patients seeking orthodontic treatment. JInd Orthodontics Soc 2012;46(4):325-328.
3. Naureen S, Kiani HG, Aman K. Frequency of Arch forms in a Pakistani sample and its association with the Curve of Spee and Gender. Pak Oral Dental J. 2023;15(2):113-117.
4. Maharjan S, Rajbhandari A, Pradhan R, Bajracharya M, Manandhar P, Pant BD. Arch Form and Mathematical Ratio in Orthodontics Patients: A Descriptive Cross-sectional Study. J Inst Med (Nepal). 2023;45(2):49-53.
5. Saleem T, Shafique A. mandibular arch form analysis: a comparison between result of two different method. Pak Oral Dental J 2012;32(3):556-560
6. Shafique A,Saleem T, Chatta MR. Arch form analysis: comparison of two different methods. Pak Oral Dental J 2011;31(2):347-351.
7. Ahmed M, Shaikh A, Fida M. Evaluation of conformity of preformed orthodontic arch-wires and dental arch form. Dent Press J Orthod. 2019;24(1):44-52.
8. Sharaf RF, Radwan E, Salem GA, Abou El-yazeed M. Dental arch form and arch dimensions among a group of Egyptian children and adolescents. Bull Natl Res Cent. 2022;46:201.
9. Kulsoom T, Faisal SS, Hussain SS. Evaluation of curve of spee among patients seeking orthodontic treatment in a tertiary care hospital. Pak Oral Dental J. 2018;38(3):324-326.
10. Oliva B, et al. (you'll need full author list) Differences in upper and lower transversal and longitudinal diameters between male and female patients in Italian sample. Prog Orthod. 2018;19:34.
11. Al-Dulaimy DA, Al-Khannaq MR, Nahidh M, Marrapodi MM, Cervino G, Cicciù M, Minervini G. Assessment of dental arch forms in a sample of children. J Clin Pediatr Dent. 2023;47(5):51-56.
12. Olkun HK, Borzabadi-Farahani A, Uçkan S. Orthognathic surgery treatment need in a Turkish adult population: a retrospective study. Int. J. Environ. Res. Public Health. 2019;16(11):1881.
13. Anwar N, Fidda M. Variability of arch forms in various vertical facial patterns. J Coll Physicians Surg Pak. 2010; 20(9) : 565-570.
14. Al-Dulaimy DA, Al-Khannaq MR, Nahidh M, Marrapodi MM, Cervino G, Cicciù M, Minervini G. Assessment of dental arch forms in a sample of children. J Clin Pediatr Dent. 2023;47(5):51–56.
15. Luo J, Liu T, Wang Y, et al. The association between dental and dentoalveolar arch forms of children with normal occlusion and malocclusion: a cross-sectional study. BMC Oral Health. 2024;24:731.
16. Nojima K, McLaughlin RP, Isshiki Y, Sinclair PM. A comparative study of Caucasian and Japanese mandibular clinical arch forms. Angle Orthod. 2001;71(3):195–200.
17. Nguyen T, Jackson T. 3D technologies for precision in orthodontics. InSeminars in Orthodontics 2018 Dec 1 (Vol. 24, No. 4, pp. 386-392). WB Saunders.

18. Kulsoom T, Faisal SS, Hussain SS. Radius of curve of spee in patients referring to the orthodontic department of tertiary care hospital. Pakistan Oral & Dental Journal. 2021;41(2):67-69.
19. Ashfaq M, Faisal SS, Rizwan S, Hussain SS. Mean Mesiodistal Width Determination of Canines in Patients Reporting to a Tertiary Care Hospital at Karachi. Ann. Abbasi Shaheed Hosp. Karachi Med. Dent. Coll. 2020;25(01):16-21.
20. Mahmood B, Hassan B. Three dimensional analysis of dental arch form and dimensions in a sample of Kurdish students in Hawler Medical University. Erbil Dental Journal. 2023;6(1):1–9.
21. Olmez S, Dogan S. Comparison of the arch forms and dimensions in various malocclusions of the Turkish population. Open Journal of Stomatology. 2011;1(4):158-164.
22. Hassan AH, Asad S, Iqbal T, Muneer M. Frequency distribution of arch forms in a sample of Pakistani population. Pak Oral Dent J. 2011;31(1):120–123
23. Al-Rumman N, Mohammed HA, Al-Attar MH, Al-Khayat A, Al-Khawaja NF. Mandibular clinical arch forms in Iraqi population: a national survey. Diagnostics (Basel). 2022;12(10):2352.
24. Rehman SA, Rizwan S, Faisal SS, Hussain SS. Association between intercanine width and mandibular dental arch forms. J Coll Physicians Surg Pak. 2021;30(4):478-480.