# **Supplemental Information**

# **A Systematic Review and Meta-analysis on Bolton's ratios: Part I - Normoclusion**

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# **Legends**

# **Table S1.** PRISMA 2009 Checklist.

# **Table S2.** List of potentially relevant studies not included in the systematic review, along with the reasons for exclusion.

# **Table S3.** Quality assessment according to STROBE Statement.

# **Figure S4.** Forest plot of studies with OR mean values comparing between male and female for normoclusion patients.

# **Figure S5.** Forest plot of studies with AR mean values comparing between male and female for normoclusion patients.

# **Figure S6.** Continent subgroup forest plot of studies with OR mean values comparing between male and female for normoclusion patients.

# **Figure S7.** Continent subgroup forest plot of studies with AR mean values comparing between male and female for normoclusion patients.

# **Figure S8.** Funnel plot of OR and AR studies.

# **Table S9.** Random-effect meta-regressions.

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# **Table S1.** PRISMA 2009 Checklist.

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| **Section/topic** | **#** | **Checklist item** | **Reported on page #** |
| **TITLE** | | |  |
| Title | 1 | Identify the report as a systematic review, meta-analysis, or both. | 1 |
| **ABSTRACT** | | |  |
| Structured summary | 2 | Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number. | 2 |
| **INTRODUCTION** | | |  |
| Rationale | 3 | Describe the rationale for the review in the context of what is already known. |  |
| Objectives | 4 | Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS). |  |
| **METHODS** | | |  |
| Protocol and registration | 5 | Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number. |  |
| Eligibility criteria | 6 | Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale. |  |
| Information sources | 7 | Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched. |  |
| Search | 8 | Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated. |  |
| Study selection | 9 | State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis). |  |
| Data collection process | 10 | Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators. |  |
| Data items | 11 | List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made. |  |
| Risk of bias in individual studies | 12 | Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis. |  |
| Summary measures | 13 | State the principal summary measures (e.g., risk ratio, difference in means). |  |
| Synthesis of results | 14 | Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I2) for each meta-analysis. |  |

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| **Section/topic** | **#** | **Checklist item** | **Reported on page #** |
| Risk of bias across studies | 15 | Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies). |  |
| Additional analyses | 16 | Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified. |  |
| **RESULTS** | | |  |
| Study selection | 17 | Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram. |  |
| Study characteristics | 18 | For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations. |  |
| Risk of bias within studies | 19 | Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). |  |
| Results of individual studies | 20 | For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot. |  |
| Synthesis of results | 21 | Present results of each meta-analysis done, including confidence intervals and measures of consistency. |  |
| Risk of bias across studies | 22 | Present results of any assessment of risk of bias across studies (see Item 15). |  |
| Additional analysis | 23 | Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]). |  |
| **DISCUSSION** | | |  |
| Summary of evidence | 24 | Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers). |  |
| Limitations | 25 | Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias). |  |
| Conclusions | 26 | Provide a general interpretation of the results in the context of other evidence, and implications for future research. |  |
| **FUNDING** | | |  |
| Funding | 27 | Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review. |  |

*From:*  Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: **www.prisma-statement.org**.

# Table S2. List of potentially relevant studies not included in the systematic review, along with the reasons for exclusion.

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|  | **Reference** | **Reason for exclusion** |
| 1 | Das PJ, et al. An evaluation of dental crowding in relation to the mesiodistal crown widths and arch dimensions in southern Indian population. J. Clin. Diagnostic Res. 2017;11(9):TC10-TC13. | No Bolton’s index analyses |
| 2 | Varghese ST, et al. Outcome of premolar extractions on Bolton’s overall ratio and tooth size discrepancies in South India. J. Int. Soc. Prev. Community Dent. 2016;6(4):309–15. | No Bolton’s index analyses |
| 3 | Kim J, et al. Accuracy of bolton analysis measured in laser scanned digital models compared with plaster models (Gold standard) and cone-beam computer tomography images. Korean J. Orthod. 2016;46(1):13–9. | No Bolton’s index analyses |
| 4 | O’Mahony G, et al. The relationship between tooth size discrepancy and archform classification in orthodontic patients. J. Clin. Exp. Dent. 2015;7(2):e268–72. | No Bolton’s index analyses |
| 5 | Khanna R, et al. Effect of intermaxillary tooth-size discrepancy on accuracy of prediction equations for mixed dentition space analysis. Eur. Arch. Paediatr. Dent. 2015;16(2):211–7. | No Bolton’s index analyses |
| 6 | Correia GDC, et al. Tooth-size discrepancy: A comparison between manual and digital methods. Dental Press J. Orthod. 2014;19(4):107–13. | No Bolton’s index analyses |
| 7 | Kaihara Y, et al. Comparative analyses of paediatric dental measurements using plaster and three-dimensional digital models. Eur. J. Paediatr. Dent. 2014;15(1):137–42. | No Bolton’s index analyses |
| 8 | Nalcaci R, et al. Comparison of Bolton analysis and tooth size measurements obtained using conventional and three-dimensional orthodontic models. Eur. J. Dent. 2013;7(5 SUPPL.):66–70. | No Bolton’s index analyses |
| 9 | Safavi SM, et al. Evaluation of Mandibular Incisor Extraction Treatment Outcome in Patients with Bolton Discrepancy Using Peer Assessment Rating Index. J. Dent. (Tehran). 2012;9(1):27. | No Bolton’s index analyses |
| 10 | Filipović G, et al. Analysis of interjaw ratios in relation to permanent tooth size in subjects with class I malocclusion. Med Pregl. 2010 May-Jun;63(5-6):343-8. | Not in English |
| 11 | Naidu D, et al. Validity, reliability and reproducibility of three methods used to measure tooth widths for bolton analyses. Aust Orthod J. 2009 Nov;25(2):97-103. | No Bolton’s index analyses |
| 12 | Uysal T, et al. New regression equations for mixed-dentition arch analysis in a Turkish sample with no Bolton tooth-size discrepancy. Am J Orthod Dentofacial Orthop. 2009 Mar;135(3):343-8. | Mixed dentition |
| 13 | Al-Nimri, et al. Tooth size discrepancies in female patients with palatally impacted canines. Aust Orthod J. 2008 Nov;24(2):129-33. | Palatally impacted canine |
| 14 | Ma QL, et al. Measurement of normal occlusion models from healthy Yizu persons in Yunnan province. Shanghai Kou Qiang Yi Xue. 2008 Apr;17(2):125-8. | Not in English |
| 15 | Othman SA, et al. Tooth-size discrepancy and Bolton's ratios: the reproducibility and speed of two methods of measurement. J Orthod. 2007 Dec;34(4):234-42; discussion 233. | No Sagittal Classification |
| 16 | Anderson AA. Dentition and occlusion development in African American children: mesiodistal crown diameters and tooth-size ratios of primary teeth. Pediatr Dent. 2005 Mar-Apr;27(2):121-8. | Primary dentition |
| 17 | Tong H, et al. The effect of premolar extractions on tooth size discrepancies. Angle Orthod. 2004 Aug;74(4):508-11. | No Bolton’s index analyses |
| 18 | Motoashi K, et al. The clinical application of tooth-size ratios. Nihon Kyosei Shika Gakkai Zasshi. 1971;30(2):270-82. | Not in English |
| 19 | Barra J. Tooth Size Ratio in Orthodontic Patients with Varied Sagittal Skeletal Patterns; A CBCT Study. Thesis. | Post-treatment orthodontic models |
| 20 | Saini C, et al. Comparison of tooth size discrepancy in Angle's class I and class II malocclusion in Rajasthani population. J Orthod Res. 2015;3(2):92-95. | Manual Calliper |
| 21 | Daniela ASM, et al. Análisis de Bolton en modelos de pacientes y relación con las diferentes Maloclusiones. Revista Latinoamericana de Ortodoncia y Odontopediatría. 2014; | Not in English |
| 22 | Gurdán Z, et al. Examining Tooth-size Discrepancies in Regard to Treatment, Treatment Planning and Completion. Open Journal of Dentistry and Oral Medicine. 2014;2(3):43-46. | No Sagittal Classification |
| 23 | Aldrees AM, et al. Is arch form influenced by sagittal molar relationship or Bolton tooth-size discrepancy? BMC Oral Health. 2015 Jun 26;15:70. | No Bolton’s index analyses |
| 24 | Kumar P, et al. Effects of premolar extractions on Bolton overall ratios and tooth-size discrepancies in a north Indian population. J Orthod Sci. 2013 Jan;2(1):23-7. | No Bolton’s index analyses |
| 25 | Ebadifar A, et al. Comparison of Bolton’s Ratios before and after Treatment in an Iranian Population. J Dent Res Dent Clin Dent Prospect 2013;7(1):30-35. | Post-treatment orthodontic models |
| 26 | Di Leonardo B, et al. Clinical Implication of a Bolton Index Reappraisal. European Journal of Orthodontics. 2012;34(5):Pages e12–e13. | Absence of measure methodology |
| 27 | Khan R, et al. Evaluation of Tooth Size Discrepancies among Different  Malocclusion Groups In Sirte. IOSR-JDMS. 2013;6(5):15-18. | Manual Calliper |
| 28 | Tayyab M, et al. Bolton Discrepancies among different classes of Malocclusion in Peshawar population. PODJ. 2014;34(4):647-650. | Manual Calliper |
| 29 | Mushtaq N. Mesiodistal Crown Dimensions and Bolton ratio in the Khan Research Laboratories Employees and their Families. Pakistan Oral & Dental Journal. 2012;32(1). | Impossible to have access |
| 30 | Neamah ZT. The Clinical application of Tooth Size Analysis among Different  Malocclusion Groups (A Cross Sectional, Comparative, Cephalometric Study). Medical Journal of Babylon. 2012;9(4).764-71. | Manual Calliper |
| 31 | Alam MK, et al. Human Mesiodistal Tooth Width Measurements and Comparison with Dental Cast in a Bangladeshi Population. The journal of contemporary dental practice 16(4):299-303 | No Bolton’s index analyses |
| 32 | Ruping L, et al. Measurement study on Bolton Index of Mongolia normal occlusion in Hohhot. MJITCWM. 2011;21. | Not in English |
| 33 | Singh S, et al. Bolton ratios in a sample of black South Africans. SADJ. 2011;66(7):336-9. | Impossible to have access |
| 34 | Doodamani GM, et al. Assessment of crown angulations, crown inclinations, and tooth size discrepancies in a South Indian population. Contemp Clin Dent. 2011;2:176-81. | Manual Calliper |
| 35 | Xue-Yan B, et al. Detection of Bolton Index for Angle Class III Malocclusion Patients. AAMQU. 2011;4. | Not in English |
| 36 | Xu L, et al. Study on tooth size discrepancies in Lanzhou patients with different malocclusion groups. CJAM. 2011;12. | Not in English |
| 37 | Khan SH, et al. Mesiodistal Crown Dimensions of Permanent Teeth in Bangladeshi Population. BSMMU J. 2011;4(2):81-87. | No Bolton’s index analyses |
| 38 | Ajayi EO. Bolton's ratios and tooth-size discrepancies in a Nigerian population. Nigerian Dental Journal. 2010;8(1). | Impossible to have access |
| 39 | Adeyemi AT, et al. Tooth size ratios of Nigerian and the applicability of Bolton's analysis. Odontostomatol Trop. 2010 Mar;33(129):5-10. | Impossible to have access |
| 40 | Watanabe-Kanno GA, et al. Determination of tooth-size discrepancy  and Bolton ratios using bibliocast Cecile3 digital models. International Orthodontics. 2010;8:215-226. | No Sagittal Classification |
| 41 | Yang CJ, et al. Bolton tooth-size discrepancy among different skeletal malocclusion groups. Shanghai journal of stomatology. 2009;18(3):251-4. | Not in English |
| 42 | Othman SA, et al. Bolton Tooth-Size Discrepancies Among University Of Malaya's Dental Students. Annals of dentistry. 2008;15(1):40-47. | No Bolton’s index analyses |
| 43 | Barnard MA. Bolton Discrepancy in a Selected Canadian Population. Thesis. | Post-treatment orthodontic models |
| 44 | Oueiss A, et al. Posterior tooth size discrepancy. J Dentofacial Anom Orthod 2008;11:8-22 | Post-treatment orthodontic models |
| 45 | Zhao HY, et al. Measurement and analysis of dentition index on normal occlusion in Harbin teenagers. Stomatoloy. 2008;12. | Not in English |
| 46 | Batool I, et al. Evaluation of tooth size discrepancy in different malocclusion groups. J Ayub Med Coll Abbottabad. 2008 Oct-Dec;20(4):51-4. | Manual Calliper |
| 47 | Pang XF, et al. Bolton Analysis of Different Malocclusion. Journal of Yunyang Medical College. 2005;1. | No Bolton’s index analyses |
| 48 | Lee SJ, et al. Tooth size and arch parameters of normal occlusion in a Iarge Korean sample. Korean J Orthod.. 2004;34: 473-480. | No Bolton’s index analyses |
| 49 | Huang M. A Study of Bolton Tooth-size Discrepancies of Malocclusion Patients. West China Journal of Stomatology. 2003;3. | No Bolton’s index analyses |
| 50 | Kim DS, et al. A study of Korean norm about tooth size and ratio in Korean adults with normal occlusion. Korean J Orthod. 2001 Oct;31(5):505-515. | No Bolton’s index analyses |
| 51 | Nourallaha AW, et al. Standardizing Interarch Tooth-Size Harmony in aSyrian Population. Angle Orthodontist. 2005;75(6):996:99. | Post-treatment orthodontic models |
| 52 | Smith SS, et al. Interarch tooth size relationships of 3 populations:“Does Bolton’s analysis apply?”. Am J Orthod. 2000;117(2):169-74. | No Bolton’s index analyses |
| 53 | Heusdens M, et al. The effect of tooth size discrepancy on occlusion: An experimental study. Am J Orthod. 2000;117(2):184-91. | No Bolton’s index analyses |
| 54 | Diop Ba K, et al. Données odontométriques : applicabilité de l'analyse de Bolton chez les Sénégalais. Orthod Fr 2007;78:257-264. | Not in english |
| 55 | Al-Tamimi T, et al. Bolton tooth-size ratio revisited. World J Orthod. 2005 Fall;6(3):289-95. | No Bolton’s index analyses |
| 56 | Binder RE, et al. Clinical evaluation of tooth-size discrepancy. J Clin Orthod. 1998 Sep;32(9):544-6. | No Bolton’s index analyses |
| 57 | Freeman JE, et al. Frequency of Bolton tooth-size discrepancies among orthodontic patients. Am J Orthod. 1996;110(1):24–27 | Vernier Calliper |
| 58 | Ho CT, et al. Clinical application of the graphical analysis of tooth width discrepancy. Aust Orthod J. 1994;13(3):137-43 | No Bolton’s index analyses |
| 59 | Murshid Z, et al. Mesiodistal tooth width in Saudi population. A preliminary report. Saudi Dent J. 1993;5(2):68-72 | No Bolton’s index analyses |
| 60 | Bishara SE, et al. Comparisons of mesiodistal and bnccolingnal crown dimensions of the permanent teeth in three populations from Egypt, Mexico, and the United States. Am J Orthod. 1989;96(5):416-22. | No Bolton’s index analyses |
| 61 | Manke M, et al. Size of the anterior Bolton Index and frequency of the Bolton discrepancy in the anterior tooth segment in untreated orthodontic patients. Fortschr Kieferorthop. 1983 Feb;44(1):59-65. | Not in english |
| 62 | Sperry TP, et al. Tooth-size discrepancy in mandibular prognathism. Am J Orthod. 1977 Aug;72(2):183-90. | No Bolton’s index analyses |
| 63 | Stifter J. A Study Of Pont's, Howes', Rees', Neff's And Bolton's Analyses On Class I Adult Dentitions\*. The Angle Orthodontist: October 1958;28(4):215-225. | No Bolton’s index analyses |
| 64 | Lundstrom A. Intermaxillary tooth width ratio and tooth alignment and occlusion. Acta odontol. Scandinav 1954;12:265-92. | No Bolton’s index analyses |
| 65 | Redahan S, et al. Orthodontic treatment outcome: the relationship between anterior dental relations and anterior inter-arch tooth size discrepancy. J Orthod. 2003 Sep;30(3):237-44. | Post-treatment orthodontic models |
| 66 | Ali AW, et al. A Study on Bolton Anterior Tooth Size Discrepancies among Different Malocclusion Groups. Bangladesh J Orthod and Dentofacial Orthopedics. 2011;2:1-4. | Absence of measure methodology |
| 67 | Al-Duliamy MJ, et al. Comparison of Bolton’s Ratios in a Sample of Iraqi and Egyptian Populations. Journal of baghdad college of dentistry. 2016;28(4), 172-175. | Absence of Normoclusion data |
| 68 | Omar H, et al. Dental arch dimensions, form and tooth size ratio among a Saudi sample. Saudi Med. J. 2018;39(1):86–91. | Absence of Normoclusion data |
| 69 | Queiroga J, et al. Prevalência da discrepância dento-dentária na população portuguesa. 2017;8:4–10 | Absence of Normoclusion data |
| 70 | Hashim H, et al. Bolton tooth size ratio among qatari population sample: An odontometric study. J. Orthod. Sci. 2017;6(1):22. | Absence of Normoclusion data |
| 71 | Jamal KM. Bolton Ratio in Different Groups of Malocclusions in Iraqi Population Key words Introduction : Materials and method : 2017;5:19–24. | Absence of Normoclusion data |
| 72 | Saritha T, et al. Applicability of Bolton’s Analysis to a South Telangana Population. Indian J. Dent. Sci. 2017;9(4):225–32. | Absence of Normoclusion data |
| 73 | Mahmoud NM, et al. Tooth Size Discrepancy among Different Malocclusion Groups in a Sudanese Sample. J. Orthod. Endod. 2017;3(2):2–7. | Absence of Normoclusion data |
| 74 | Patil G, et al. Assessment of Tip, Torque and Tooth Size Discrepancies In Angles Class II Division-2 Patients. Int. J. Contemp. Orthod. 2017;1(1):1–6. | Absence of Normoclusion data |
| 75 | Sayed ZIJI, et al The applicability of Bolton’s tooth size ratios for population‑specific malocclusion. Int. J. Orthod. Rehabil. 2017;8(1):136–40. | Absence of Normoclusion data |
| 76 | Elsheikhi F, el al. Tooth size discrepancy in a different malocclusion groups in Libya: a pilot study. Libyan Int. Med. Univ. J. 2017;2(2):92. | Absence of Normoclusion data |
| 77 | Islam R, et al. Morphometric Analysis of Tooth Size and its Relationship with BMI in Transgender Population: A New Exposure in Dentistry. J. Hard Tissue Biol. 2017;26(4):361–7. | Absence of Normoclusion data |
| 78 | Díaz RAA, el al. Bolton’s index efficacy with manual vs digital measurements. Rev. Mex. Ortod. 2016;4(1):e30–4. | Absence of Normoclusion data |
| 79 | Jan A, el al. Comparison of Bolton ratio between two ethnic groups reporting to armed forces institute of dentistry (AFID) Rawalpindi. Pakistan Armed Forces Med. J. 2016;66(1):75–8. | Absence of Normoclusion data |
| 80 | Hanna A, el al. Tooth-Size Discrepancies in Patients Requiring Mandibular Advancement Surgery. J. Oral Maxillofac. Surg. 2016;74(12):2481–6. | Absence of Normoclusion data |
| 81 | Cançado RH, el al. Association between Bolton discrepancy and Angle malocclusions. Braz Oral Res 2015;29(1):1–6. | Absence of Normoclusion data |
| 82 | Gomes AMB. Estudo da prevalência da discrepância anterior de Bolton numa população ortodôntica portuguesa. Univ. Fernando Pessoa 2015. | Absence of Normoclusion data |
| 83 | Shastri D, el al. Bolton ratio in a North Indian population with different malocclusions. J. Orthod. Sci. 2015;4(3):83. | Absence of Normoclusion data |
| 84 | Gaddam R, el al. Incidence of tooth size discrepancy in different malocclusion and relation to Incidence of Tooth Size Discrepancy in Different Groups of Malocclusion and its Relation to Extraction. J. Int. Oral Heal. J Int Oral Heal. 2015;77(July):48–5348. | Absence of Normoclusion data |
| 85 | Prasanna AL, el al. Evaluation and Comparison of Intermaxillary Tooth Size Discrepancy among Class I , Class II Division 1 , and Class III Subjects Using Bolton’s Analysis : An in vitro Study. J. Int. Oral Heal. 2015;7(9):58–64. | Absence of Normoclusion data |
| 86 | Kumar MS. Evaluation of Bolton’s Discrepancy in Un-treated Angles Class I Patients in Pondicherry population : A Cross-Sectional Study. J. Int. Oral Heal. 2015;7(October):86–9. | Absence of Normoclusion data |
| 87 | Hasija N, el al. Estimation of Tooth Size Discrepancies among Different Malocclusion Groups. Int J Clin Pediatr Dent 2014;7(2):82–5. | Absence of Normoclusion data |
| 88 | Maurya R, el al. Seventh key of occlusion: Diagnostic significance in different angle′s class I, II and III malocclusions. J. Orthod. Res. 2015;3(3):188–91. | Absence of Normoclusion data |
| 89 | Gorjizadeh F, el al. Analyzing Mesiodistal Widths of the Permanent Teeth. Iran. J. Orthod. 2015;10(2):1–5. | Absence of Normoclusion data |
| 90 | Rahman A, el al. Analysis of Tooth Size Discrepancy (Bolton Ratio) among Orthodontic Patients at Combined Military Hospital (CMH), Dhaka. Int. Med. J. 2014;21(1):38–40. | Absence of Normoclusion data |
| 91 | Alam MK, el al. Bolton tooth size ratio and its relation with arch widths, arch length and arch perimeter: a cone beam computed tomography (CBCT) study. Acta Odontol. Scand. 2014;72(8):1047–53. | Absence of Normoclusion data |
| 92 | Zerouaoui MF, el al. Study of variations of the Bolton index in the Moroccan population depending on angle malocclusion class. Int. Orthod. 2014;12(2):213–21. | Absence of Normoclusion data |
| 93 | McSwiney TP, el al. Tooth size discrepancies in Class II division 1 and Class III malocclusion requiring surgical-orthodontic or orthodontic treatment. J. Orthod. 2014;41(2):118–23. | Absence of Normoclusion data |
| 94 | Begum M, el al. Tooth size and arch parameter discrepancies among different malocclusions in young permanent dentition of 13-15-year-old school children of Nalgonda District-South Indian population. J. Orthod. Res. 2014;2(1):4–10. | Absence of Normoclusion data |
| 95 | Nagarathne N, el al. Tooth size discrepancy in a group of sri lankan ortodontic patients among different malocclusion groups. In: Proceedings of the Peradeniya Univ. International Research Sessions. 2014;18(2014):248. | Absence of Normoclusion data |
| 96 | Asma A. Comparison of anterior tooth size discrepancies among different malocclusion groups. Malaysian J. Med. Heal. Sci. 2013;9(1):73–9. | Absence of Normoclusion data |
| 97 | Hattab FN. Mesiodistal crown diameters and tooth size discrepancy of permanent dentition in thalassemic patients. J. Clin. Exp. Dent. 2013;5(5):239–44. | Absence of Normoclusion data |
| 98 | Alamir G. Revisiting Bolton Analysis Using American Board of Orthodontics Cast Models. 2013 | Absence of Normoclusion data |
| 99 | Alam MK, el al. Determination and comparison of tooth size and tooth size ration in normal occlusion and different malocclusion groups. Int. Med. J. 2013;20(4):462–5. | Absence of Normoclusion data |
| 100 | Jindal R, el al. Bolton ’ s intermaxillary tooth size ratios among school going children in Punjab population. Indian J. Oral Sci. 2013;4(3):110–3. | Absence of Normoclusion data |
| 101 | Trehan M, el al. Applicability of Bolton’s Analysis: A Study on Jaipur Population. Int J Clin Pediatr Dent 2012;5(2):113–7. | Absence of Normoclusion data |
| 102 | Rahman ANAA, el al. Comparison of tooth size discrepancy of three main ethnics in Malaysia with Bolton’s ratio. Sains Malaysiana 2012;41(2):271–5. | Absence of Normoclusion data |
| 103 | Al-Gunaid T, el al. Mesiodistal tooth width and tooth size discrepancies of Yemeni Arabians: A pilot study. J. Orthod. Sci. 2012;1(2):40. | Absence of Normoclusion data |
| 104 | Hyder M, el al. Tooth Size Discrepancies among Different Malocclusions in a Bangladeshi Orthodontic population. Bangladesh J. Orthod. Dentofac. Orthop. 2012;2(2):8–17. | Absence of Normoclusion data |
| 105 | Kansal A, el al. Analysis of Bolton’s ratio among different malocclusion groups: A hospital based study. Indian J. Dent. 2012;3(3):139–44. | Absence of Normoclusion data |
| 106 | Oyeyemi V-O, el al. Bolton tooth size analysis in a sample of Nigerian adolescents. Int. Dent. African Ed. 2013;3(3):32–9. | Absence of Normoclusion data |
| 107 | Ogodescu E, el al. Biomedical imaging for tooth size measurements in a sample of Romanian subjects. Recent Adv. Appl. Biomed. Informatics Comput. Eng. Syst. Appl. 2011:446–52. | Absence of Normoclusion data |
| 108 | Quraishi BA, el al. Frequency of Bolton tooth size discrepancies outside 2 standard deviation of the Bolton’s mean among orthodontic patients. J. pakistan Dent. Assoc. 2011;20(4):250–3. | Absence of Normoclusion data |
| 109 | Sharma R, el al. Prevalence of tooth size discrepancy among North Indian orthodontic patients. Contemp. Clin. Dent. 2011;2(3):170. | Absence of Normoclusion data |
| 110 | Johe RS, el al. Intermaxillary tooth-size discrepancies in different sexes, malocclusion groups, and ethnicities. Am. J. Orthod. Dentofac. Orthop. 2010;138(5):599–607. | Absence of Normoclusion data |
| 111 | O’Mahony G, el al. Tooth size discrepancies in Irish orthodontic patients among different malocclusion groups. Angle Orthod. 2011;81(1):130–3. | Absence of Normoclusion data |
| 112 | Paredes V, el al. Mesiodistal sizes and intermaxillary tooth-size ratios of two populations; Spanish and Peruvian. A comparative study. Med. Oral Patol. Oral Cir. Bucal 2011;16(4) | Absence of Normoclusion data |
| 113 | Vela E, el al. Differences in craniofacial and dental characteristics of adolescent Mexican Americans and European Americans. Am. J. Orthod. Dentofac. Orthop. 2011;140(6):839–47. | Absence of Normoclusion data |
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# **Table S3.** Quality assessment according to STROBE Statement.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Recommendation** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| **Title and abstract** | 1 | (a) Indicate the study’s design with a commonly used term in the title or the abstract | X | ✓ | X | X | X | X | X | X | ✓ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
|  | 2 | (b) Provide in the abstract an informative and balanced summary of what was done and what was found | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | X |
| **Background/rationale** | 3 | Explain the scientific background and rationale for the investigation being reported | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Objectives** | 4 | State specific objectives, including any prespecified hypotheses | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Study design** | 5 | Present key elements of study design early in the paper | ✓ | ✓ | ✓ | X | X | ✓ | X | X | X | ✓ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Setting** | 6 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | ✓ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | ✓ | X |
| **Participants** | 7 | (a) Give the eligibility criteria, and the sources and methods of selection of participants | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Variables** | 8 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Data sources/ measurement** |  | Sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods. | NA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Bias** | 9 | Describe any efforts to address potential sources of bias | ✓ | X | X | X | ✓ | ✓ | X | ✓ | ✓ | X | ✓ | X | ✓ | ✓ | X | ✓ | ✓ | X | X | ✓ | X | X | X | ✓ | ✓ | X | X | ✓ | ✓ | ✓ | X | ✓ |
| **Study size** | 10 | Explain how the study size was arrived at | ✓ | X | X | X | X | X | X | X | ✓ | ✓ | X | X | X | ✓ | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Quantitative variables** | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Statistical methods** | 12 | (a) Describe all statistical methods, including those used to control for confounding | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
|  | 13 | (b) Describe any methods used to examine subgroups and interactions | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
|  |  | (c) Explain how missing data were addressed | NA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | 14 | (d) If applicable, describe analytical methods taking account of sampling strategy | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
|  |  | (e) Describe any sensitivity analyses | NA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Participants** | 15 | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, and analysed | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
|  | (b) Give reasons for non-participation at each stage | NA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|  | (c) Consider use of a flow diagram | NA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Descriptive data** | 16 | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
|  |  | (b) Indicate number of participants with missing data for each variable of interest | NA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Outcome data** |  | Report numbers of outcome events or summary measures | NA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Main results** | 17 | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
|  | 18 | (b) Report category boundaries when continuous variables were categorized | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
|  |  | (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Other analyses** |  | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | NA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Key results** | 19 | Summarise key results with reference to study objectives | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Limitations** | 20 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | ✓ | X | X | X | X | ✓ | ✓ | X | ✓ | X | ✓ | X | X | X | X | X | X | X | ✓ | X | X | X | X | X | X | ✓ | X | X | X | X | X | X |
| **Interpretation** | 21 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Generalisability** | 22 | Discuss the generalisability (external validity) of the study results | ✓ | X | ✓ | ✓ | ✓ | ✓ | X | X | ✓ | X | X | ✓ | X | X | X | X | X | X | X | X | ✓ | X | ✓ | X | ✓ | X | ✓ | X | X | X | X | ✓ |
| **Funding** |  | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | NA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

NA – Not Applicable.

1 - Machado et al. (2018), 2 - Devi et al. (2017), 3 - Kumar et al. (2017), 4 - Patel et al. (2017), 5 - Sakoda et al. (2016), 6 - Shahid et al. (2016), 7 - Lombardo et al. (2016), 8 - Chugh et al. (2015), 9 - Bughaighis et al. (2015), 10 - Ismail et al. (2015), 11 - Hashim et al. (2015), 12 - Subbarao et al. (2014), 13 - Ricci et al. (2013), 14 - Celikoglu et al. (2013), 15 - Jóias et al. (2011), 16 - Fernandes et al. (2011), 17 - Manopatanakul et al. (2011), 18 - Kachoei et al. (2011), 19 - Lee et al. (2010), 20 - Oktay et al. (2010), 21 - Anil et al. (2010), 22 - Jóias et al. (2009), 23 - Mirzakouchaki et al. (2007), 24 - Freire et al. (2007), 25 - Endo et al. (2007), 26 - Poosti et al. (2007), 27 - Ciger et al. (2006), 28 - Carreiro et al. (2005), 29 - Uysal et al. (2005), 30 - Alkofide et al. (2002), 31 - Nie et al. (1999), 32 - Lavelle et al. (1972).

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# **Figure S4.** Forest plot of studies with OR mean values comparing between male and female for normal occlusion patients. Mean effect size estimates have been calculated with 95% confidence intervals and are shown in the figure. Area of squares represents sample size, continuous horizontal lines and diamonds width represents 95% confidence interval. Blue diamond center and the vertical red dotted line point to the overall pooled estimate.

# 

# **Figure S5.** Forest plot of studies with AR mean values comparing between male and female for normal occlusion patients. Mean effect size estimates have been calculated with 95% confidence intervals and are shown in the figure. Area of squares represents sample size, continuous horizontal lines and diamonds width represents 95% confidence interval. Blue diamond center and the vertical red dotted line point to the overall pooled estimate.

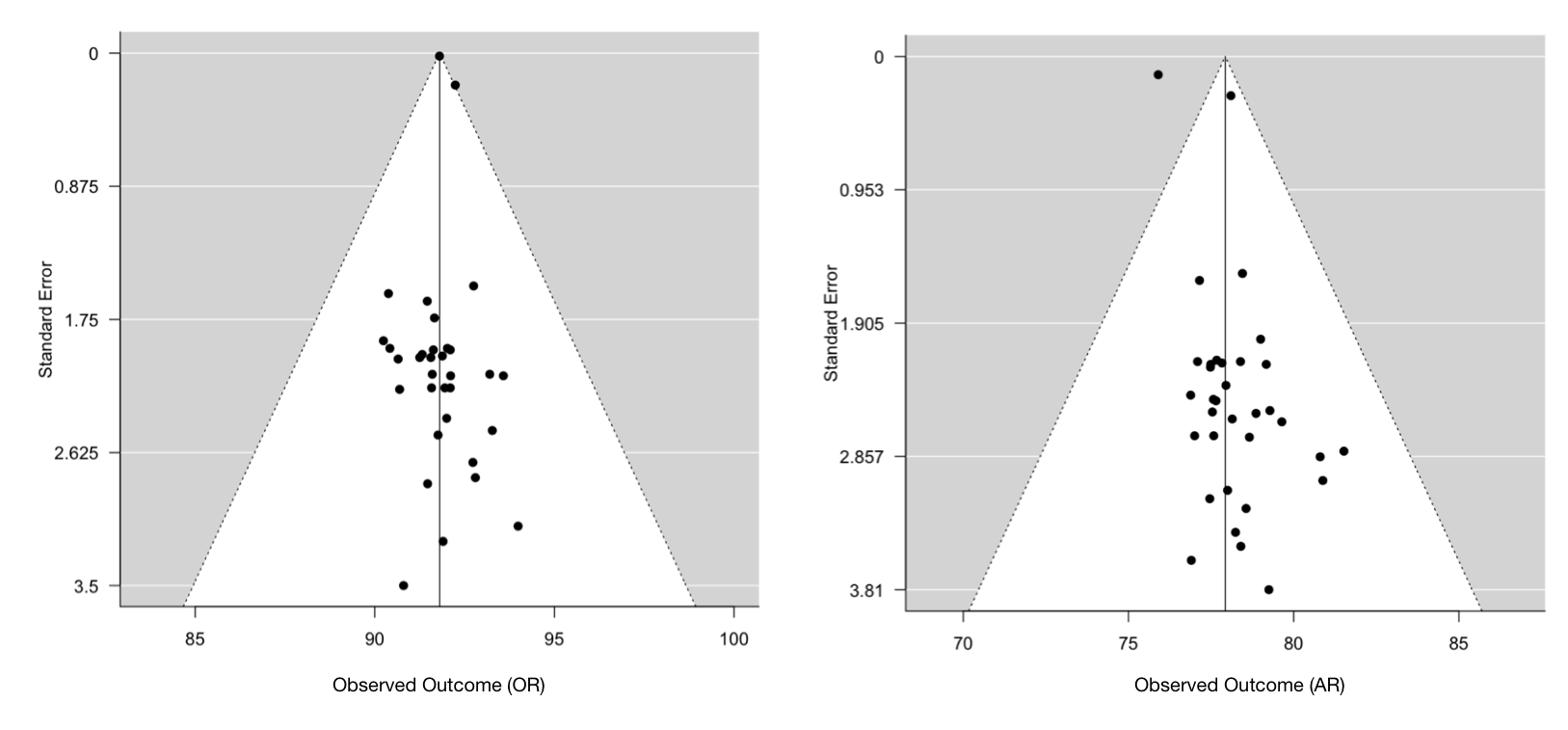
# 

# **Figure S6.** Continent subgroup forest plot of studies with OR mean values comparing between male and female for normal occlusion patients. Studies have been grouped according to the continent: Europe, Asia, America and Africa. Mean effect size estimates have been calculated with 95% confidence intervals and are shown in the figure. Area of squares represents sample size, continuous horizontal lines and diamonds width represents 95% confidence interval. Yellow diamonds center indicates the subgroup pooled estimates while the blue diamond center and the vertical red dotted line both point to the overall pooled estimate.

# 

# **Figure S7.** Continent subgroup forest plot of studies with AR mean values comparing between male and female for normal occlusion patients. Studies have been grouped according to the continent: Europe, Asia, America and Africa. Mean effect size estimates have been calculated with 95% confidence intervals and are shown in the figure. Area of squares represents sample size, continuous horizontal lines and diamonds width represents 95% confidence interval. Yellow diamonds center indicates the subgroup pooled estimates while the blue diamond center and the vertical red dotted line both point to the overall pooled estimate.

# **Figure S8.** Funnel plot of OR and AR means. The presence of a symmetrical funnel plot is consistent with absence of publication bias. OR - overall ratio; AR - anterior ratio.



# **Table S9.** Random-effect meta-regressions. No meaningful effect was found for latitude or longitude on anterior and overall ratios.

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Coefficients** | **95% IC** | **p-value** |
| **Total normoclusion patients – OR mean values** | | | |
| Latitude | 0.006 | (-0.005; 0.017) | 0.291 |
| Longitude | 0.004 | (-0.002; 0.009) | 0.162 |
| **Total normoclusion patients – AR mean values** | | | |
| Latitude | 0.009 | (-0.004; 0.023) | 0.169 |
| Longitude | 0.008 | (0.001; 0.014) | 0.016\* |
| **Normoclusion patients Male vs. Female – AR mean values** | | | |
| Latitude | -0.004 | (-0.013; 0.005) | 0.368 |
| Longitude | 0.001 | (-0.001; 0.005) | 0.755 |
| **Normoclusion patients Male vs. Female – OR mean values** | | | |
| Latitude | -0.004 | (-0.017; 0.010) | 0.586 |
| Longitude | -0.003 | (-0.009; 0.003) | 0.326 |

\*Omnibus p < 0.05