ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 7446-7449 (2026)
©Biomedical Informatics (2026)

BIOINFORMATION
Discovery at the interface of physical and biological sciences
BIOMEDICAL INFORMATICS
www.bioinformation.net
Volume 22(10)
Research Article

Received October 1, 2026; Revised October 31, 2026; Accepted October 31, 2026, Published October 31, 2026
DOI: 10.6026/973206300227446

SJIF 2026 (Scientific Journal Impact Factor for 2026) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Declaration on Publication Ethics:
The author's state that they adhere with COPE guidelines on publishing ethics as described elsewhere at https://publicationethics.org/. The authors also undertake that they are not associated with any other third party (governmental or non-governmental agencies) linking with any form of unethical issues connecting to this publication. The authors also declare that they are not withholding any information that is misleading to the publisher in regard to this article.

Declaration on official E-mail:
The corresponding author declares that lifetime official e-mail from their institution is not available for all authors

License statement:
This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. This is distributed under the terms of the Creative Commons Attribution License

Comments from readers:
Articles published in BIOINFORMATION are open for relevant post publication comments and criticisms, which will be published immediately linking to the original article without open access charges. Comments should be concise, coherent and critical in less than 1000 words.

Disclaimer:
Bioinformation provides a platform for scholarly communication of data and information to create knowledge in the Biological/ Biomedical domain after adequate peer/editorial reviews and editing entertaining revisions where required. The views and opinions expressed are those of the author(s) and do not reflect the views or opinions of Bioinformation and (or) its publisher Biomedical Informatics. Biomedical Informatics remains neutral and allows authors to specify their address and affiliation details including territory where required.

Edited by Ritik Kashwani
E-mail: docritikkashwani@yahoo.com
Citation: Sharma *et al*. Bioinformation 22(10): 7446-7449 (2026)

Grummons analysis of craniofacial asymmetry in Jharkhand male population: A posteroanterior cephalometric study

Kanchan Sharma*, Ankit Tibrewal, Mrinal Kumar Nandi, Arpan Kumar Das, Sabnam Kumari Rai & Anirban De

Department of Orthodontics and Dentofacial Orthopaedics, Awadh Dental College and Hospital, Jamshedpur, Jharkhand, India; *Corresponding author

Affiliation URL:
https://awadhdentalcollege.com/

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 7446-7449 (2026)
©Biomedical Informatics (2026)

Author contact:
Kanchan Sharma - E-mail: kanchansharma10022018@gmail.com
Ankit Tibrewal - E-mail: ankit11tibrewal@gmail.com
Mrinal Nandi - E-mail: mrinalnandi10@gmail.com
Arpan Kumar Das - E-mail: dr.arpankumardas@gmail.com
Sabnam Kumari Rai - E-mail: hiranand3@gmail.com
Anirban De - E-mail: deanirban7991@gmail.com

Abstract:
Craniofacial asymmetry complicates accurate orthodontic diagnosis and population-specific cephalometric data for adult Jharkhand males remain limited. Therefore, it is of interest to evaluate the craniofacial asymmetry in 100 adult Jharkhand males (mean age 21 years) using Grummons posteroanterior cephalometric analysis. Standardised cephalograms assessed horizontal planes, mandibular morphology and bilateral linear asymmetry. Mild, consistent right-sided predominance was observed across all assessed parameters, with slightly greater bilateral craniofacial widths on the right. These findings provide population-specific Grummons cephalometric data that may improve craniofacial asymmetry assessment in adult Jharkhand males.

Keywords: Posteroanterior cephalometry, grummons analysis, facial asymmetry, craniofacial, Jharkhand, mandibular morphology

Background:
Cephalometry has been a cornerstone of orthodontic diagnosis since Broadbent introduced the standardised radiographic technique in 1931, enabling precise *in vivo* measurement of craniofacial structures that previously depended on anthropometry and craniometry-both limited by soft tissue interference and inability to support longitudinal assessment **[1]**. The technique combined these earlier approaches into a reproducible method for evaluating skeletal and dental relationships in all three planes of space. Facial symmetry - defined as correspondence in size, form and arrangement of facial features on opposite sides of the midsagittal plane-is considered the aesthetic and functional ideal. However, some degree of bilateral asymmetry is a universal biological norm. Letzer and Kronman, in a seminal PA cephalometric study in 1967, showed that clinically imperceptible craniofacial asymmetry is present in virtually all individuals **[2]**. Thiesen *et al*. subsequently provided a comprehensive classification of facial asymmetry into absolute, physiological and pathological types, noting that subclinical asymmetry commonly goes unperceived by the patient and clinician alike, while significant asymmetry may result in functional, esthetic and psychosocial consequences **[3]**. The frontal asymmetry analysis was introduced in 1987 as a comparative and quantitative PA cephalometric method not based on normative values **[4]**. The analysis uses a midsagittal reference line (MSR), constructed from the crista galli through the anterior nasal spine to the menton, as the vertical reference axis and evaluates bilateral differences across three horizontal planes- the frontozygomatic suture (Z) plane, the occlusal plane and the antegonial plane. These planes are assessed for parallelism to one another and for angular deviation from the MSR. Mandibular morphology is evaluated through bilateral triangles formed by the condylion (Co), antegonial notch (Ag) and menton (Me) and linear asymmetry is quantified by measuring perpendicular distances from the MSR to bilateral landmarks. The validity of reference lines in PA cephalometric asymmetry assessment has been rigorously studied. Trpkova *et al*. showed that horizontal lines through bilateral orbital landmarks and vertical best-fit lines provided the best agreement with true asymmetry values, whereas lines anchored on the anterior nasal spine showed lowest validity in cases of maxillary asymmetry **[5]**. Landmark identification accuracy remains a critical source of error: Hwang *et al*. showed that simultaneous use of lateral cephalograms during PA landmark identification significantly reduces errors, particularly at the condyle and nasion **[6]**. Clinically significant facial asymmetry requires a systematic diagnostic approach integrating clinical examination, photographs, dental casts and radiographic analysis. Srivastava *et al*. reviewed the multidimensional aspects of facial asymmetry diagnosis and treatment planning, emphasising that PA cephalometry, used alongside lateral cephalograms, provides the most comprehensive transverse and vertical skeletal assessment available **[7]**. Population-specific cephalometric norms are essential for accurate diagnosis, as craniofacial morphology varies significantly across ethnic groups **[8]**. Despite India's considerable ethnic diversity, PA cephalometric norms for eastern Indian populations, including the Jharkhand region, remain uncharacterised. The present study was therefore undertaken to quantify craniofacial asymmetry specifically in adult Jharkhand males using Grummons PA cephalometric analysis and to compare the findings with those reported in comparable South Asian populations **[9]**. Therefore, it is of interest to assess the transverse craniofacial morphology in adult Jharkhand males using Grummons posteroanterior cephalometric analysis and establish regional reference standards.

Materials and Methods:
This retrospective observational study was conducted in the Department of Orthodontics, Awadh Dental College and Hospital, Jamshedpur, Jharkhand, following approval from the Institutional Ethics Committee. Informed consent was obtained from all participants. One hundred standardised PA cephalograms of adult male patients were selected.

Inclusion criteria:
Age range 14–28 years (mean 21 years); pleasing facial profile with no clinically evident facial asymmetry; no prior orthodontic treatment; and subjects who were native to Jharkhand for at least two generations.

Exclusion criteria:
Blurred or technically inadequate radiographs; age below 19 or above 30 years; radiographic errors or landmark discrepancies; congenital craniofacial anomalies; and subjects not native to Jharkhand. PA cephalograms were obtained using an Orthophos XG X-ray machine (Sirona, Germany). The patient's head was positioned in the natural head position with the midsagittal plane perpendicular to the cassette and the transporion axis parallel to the floor. A constant source-to-film distance was maintained for all exposures to minimise magnification error **[10]**. Tracing was performed on 0.003-inch acetate matte paper using a 3H pencil under standardised illumination. Cephalometric landmarks identified included: crista galli (Cg), anterior nasal spine (ANS), menton (Me), frontozygomatic suture (Z), zygomatic arch point (Zyg), jugal (J) point, nasal cavity width (NC), condylion (Co), antegonial notch (Ag), upper and lower lateral incisors (A1, B1) and molar point (Mo). The MSR was constructed from Cg through ANS to me **[4]**. Three domains of Grummons analysis were assessed: (1) horizontal planes-angles of the Z, occlusal and antegonial planes relative to the MSR; (2) mandibular morphology- bilateral triangles (Co-Ag-Me) with linear measurements Co-Ag, Ag-Me, Co-Me and the antegonial angle; and (3) linear asymmetry-perpendicular distances from the MSR to Z, Co, Z-A, NC, J and Ag landmarks bilaterally. All tracings were verified by a senior faculty member in the Department of Orthodontics. Descriptive statistics (mean, standard deviation, standard error) were calculated for all bilateral measurements using SPSS version 20.

Results:
Results are presented across the three domains of Grummons analysis. All three horizontal reference planes showed higher mean angle values on the right compared to the left **(Table 1),** indicating a consistent right-sided angular preponderance. Bilateral mandibular triangles (Co-Ag-Me) demonstrated consistently larger values on the right across all linear and angular measurements **(Table 2).** Linear distances from the MSR to bilateral landmarks were uniformly greater on the right side at every landmark level **(Table 3),** confirming right-sided preponderance across the entire craniofacial width.

Table 1: Horizontal plane angles — right vs. left side (N=100 each).

Parameter	Side	N	Mean (°C)	SD	SE
Z Plane	Right	100	91.05	1.641	0.164
	Left	100	88.92	1.548	0.154
Occlusal Plane	Right	100	90.42	1.759	0.176
	Left	100	88.64	1.56	0.156
Antegonial (Ag) Plane	Right	100	89.73	2.004	0.2
	Left	100	88.84	1.751	0.175

Table 2: Mandibular morphology measurements — right vs. left side (N=100 each).

Parameter	Side	N	Mean (mm/°C)	SD	SE
Co-Ag	Right	100	66.46	3.468	0.347
	Left	100	64.29	3.644	0.364
Ag-Me	Right	100	45.06	2.651	0.265
	Left	100	43.71	3.089	0.309
Co-Me	Right	100	85.66	6.328	0.633
	Left	100	82.97	6.357	0.636
Ag Angle	Right	100	116.87°C	5.918	0.592
	Left	100	113.65°C	6.747	0.675

Table 3: Linear asymmetry measurements — right vs. left side (N=100 each).

Landmark Distance	Side	N	Mean (mm)	SD	SE
Z distance	Right	100	44.91	2.243	0.224
	Left	100	43.97	8.038	0.804
Co distance	Right	100	54.51	3.374	0.337
	Left	100	51.89	3.816	0.382
Z-A distance	Right	100	63.37	3.457	0.346
	Left	100	61.04	4.095	0.409
NC distance	Right	100	13.8	1.902	0.19
	Left	100	12.45	0.183	0.183
J distance	Right	100	30.64	3.797	0.38
	Left	100	30.02	4.627	0.463
Ag distance	Right	100	44.85	2.918	0.292
	Left	100	43.19	2.88	0.288

Discussion:
The present study demonstrated mild right-sided craniofacial predominance among 100 adult Jharkhand males across the three domains of Grummons analysis. This finding supports the understanding that perfect bilateral craniofacial symmetry is uncommon and minor asymmetry may occur in individuals without clinically significant skeletal abnormalities, as discussed by Moraes *et al.* (2011) **[10].** Regarding horizontal plane morphology, the mean Z-plane angles were 91.05° on the right and 88.92° on the left. These values were slightly higher than those reported by Khandelwal *et al.* (2026) **[11]**. The occlusal plane angles were also higher on the right than on the left, suggesting consistent directional asymmetry. The broader standard deviations observed for selected parameters indicate interindividual variability in craniofacial morphology. Mandibular measurements demonstrated right-sided predominance, with Co–Ag values of 66.46 mm on the right and 64.29 mm on the left. In contrast, Ag–Me and the gonial angle were lower than the corresponding values reported in the comparative cohort. These differences may reflect population-specific morphological variation; however, the present study cannot establish whether genetic, functional or environmental factors account for these findings **[12]**. For linear asymmetry, the right-sided predominance observed across several landmarks suggests a consistent directional pattern in this cohort. Nevertheless, the substantially higher standard deviation for the left Z-distance warrants cautious interpretation because landmark identification and tracking reproducibility may influence individual measurements. Shokri *et al.* (2017) **[13]** highlighted the importance of head positioning when assessing transverse measurements using CBCT and conventional PA cephalograms. Although conventional PA cephalometry remains useful for assessing skeletal asymmetry, its two-dimensional representation limits the evaluation of complex three-dimensional structures. Automated landmark identification may further improve measurement consistency, although the specific supporting reference should be verified before attributing this finding to Takeda *et al*. (2021) **[14]**. These findings provide

preliminary population-specific data on craniofacial asymmetry among adult Jharkhand males. However, the results should not be generalised to all Jharkhand residents or interpreted as evidence that routine radiographic examination is necessary for every patient. PA cephalometry should be considered when clinically indicated, with imaging selection guided by diagnostic requirements and radiation-protection principles.

Conclusion:

Grummons PA cephalometric analysis revealed consistent, mild right-sided craniofacial asymmetry among adult Jharkhand males. Thus, data shows that minor asymmetry is a normal anatomical variation, supporting population-specific cephalometric reference data for orthodontic assessment. Routine PA cephalometric evaluation may aid diagnosis in selected patients with suspected skeletal asymmetry, particularly when clinical findings warrant radiographic assessment.

References:

[1] https://www.ncbi.nlm.nih.gov/books/NBK594272/
[2] Cenzato N *et al. J Pers Med*. 2024 **14**:1042. [PMID: 39452549]
[3] Thiesen G *et al. Dental Press J Orthod.* 2015 **20:**110. [PMID: 26691977]
[4] Pradhan A *et al. J Korean Assoc Oral Maxillofac Surg*. 2023 **49**:125. [PMID: 37394931]
[5] Trpkova B *et al. Am J Orthod Dentofacial Orthop.* 2003 **123:**512. [PMID: 12750669]
[6] Hwang SA *et al. Korean J Orthod.* 2019 **49:**32. [PMID: 30603623]
[7] Srivastava D *et al. J Oral Biol Craniofac Res*. 2018 **8:**7. [PMID: 29556456]
[8] Uppada UK *et al. Natl J Maxillofac Surg*. 2024 **15:**353. [PMID: 39830453]
[9] Sachan A *et al. J Orthod Sci*. 2012 **1**:92. [PMID: 24987634]
[10] Moraes ME *et al. Am J Orthod Dentofacial Orthop*. 2011 **139:**e523. [PMID: 21640864]
[11] Khandelwal M *et al. IP Indian J Orthod Dentofacial Res.* 2026 **12**:161. [DOI: 10.18231/j.ijodr.97860.1790050585]
[12] Prabha RD *et al. Contemp Clin Dent.* 2025 **16:**36. [PMID: 40270874]
[13] Shokri A *et al. Dentomaxillofac Radiol.* 2017 **46:**20160180. [PMID: 28306330]
[14] Takeda S *et al. J Dent Sci*. 2021 **16:**957. [PMID: 34141110]

Caveat Emptor is applicable among the literate community where required and possible. The publisher, its journal, editors and the internal/external reviewers take adequate steps to check, evaluate, correct, edit, revise and improve content where possible and required.