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# The craniofacial indicators of aggression: a cross-sectional multiparametric anthropometry study

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**The craniofacial indicators of aggression: a cross-sectional multiparametric anthropometry study**

Running head: The craniofacial shape and aggressive behavior

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**ABSTRACT**

The craniofacial features of a person are unique and critical in the evaluation of age, gender, and ethnicity. The relationship between craniofacial properties and behavioral patterns have been one of the most common research topics. There are studies on the association of facial width-to-height ratio (fWHR) and aggressive behavior in men; however, no consensus has been reached as there are inconsistent study results. Most of the studies focus on measuring the pre-determined fWHR in searching for a link to aggression. As the literature lacks data on the associations of multiple craniofacial ratios and aggression, we aimed to study the correlation of aggressive behavior and multiparametric anthropometric measurements of the craniofacial region in a study group consisting of university students aging 18-38 years. The aggression questionnaire results showed that male students had statistically higher scores than females in all subdomains, except physical aggression. Anthropometric studies revealed that males had higher mean values of craniofacial dimensions and indices than females, except the frontal height, the total lip height, frontal index, and cranial length-head circumference index. The statistical analyses for correlations showed that frontal, upper facial, and total facial height-facial width indices correlated with general and verbal aggression, frontal and upper facial indices correlated with physical aggression, and upper facial and total facial height-facial width indices correlated with indirect aggression only in males. We conclude that our study represents the first example of an extensive craniofacial anthropometric research that correlates several craniofacial measurements and ratios with various aggression subdomains.

**Key words: anthropometry, aggression, craniofacial, anatomy, behavior**

## INTRODUCTION

Every human being is unique in their craniofacial features that are closely related to the overall form and proportions of the body. The human craniofacial variations in different populations have long been an interesting topic for scientists. The environmental factors and evolutionary mechanisms that act on craniofacial features have been investigated by anthropologists, while the related databases are used routinely by forensic scientists, surgeons, dentists, and anatomists for diagnostic and therapeutic purposes. The information on the craniofacial dimensions is especially critical in evaluating the age, gender, and ethnic background of individuals [28].

Many craniofacial properties show dimorphism between sexes; for instance, males are known for the broader zygomatic region, supraorbital ridge, and prominent mandibula, while females have longer and narrower faces, rounder and broader foreheads, and thicker lips compared to males [24, 30]. In addition to the age, nutrition, biomechanical forces, the endocrine factors, especially pubertal sex hormones, have been established as the primary influencers of masculinization and feminization of craniofacial features [30]. The influence of pubertal testosterone was shown on facial width/lower facial height and cheekbone prominence decrease, and lower face height/full face height increase [16].

Apart from the dimorphism in craniofacial characteristics, males and females show dimorphism in some behavioral patterns, like aggression. When aggression is kept within normal limits, it provides and defends the required vital sources; however, its inappropriate manifestation can be harmful. Professionals dealing with aggressive behavior need to know its etiopathogenesis to provide optimal management strategies [35].

The research demonstrated that males, compared to females, display higher aggressive behavior under unprovoked conditions [3] and higher physical aggression in real-world settings [2, 13]. The link between craniofacial features and aggression has been studied extensively. The ratio of facial width to height (fWHR) is the most common measurement of masculinity related to aggression [1, 7, 12, 15, 27]. The relationship between fWHR and testosterone levels has been indicated in some research studies [7, 16, 22]. However, the results of other studies did not support the presence of such an association [4, 20, 27]. Moreover, the dimorphism of fWHR had also been questioned [21].

The reasons for those inconsistencies might range from sampling variations to the size of the study group, from ethnicity and socioeconomic status of the investigated population to the unstandardized measurement techniques used in anthropometric studies [26]. The measurement of fWHR as the sole anthropometric factor in most studies that investigate a link between facial features and aggression has also been considered to be responsible for inconsistent results [19]. To the best of our knowledge, the literature lacks data on correlation studies of aggression and multiple craniofacial features. Hence, we aimed to fill in this gap by designing a study that investigates the association of aggressive behavior and craniofacial features by using multiple anthropometric parameters in a large study population.

## MATERIALS AND METHODS

### Study group

This study was conducted on university students older than eighteen years. The sex distribution of participants showed that there were 156 female and 147 male subjects, aging 18-38 years, with a mean of 20.88 (SD:2.9) and 21.23 (SD:3.38) years for females and males, respectively. No statistically significant difference was observed between the mean age of females and males in the study (p >0.05). The presence of a history of surgery, trauma, and congenital abnormalities in the craniofacial region were considered as exclusion criteria. The study participants provided informed consent, and institutional ethics committee approval was obtained (Approval number: KA09/306).

## Study design and protocol

In this prospective cross-sectional study, the subjects who met the study criteria were evaluated by an adapted Turkish version of the "Aggression Questionnaire" [6] constructed originally by Buss and Perry [5]. The responses ranged on a scale of one to five points (e.g., "1 point" stood for "extremely uncharacteristic of me", and "5 points" stood for "extremely characteristic of me"). Five subdomains of aggressive behavior assessed by the questionnaire included physical and verbal aggression, indirect aggression, anger, and hostility. Cronbach's alpha for the five aggressiveness scores were as follows: physical aggression: 0.82, verbal aggression: 0.79, anger: 0.81, hostility: 0.75, indirect aggression: 0.87.

The anthropometric studies were performed on all participants. A weighing scale and an anthropometer were used for measuring weight and stature. Craniofacial anthropometric measurements carried out according to a previously described technique [18] and pre-determined craniofacial landmarks were taken twice to minimize operator-related and technical errors. A measuring tape, spreading, and sliding calipers were used as required in craniofacial measurements (Table 1).

The body mass index (BMI) of the subjects was determined by dividing the weight to the height squared. A total of eight craniofacial indices that were relevant to the study were derived from the craniofacial dimensions by formulas described previously [11]. The cranial indices calculated were cephalic index (C-I), the cranial length-head circumference index (CL-HC-I), and frontal index (F-I), while the facial indices consisted of total facial height-facial width index (TFH-FW-I), upper facial index (UF-I), mandible-facial width index (M-FW-I), nasal index (N-I), and total lip height-mouth width (TLH-MW-I) index.

**Statistical analysis**

Intraclass correlation coefficient analysis was performed to test the reliability of anthropometric measurements. The descriptive statistics were presented as the mean±standard deviation. The normal distribution of numerical variables was controlled by the Kolmogorov Smirnov test. Independent samples t-test was used for analyzing the results of anthropometric measurements and aggression scores concerning sex. The correlation among variables was assessed by using the Pearson Correlation Coefficient. Multiple regression model was used to evaluate the effect of craniofacial indices on the scores of aggression questionnaire. The statistical analyses were done by using Statistical Package for Social Sciences (SPSS Version 18.0; SPSS Inc. Chicago), and a p-value of or lower than 0.05 was considered significant.

**RESULTS**

The responses of participants to the aggression questionnaire were evaluated, and the mean scores of five aggression subdomains were calculated for each gender. The scores of aggressive behavior of female and male subjects were shown in Table II. In all subdomains, except in physical aggression, the scores of the male subjects were significantly higher than those of the females ($p<0.001$). Although the physical aggression scores of males (24.44±7.66) were higher than the females (18.41±7.17), it was not statistically significant ($p>0.05$). The mean of general aggression score of the male subjects was 25.86 ±4.96, while the females had a mean score of 22.90±5.55, and there was a statistically significant difference between males and females concerning general aggression scores ($p<0.001$).

The mean values of weight, stature, and BMI of males (75.69±12.94 kg, 174.93±59.75 cm, 24.69±3.66, respectively) were significantly higher than those of the females (58.67±9.03 kg, 162.2±57.82 cm, 22.28±3.04, respectively) ($p<0.001$) (Table II). The mean value of all cranial and facial anthropometric measurements was calculated and compared between genders. Except for the FH, all mean values of the cranial measurements were significantly higher in the male subjects than the females ($p<0.001$). Among the twelve facial anthropometrical measures, the mean value of the

TLH was similar in both genders (p: 0.991), while the remaining eleven measurements showed a statistically significantly higher value in male subjects compared to those in the females (p<0001). The distribution of mean value for all craniofacial anthropometric measurements was presented in Table II.

We did not find any significant difference in the C-I between sexes (p>0.05). The remaining two cranial indices (CL-HC-I, F-I) were found to be significantly higher in males compared to female subjects (p<0.001). None of the facial indices showed a significant difference between the genders (p>0.05). The data and results of statistical analyses regarding the craniofacial indices were presented in Table II.

We evaluated the correlation between the craniofacial indices and the subdomains of aggressive behavior by a multi-variant regression model. First, the model Fit p-value was used to assess the presence of a statistical significance for the model. Male participants showed a statistical significance for models of indices on physical, verbal, indirect, and general aggression (p: <0.001, 0.004, <0.01, and 0.01, respectively); however, there was no such statistical significance in female subjects (Table III). Further evaluation of the correlations between subdomains of aggression and craniofacial indices in male subjects revealed that the F-I, UF-I, and TFH-FW-I were significantly related with higher scores of verbal and general aggression, while F-I and UF-I were only significantly related with higher physical aggression scores, and UF-I and TFH-FW-I were only significantly related with indirect aggression (p values below 0.05 for all correlations). There was no significant relationship between craniofacial indices and anger and hostility (p>0.05). The correlations between the craniofacial indices and the types of aggression were presented in Table III.

## DISCUSSION

Facial WHR is an important characteristic that emerged as a result of sexual selection in the evolution of the genus Homo, therefore facial WHR provided information about general level of testosterone and masculinization. Due to its relevance to testosterone and masculinization, WHR is considered an indirect indicator of aggression. In the current study, we investigated the relationship of craniofacial features and aggression by extensive anthropometric studies and a questionnaire [5, 6] for assessing aggression subdomains in a group of university students. The strength of this study is that not only WHR, but also many craniofacial characters have been studied. The weakness of this study is that it does not contain moderator variables such as social status and income level.

Only one study reported relationships among income, craniofacial features, and aggression. In this study it was shown that the income of subjects could be a moderator in the association of aggression and fWHR; the authors observed that fWHR predicted aggressive behavior only in subjects with low income [13]. Another study demonstrated the effects of social status moderated the association of fWHR and risk-taking behavior in males [36]. Noser et al. found that income played a critical role in fWHR and physical aggression relation, so the authors suggested that social status had to be taken into account in such anthropometric studies [26].

Aggression was recently defined as "the feelings of anger or antipathy resulting in hostile or violent behavior" by Im et al. [17]. The manifestation of aggression has been widely studied by using aggression paradigms [35] and self-report questionnaires [5]. Studies on aggression with self-reported data were argued against an inherent social-desirability bias, and a recent study investigating the relationship between fWHR and aggressiveness was designed to incorporate data collected from the colleagues of the study subjects [34]. However, that study design still carries an intrinsic risk of bias, as the colleagues might hesitate to reveal real opinions on the behavioral characteristics of the subjects studied. For nearly three decades, the Buss-Perry questionnaire [5] has been one of the most commonly used instruments for assessing aggression with confirmed statistical relevance. Most studies revealed that aggressive tendencies of males, especially in physical and direct subdomains of aggression were more prominent than females, and under unprovoked conditions [2, 3, 17]. We used an adapted version of the Buss-Perry questionnaire [6], and found that general aggression scores of males were significantly higher than the scores of females. The males had higher scores in verbal aggression, anger, hostility, and indirect aggression subdomains. Although male students scored higher in physical aggression, the statistical analysis did not show any significant difference between genders. In a very recent study, the gender difference was shown to be erased for physical aggression in situations that involved provocative stimulations [35]. Based on those recent findings, it can be speculated that the questions, in particular, the ones assessing the physical aggression subdomain, might have provoked emotionally stimulative responses in female students.

The dimensions and shape of the craniofacial region that are extremely variable among human populations and ethnic groups [23] have been routinely used by anthropologists, forensic experts, anatomists, and surgeons. Although indirect methods of anthropometric measurements have been used, the gold standard is still considered to be the direct in-vivo technique, which is conventional and low-cost. This quantitative method allows an accurate measurement of hair-covered areas and lacks the risk of causing distorted views that are occasionally caused by photographic images used in indirect anthropometry [23, 33]. Pouya et al. compared the direct and indirect anthropometric measurements for the analysis of cephalofacial dimensions and found that the mean cranial length of males was higher than females. As a negligible difference was found between the two techniques, they suggested using the robust and low-cost direct anthropometric methodology for constructing more extensive normative databases [29]. A complete assessment of the craniofacial region, consisting of the shape and form of cranium and face, can be performed thoroughly by using anthropometrical indices derived from craniofacial measurements [9, 33]. In recent anthropometric studies of the face, the results showed that total facial height, upper facial height, and facial width of males were higher than those of females. The facial indices were also found to be higher in males compared to females [9, 28]. The results of a multiparametric cranial morphometric study in a Turkish population showed that fourteen radiologically assessed measurements were higher in males than females [10]. In the current study, out of the six cranial and twelve facial dimensions measured, we found that only the frontal height and the total lip height were not significantly different between male and female students. The remaining sixteen craniofacial measurements were significantly higher in males compared to females. The total lip height of males was found to be significantly higher than the females in a study [31]. A recent study showed that the mean value of frontal height in males was significantly more than that of the females [32]. The discrepancy between our findings and the results of the study by Sirinturk et al. might be due to direct and indirect anthropometric techniques used in ours and theirs, respectively.

There is extensive research on the association of physical characteristics and behavioral tendencies, and facial width-to-height ratio (fWHR) appears to be the most common point of consensus on its relationship with aggression in males [1, 12, 13, 15], although there are some study results that did not reveal this relationship [14, 27]. Testosterone has been suggested as the primary mediator of the fWHR and aggression relationship [7, 16, 22]; however, several study results did not support this suggestion [4, 22]. In a recent genetics study, three SNPs associated with the testosterone levels in the body were reported to have an apparent effect on mandible shape and fWHR [30]. The considered dimorphic property of fWHR [12] is also questioned in a meta-analysis [21]. Köllner et al. argued against those negative claims and emphasized the importance of conducting investigative studies without pre-specification of facial features of interest. The authors further suggested the measurement of additional points, ratios, and distances to keep the research from over-focusing on the same subset of indicators with inconsistent results [19]. Moreover, the authors of a study suggested the facial height and width should be tested independently to reduce the ambiguity of using the ratio between these two components [8]. In another study, the authors discussed that the missing link causing inconsistent results between fWHR and aggression could be the lack of control over critical influencing factors such as BMI [25].

In consideration of the arguments and suggestions reviewed from the available literature, we analyzed our results statistically for the correlation between aggression and craniofacial characteristics by controlling the BMI. We measured six cranial and twelve facial anthropometric dimensions and derived three cranial and five facial indices from those. None of the facial indices showed a significant difference between the genders, while cranial CL-HC-I and F-I indices were significantly higher in the male students compared to those of the females.

When we analyzed the correlation between aggression and craniofacial characteristics, we found that none of the craniofacial indices of female students were significantly correlated with aggression or its subdomains. For male students, no correlation in anger and hostility subdomains was present for any of the craniofacial indices. The general and verbal aggression in males correlated with frontal, upper facial, and total facial height-facial width indices. The physical aggression subdomain in males was found to be correlated with frontal and upper facial indices, while indirect aggression in males correlated with upper facial and total facial height-facial width indices.

To the best of our knowledge, this is the first anthropometric evaluation of multiparametric craniofacial features and their correlation with aggression and subdomains in a large sample size with both genders represented. The strengths and limitations of our study should be acknowledged. The sample size, as well as the sampling homogenization, the evaluation of multiparametric craniofacial characteristics by using direct measurement technique, constitute the advantages of the current study compared to similar studies. Nevertheless, we should note that the study population only involves students, so the results cannot be safely extrapolated to the general population. The current study also has the same disadvantages inherent to most anthropometric studies, which is the lack of standardized terminology and methodology. These two points are crucial and need to be improved for reducing the errors in measurement and interpretation of the results.

## CONCLUSIONS

In conclusion, we suggest that further studies designed with multiple anthropometric measurements and a study group reflecting the general structure of the population should be conducted for investigating the association of aggression and craniofacial features, and replicate and extend the current findings.

## REFERENCES


1. Alrajih S, Ward J. Increased facial width-to-height ratio and perceived dominance in the faces of the UK's leading business leaders. Br J Psychol. 2014;105(2):153-161, doi:10.1111/bjop.12035, indexed in PubMed: 24754804.
2. Archer J. Sex Differences in Aggression in Real-World Settings: A Meta-Analytic Review. Review of General Psychology. 2004;8(4):291-322, doi:10.1037/1089-2680.8.4.291.
3. Bettencourt BA, Miller N. Gender differences in aggression as a function of provocation: a meta-analysis. Psychol Bull. 1996;119(3):422-447, doi:10.1037/0033-2909.119.3.422, indexed in PubMed: 8668747.
4. Bird BM, Cid Jofré VS, Geniole SN, Welker KM, Zilioli S, Maestripieri D, Arnocky S, Carré JM. Does the facial width-to-height ratio map onto variability in men's testosterone concentrations? Evolution and Human Behavior. 2016;37(5):392-398, doi:https://doi.org/10.1016/j.evolhumbehav.2016.03.004.

5. Buss AH, Warren WL. *Aggression questionnaire:(AQ)*. Los Angeles: Western Psychological Services; 2000.
6. Can S. “Aggression Questionnaire” adlı ölçeğin Türk popülasyonunda geçerlilik ve güvenilirlik çalışması. İstanbul: GATA Haydarpaşa Eğitim Hastanesi; 2002.
7. Carré JM, McCormick CM. In your face: facial metrics predict aggressive behaviour in the laboratory and in varsity and professional hockey players. Proceedings Biological sciences. 2008;275(1651):2651-2656, doi:10.1098/rspb.2008.0873, indexed in PubMed: 18713717.
8. Costa M, Lio G, Gomez A, Sirigu A. How components of facial width to height ratio differently contribute to the perception of social traits. PloS one. 2017;12(2):e0172739-e0172739, doi:10.1371/journal.pone.0172739, indexed in PubMed: 28235081.
9. Dodangheh M, Mokhtari T, Mojaverrostami S, Nemati M, Zarbakhsh S, Arabkheradmand A, Hassanzadeh G. Anthropometric Study of the Facial Index in the Population of Medical Students in Tehran University of Medical Sciences. GMJ Medicine. 2018;2(1):51-57, doi:10.29088/gmjm.2018.51.
10. Ekizoglu O, Hocaoglu E, Inci E, Can IO, Solmaz D, Aksoy S, Buran CF, Sayin I. Assessment of sex in a modern Turkish population using cranial anthropometric parameters. Legal medicine (Tokyo, Japan). 2016;21:45-52, doi:10.1016/j.legalmed.2016.06.001, indexed in PubMed: 27497333.
11. Farkas LG, Hreczko TM, Katic MJ, Forrest CR. Proportion indices in the craniofacial regions of 284 healthy North American white children between 1 and 5 years of age. The Journal of craniofacial surgery. 2003;14(1):13-28, doi:10.1097/00001665-200301000-00004, indexed in PubMed: 12544216.
12. Geniole SN, Denson TF, Dixson BJ, Carre JM, McCormick CM. Evidence from Meta-Analyses of the Facial Width-to-Height Ratio as an Evolved Cue of Threat. PLoS One. 2015;10(7):e0132726, doi:10.1371/journal.pone.0132726, indexed in PubMed: 26181579.
13. Goetz SM, Shattuck KS, Miller RM, Campbell JA, Lozoya E, Weisfeld GE, Carre JM. Social status moderates the relationship between facial structure and aggression. Psychol Sci. 2013;24(11):2329-2334, doi:10.1177/0956797613493294, indexed in PubMed: 24068116.
14. Gomez-Valdes J, Hunemeier T, Quinto-Sanchez M, Paschetta C, de Azevedo S, Gonzalez MF, Martinez-Abadias N, Esparza M, Pucciarelli HM, Salzano FM, Bau CH, Bortolini MC, Gonzalez-Jose R. Lack of support for the association between facial shape and aggression: a reappraisal based on a worldwide population genetics perspective. PLoS One. 2013;8(1):e52317, doi:10.1371/journal.pone.0052317, indexed in PubMed: 23326328.
15. Haselhuhn MP, Ormiston ME, Wong EM. Men's facial width-to-height ratio predicts aggression: a meta-analysis. PLoS One. 2015;10(4):e0122637, doi:10.1371/journal.pone.0122637, indexed in PubMed: 25849992.
16. Hodges-Simeon CR, Hanson Sobraske KN, Samore T, Gurven M, Gaulin SJC. Facial Width-To-Height Ratio (fWHR) Is Not Associated with Adolescent Testosterone Levels. PLOS ONE. 2016;11(4):e0153083, doi:10.1371/journal.pone.0153083.
17. Im S, Jin G, Jeong J, Yeom J, Jekal J, Lee S-I, Cho JA, Lee S, Lee Y, Kim D-H, Bae M, Heo J, Moon C, Lee C-H. Gender Differences in Aggression-related Responses on EEG and ECG. Experimental neurobiology. 2018;27(6):526-538, doi:10.5607/en.2018.27.6.526, indexed in PubMed: 30636903.
18. Kolar JC, Salter EM. *Craniofacial Anthropometry: Practical Measurement of the Head and Face for Clinical, Surgical, and Research Use*. Springfield, Illinois: C.C. Thomas; 1997.
19. Kollner MG, Janson KT, Schultheiss OC. Commentary: Sexual Dimorphism of Facial Width-to-Height Ratio in Human Skulls and Faces: A Meta-Analytical Approach. Front Endocrinol (Lausanne). 2018;9:227, doi:10.3389/fendo.2018.00227, indexed in PubMed: 29867760.
20. Kosinski M. Facial Width-to-Height Ratio Does Not Predict Self-Reported Behavioral Tendencies. Psychol Sci. 2017;28(11):1675-1682, doi:10.1177/0956797617716929, indexed in PubMed: 28976810.
21. Kramer RSS. Sexual dimorphism of facial width-to-height ratio in human skulls and faces: A meta-analytical approach. Evolution and Human Behavior. 2017;38(3):414-420, doi:https://doi.org/10.1016/j.evolhumbehav.2016.12.002.
22. Lefevre CE, Lewis GJ, Perrett DI, Penke L. Telling facial metrics: facial width is associated with testosterone levels in men. Evolution and Human Behavior. 2013;34(4):273-279, doi:https://doi.org/10.1016/j.evolhumbehav.2013.03.005.
23. Majeed MI, Haralur SB, Khan MF, Al Ahmari MA, Al Shahrani NF, Shaik S. An Anthropometric Study of Cranio-Facial Measurements and Their Correlation with Vertical Dimension of Occlusion among Saudi Arabian Subpopulations. Open Access Maced J Med Sci. 2018;6(4):680-686, doi:10.3889/oamjms.2018.082, indexed in PubMed: 29731941.

24. Matthews HS, Penington AJ, Hardiman R, Fan Y, Clement JG, Kilpatrick NM, Claes PD. Modelling 3D craniofacial growth trajectories for population comparison and classification illustrated using sex-differences. Sci Rep. 2018;8(1):4771, doi:10.1038/s41598-018-22752-5, indexed in PubMed: 29556038.
25. Muñoz-Reyes J-A, Gil-Burmann C, Turiegano E. Digit Ratio 2D:4D, facial masculinization and aggressiveness in Spanish adolescents / Índice 2D:4D, masculinización facial y agresividad en adolescentes españoles. Estudios de Psicología. 2014;35(2):319-340, doi:10.1080/02109395.2014.922259.
26. Noser E, Schoch J, Ehlert U. The influence of income and testosterone on the validity of facial width-to-height ratio as a biomarker for dominance. PLoS One. 2018;13(11):e0207333, doi:10.1371/journal.pone.0207333, indexed in PubMed: 30412629.
27. Özener B. Facial width-to-height ratio in a Turkish population is not sexually dimorphic and is unrelated to aggressive behavior. Evolution and Human Behavior. 2012;33(3):169-173, doi:https://doi.org/10.1016/j.evolhumbehav.2011.08.001.
28. Pandeya A, Atreya A. Variations in the Facial Dimensions and Face Types among the Students of A Medical College. JNMA J Nepal Med Assoc. 2018;56(209):531-534, indexed in PubMed: 30058638.
29. Pouya F, Eftekhar-Vaghefi SH, Salehinejad P. Anthropometric Analysis of Cephalofacial Dimensions in Kerman, Iran. Acta medica Iranica. 2017;55(4):241-248, indexed in PubMed: 28532135.
30. Roosenboom J, Indencleef K, Lee MK, Hoskens H, White JD, Liu D, Hecht JT, Wehby GL, Moreno LM, Hodges-Simeon C, Feingold E, Marazita ML, Richmond S, Shriver MD, Claes P, Shaffer JR, Weinberg SM. SNPs Associated With Testosterone Levels Influence Human Facial Morphology. Front Genet. 2018;9:497, doi:10.3389/fgene.2018.00497, indexed in PubMed: 30405702.
31. Sharma RL, Pancholi P, Sharma S, Sastya A. Anthropometric measurement of lips in adults of MP India. IJAR. 2017;3(2):210-212.
32. Sirinturk S, Bagheri H, Govsa F, Pinar Y, Ozer MA. Study of frontal hairline patterns for natural design and restoration. Surgical and radiologic anatomy : SRA. 2017;39(6):679-684, doi:10.1007/s00276-016-1771-1, indexed in PubMed: 27830323.
33. Torres-Restrepo AM, Quintero-Monsalve AM, Giraldo-Mira JF, Rueda ZV, Vélez-Trujillo N, Botero-Mariaca P. Agreement between cranial and facial classification through clinical observation and anthropometric measurement among Envigado school children. BMC oral health. 2014;14:50-50, doi:10.1186/1472-6831-14-50, indexed in PubMed: 24886038.
34. Wang D, Nair K, Kouchaki M, Zajac EJ, Zhao X. A Case of Evolutionary Mismatch? Why Facial Width-to-Height Ratio May Not Predict Behavioral Tendencies. Psychological science. 2019;30(7):1074-1081, doi:10.1177/0956797619849928, indexed in PubMed: 31180794.
35. Weidler C, Habel U, Hupen P, Akkoc D, Schneider F, Blendy JA, Wagels L. On the Complexity of Aggressive Behavior: Contextual and Individual Factors in the Taylor Aggression Paradigm. Front Psychiatry. 2019;10:521, doi:10.3389/fpsyt.2019.00521, indexed in PubMed: 31404138.
36. Welker KM, Goetz SMM, Carré JM. Perceived and experimentally manipulated status moderates the relationship between facial structure and risk-taking. Evolution and Human Behavior. 2015;36(6):423-429, doi:https://doi.org/10.1016/j.evolhumbehav.2015.03.006.

**Table I.** Craniofacial anthropometric measurements

| Cranial dimensions | Description |
|---|---|
| Cranial length (CL) | Between glabella to opisthocranion |
| Cranial width (CW) | Between right and left biparietale |
| Head circumference (HC) | |
| Frontal breadth (FB) | Between right and left frontotemporale |
| Frontal height (FH) | From trichion to glabella |

| | |
|---|---|
| Auricular head height (AHH) | From external meatus to vertex |
| **Facial dimensions** | |
| Facial width (FW) | Between right and left zygion |
| Lower facial heigths (LWH) | Between subnasale and gnothion |
| Upper facial heigths (UFH) | Between nasion and stomion |
| Mandibular breadth (MB) | Between right and left gonium |
| Mandibular height (MH) | Between sublabiale and gnathion |
| Mouth width (MW) | Between right and left chelion |
| Nasal height (NH) | Between nasion and subnasale |
| Nasal width (NW) | Between right and left alare |
| Supraorbital depth (SOD) | Between glabella and tragion |
| Interchantal breadth (ICB) | Between right and left endocanthion |
| Biocular width (BOW) | Between right and left exocanthion |
| Total lip height (TLH) | Between labium superius oris and labium inferius oris |

**Table II.** Anthropometric measurements, cranial indices, aggression scores (mean±SD)

| | **Gender** | | | |
|---|---|---|---|---|
| | **Male (n=147)** | **Female (n=156)** | **p** | **p*** |
| **Weight** | 75.69 ± 12.94 | 58.67 ± 9.03 | **<0.001** | - |
| **Stature** | 174.93 ± 59.75 | 162.2 ± 57.82 | **<0.001** | - |
| **BMI** | 24.69 ± 3.66 | 22.28 ± 3.04 | **<0.001** | - |
| **Cranial measurements** | | | | |
| Cranial length | 189.9 ± 7.54 | 178.56 ± 6.48 | **<0.001** | **0.006** |
| Cranial width | 155.44 ± 6.87 | 146.97 ± 5.1 | **<0.001** | **0.0001** |
| Head circumference | 562.58 ± 15.78 | 537.08 ± 13.61 | **<0.001** | **0.0001** |
| Frontal breadth | 119.33 ± 4.85 | 112.37 ± 4.16 | **<0.001** | **0.0001** |
| Frontal height | 53.77 ± 7.58 | 53.63 ± 5.65 | 0.855 | 0.669 |
| Auricular head height | 69.81 ± 8.57 | 64.52 ± 10.12 | **<0.001** | **0.001** |
| **Facial measurements** | | | | |
| Facial width | 142.22 ± 5.57 | 132.31 ± 4.98 | **<0.001** | **<0.001** |
| Lower facial height | 65.49 ± 5.20 | 59.74 ± 5.17 | **<0.001** | **0.006** |
| Upper facial height | 75.57 ± 6.23 | 70.45 ± 5.63 | **<0.001** | **0.020** |
| Mandibular breadth | 97.48 ± 8.25 | 89.35 ± 8.2 | **<0.001** | **0.001** |
| Mandibular height | 26.03 ± 3.75 | 24.09 ± 3.28 | **<0.001** | 0.061 |
| Mouth width | 51.55 ± 4.64 | 49.15 ± 4.53 | **<0.001** | **0.025** |
| Nasal height | 51.63 ± 3.64 | 48.28 ± 4.30 | **<0.001** | **0.028** |
| Nasal width | 36.71 ± 2.90 | 33.16 ± 2.89 | **<0.001** | **<0.001** |
| Supraorbital depth | 124.2 ± 5.26 | 116.48 ± 4.8 | **<0.001** | **<0.001** |
| Interchantal breadth | 34.10 ± 3.93 | 31.85 ± 3.57 | **<0.001** | 0.191 |
| Biocular width | 107.6 ± 6.03 | 103.78 ± 5.79 | **<0.001** | 0.056 |
| Total lip height | 16.45 ± 3.92 | 16.27 ± 3.43 | 0.991 | 0.907 |
| **Indices** | | | | |
| Cephalic index | 82.12 ± 4.7 | 82.42 ± 4.18 | > 0.05 | - |
| Cranial length-head circumference index | 33.73 ± 0.92 | 33.25 ± 0.85 | **<0.001** | - |
| Frontal index | 45.06 ± 6.47 | 47.68 ± 5.11 | **<0.001** | - |
| Upper facial index | 189.63 ± 19.52 | 189.07 ± 17.07 | > 0.05 | - |
| Total facial height-facial width index | 101.25 ± 7.73 | 102.08 ± 7.42 | > 0.05 | - |
| Mandibular-facial width index | 68.57 ± 5.62 | 67.57 ± 5.88 | > 0.05 | - |
| Total lip height-mouth width index | 32.1 ± 7.6 | 33.2 ± 6.79 | > 0.05 | - |
| Nasal index | 71.42 ± 7.19 | 69.15 ± 7.71 | > 0.05 | - |

| | | | | |
|---|---|---|---|---|
| **Buss & Perry Aggression Score** | | | | |
| General aggression | 25.86 ±4.96 | 22.90 ±5.55 | **<0.001** | - |
| Physical aggression | 24.44 ± 7.66 | 18.41 ± 7.17 | >0.05 | - |
| Verbal aggression | 27.67 ± 6.83 | 26.37 ± 6.89 | **<0.001** | - |
| Anger | 27.71 ± 6.20 | 25.43 ± 6.78 | **<0.001** | - |
| Hostility | 25.50 ± 6.63 | 23.78 ± 6.87 | **<0.001** | - |
| Indirect aggression | 24.46 ± 6.42 | 21.31 ± 6.25 | **<0.001** | - |

** The effects of height and BMI values were controlled by ANCOVA model*

**Table III.** Correlation of craniofacial indices and aggression types by multi-regression analysis

| | | **Dependent Variables** | | | | | |
|---|---|---|---|---|---|---|---|
| | **Aggression** | **Genel** | **Physical** | **Verbal** | **Anger** | **Hostility** | **Indirect** |
| **Sex** | **Independent Variables (Model Fit p-value)** | **0.010** | **<0.001** | **0.004** | 0.109 | 0.198 | **<0.001** |
| | | ***Standardized Beta Coefficient*** | | | | | |
| **Male** | C-I | -0.206 | -0.342 | -0.244 | 0.064 | 0.191 | 0.279 |
| | CL-HC-I | -0.180 | -0.230 | -0.189 | 0.063 | 0.139 | 0.210 |
| | F-I | **0.264*** | **0.224*** | **0.313*** | 0.126 | 0.174 | 0.114 |
| | UF-I | **0.551*** | **0.335*** | **0.487*** | **0.586**** | 0,284 | **0.598*** |
| | TFH-FW-I | **0.441*** | 0.067 | **0.355*** | **0.493*** | 0.166 | **0.387*** |
| | M-FW-I | -0.037 | -0.060 | 0.001 | 0.039 | 0.053 | -0.049 |
| | TLH-MW-I | -0.010 | -0.015 | 0.027 | 0.076 | 0.032 | -0.186 |
| | N-I | 0.080 | 0.102 | 0.045 | 0.089 | -0.118 | 0.089 |
| | **Independent Variables (Model Fit p-value)** | 0.120 | 0.131 | 0.341 | 0.093 | 0.196 | 0.195 |
| | | ***Standardized Beta Coefficient*** | | | | | |
| **Female** | CL-HC-I | -0.083 | -0.101 | -0.109 | -0.017 | 0.030 | 0.031 |
| | F-I | 0.066 | -0.174 | -0.221 | -0.045 | 0.117 | -0.034 |
| | UF-I | 0.108 | 0.173 | -0.001 | -0.021 | -0.022 | 0.089 |
| | TFH-FW-I | -0.226 | 0.255 | -0.041 | 0.002 | 0.139 | -0.103 |
| | M-FW-I | -0.048 | 0.160 | -0.046 | -0.093 | -0.220 | -0.099 |
| | TLH-MW-I | 0.166 | -0.055 | 0.054 | -0.010 | -0.030 | -0.088 |
| | N-I | 0.160 | 0.073 | 0.163 | 0.197 | 0.139 | 0.078 |

** p<0.05, **p<0.01 .*