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Original Article

Anatomy Section

Facial Anthropometry and Self-expressed Behaviours: A Systematic Review

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ABSTRACT

Introduction: Facial anthropometry is a systematic technique based on a series of measurements and proportions of the face. It is useful for identifying a person's self-expressed behaviours (physiognomic evaluation). Previous research on humans and non human primates has revealed an association between the facial Width-to-Height Ratio (fWHR) and various traits, including achievement drive, aggression, unethical behaviour and dominance. Additionally, facial symmetry has been significantly associated with the Big Five personality factors, which encompass traits such as averageness, truthfulness, judgment and youthfulness.

Aim: To assess the association of facial measurements with self-expressed behaviours and to determine how strongly these behaviours correlate with facial measurements.

Materials and Methods: A PubMed database search was performed using the following keywords: Behaviour* OR Threat* OR Aggress* OR trait* OR Socia* AND Personality Mesh term and fWHR OR Facial* AND Anthropometry Mesh term. The eligibility criteria for including studies were: selection of primary data, English language and facial anthropometric measurements (fWHR, bizygomatic width, forehead length, forehead width, forehead slant, facial index and upper facial index) related to self-expressed or actual behaviour in humans and monkeys. After applying the eligibility criteria, 340 articles published between 2004 and 2022 were identified, of which 17 articles/studies were found relevant for the results analysis. The identified titles and abstracts were screened independently by two authors and studies that mentioned facial anthropometry in relation to self-expressed behaviour or personality in humans and monkeys were included.

Results: This review describes the statistical results and conclusions of 17 studies regarding different behaviours and their relation to facial anthropometry. A meta-analysis of four studies involving a total of 236 subjects was conducted, with weighted assignments to each study ranging from 8.4 to 25.8%. The correlation coefficients from individual studies ranged between 0.38 and 0.53, except for one study, which showed a negative correlation of -0.40. The overall coefficient across all studies was r=0.37, 95% Confidence Interval (CI) (0.27, 0.47), p<0.01, indicating a moderate positive correlation.

Conclusion: The data from various populations in present review support the hypothesis that facial structures are important biological markers for assessing behaviours or personality traits. The findings of present review provide new insights for future research in the fields of behavioural medicine and computational face recognition.

Keywords: Bizygomatic width, Face recognition, Facial index, Facial width to height ratio, Personality

INTRODUCTION

Facial anthropometry is a systematic technique based on a series of measurements and proportions of the face, which facilitates the identification of phenotypic variation and diversity in terms of age, sex and ethnicity [1]. Many studies have been conducted on the applicability of facial anthropometry in different disciplines such as forensics, surgeries, dentistry, diagnostics and therapeutics [2,3]. The fWHR, bizygomatic width, bigonial width, facial height and upper facial height, among others, have been used to predict both actual [2,4-6] and perceived behaviour [7,8] in humans and animals. However, the mechanism behind the connection between facial anthropometry and behaviour or personality traits has not been clearly defined.

There are mainly three aspects to consider in understanding the association between facial anthropometry and human behaviours: brain development and its close association with the face, genetic influences on facial phenotypes and the effect of pubertal testosterone on facial morphology. The entire human face develops from crest cells that migrate from the edges of the cranial neural tube and facial development is under the induction of centres from the prosencephalon and rhombencephalon [9]. Inhibition of Sonic hedgehog (Shh) signaling from the neuroectoderm alters the dorsoventral polarity of the forebrain, resulting in a loss of Shh in the ventral telencephalon, a reduction in the expression of the ventral markers Nkx2.1 and Dlx2 and a concomitant expansion of the dorsal marker Pax6. In addition to changes in the forebrain neuroectoderm, gene expression patterns in the facial ectoderm are also altered. Consequently, a signaling centre in the frontonasal prominence is disrupted, preventing the prominence from undergoing proximodistal and mediolateral expansion [10].

Genes influencing facial structures could have pleiotropic effects on other systems of the body, apart from the brain and surrounding craniofacial morphology (e.g., cardiovascular, endocrine, gastrointestinal, central nervous, musculoskeletal and urogenital systems). This suggests that heredity maintained by a single gene could influence both facial morphology and other behavioural systems, such as the endocrine system and the central nervous system. A classic example of this theory is the association between nose prominence and nose length, both of which are linked to the PRDM16 gene. It has been found that psychotic and schizophrenic patients tend to have larger noses [11].

As the brain regulates facial development, there is reciprocal signaling from the facial tissues that contributes to brain development. Apart from the structural relationship between the brain and the face, significant differences have been observed in the shapes of individuals' faces suffering from psychological disorders, one of which may be bipolar disorder. A study found that both male and female bipolar patients exhibited facial dysmorphology, including facial widening, increased nose width, narrowing of the mouth and upward displacement of the chin [12].

Brain shape has also been significantly correlated with neuropsychiatric traits, cognitive behaviour and subcortical volume, whereas face shape has shown significant but weaker correlations with subcortical volume measures [13]. The heritability of personality traits, such as neuroticism and openness, along with genetic overlap [14] and the transmission of facial characteristics from parents to offspring [15] have provided new insights for this review. Additionally, forehead slant, impulsiveness and cortical thickness of the brain have been positively correlated [16] and significant relationships between Width Difference (WD)- the difference between bizygomatic arch width and bigonial width- and the psychological variables studied have also been found [17].

There are factors that moderate the relationship between the fWHR and physical aggression, as well as dark triad traits such as psychopathy and Machiavellianism, but this has been found only in low-income individuals. In contrast, testosterone has influenced the relationship between fWHR and the Dark Triad trait of narcissism [18]. A study investigating the effects of testosterone-related genetic variants on human facial morphology revealed a significant association between intronic variants of SHBG (rs12150660 and rs1799941) and mandible shape. Additionally, the intronic variant rs8023580 of NR2F2-AS1 was associated with fWHRs, suggesting that testosterone-related genetic variants primarily influence facial morphology, particularly in regions that exhibit strong sexual dimorphism, such as mandible shape and fWHRs [19].

The genetic crosstalk between brain development and facial structure, along with its function and neuroendocrine moderation, has influenced this systematic literature review that is being conducted. A review was conducted on the association of a single facial measurement, fWHR, with perceived and actual behaviour combined [20]; however, the present systematic review focuses solely on multiple facial anthropometric measurements and self-expressed behaviour. A study conducted by Arun P et al., on medical students reported that 13.9% of the sample were found to have depression (moderately severe or severe), 20.2% were found to have anxiety disorders (moderate or severe) and 29.6% of students were found to be at risk of suicide [21]. The study reported that the most common barriers to seeking mental healthcare were a preference for informal consultations, concerns about confidentiality and a preference for self-diagnosis. Students with psychiatric disorders perceived more barriers to mental healthcare seeking compared to those without psychiatric disorders [21].

Keeping this issue in mind, a review of the literature was conducted to explore the question, “Can facial features reveal one’s behaviour or personality traits?” If, the answer is affirmative, the present review could provide a new perspective on the study of the evolutionary foundations of behaviours by identifying genetically determined physical predictors.

MATERIALS AND METHODS

Survey protocol: A number of different electronic repositories were used to search for related articles before applying relevant inclusion and exclusion criteria to filter the number of articles. The relevant articles and papers were selected based on the study’s research questions, followed by analysis and reporting.

Research Questions*

This review addressed the following research questions:

RQ1. What are the facial measurements associated with self-expressed behaviours?

RQ2. How strongly are self-expressed behaviours associated with facial measurements?

Data Sources and Search Strategy*

Data collection was conducted through electronic pathways, using keywords to search for all relevant papers. A PubMed database search was performed using the following terms: Behaviour* OR Threat* OR Aggress* OR Trait* OR Socia* AND Personality (MeSH term) and fWHR OR Facial* AND Anthropometry (MeSH term). The ProQuest search was done using the terms Craniofacial Anthropometry and Human Behaviour. Articles and papers were also searched on Google Scholar using the terms Facial Anthropometry, Facial Measurements, Personality and Human Behaviour. To understand the connection between facial anthropometry and traits, the search was also carried out using the terms “Gene responsible for face and brain development” and “Facial measurements and Deoxyribonucleic Acid (DNA).”

Inclusion and Exclusion criteria: To select the studies for review, specific inclusion and exclusion criteria were applied, as mentioned in [Table/Fig-1]. The articles included in the results synthesis were those published from 2004 to 2022.

Inclusion criteria	Exclusion criteria
• Primary data • English language • Human and monkeys • Facial anthropometric measurements (fwhr, Bizygomatic width, Forehead length, Forehead width, Forehead slant, Facial index and upper facial index) • Self-expressed or actual behaviour	• Review article • Non english language • Perceived or judgmental behaviour • Cranial measurements

[Table/Fig-1]: Inclusion and exclusion criteria of article selection for present systematic review.

Assessment of studies: The identified titles and abstracts were screened independently by two authors, who included studies that explored facial anthropometry in relation to self-expressed behaviour or personality in humans and monkeys. The selected studies were then screened for methodological similarity and quality by the same two authors. The data items were chosen by the two reviewers through mutual discussion.

Survey classification: In this section, a detailed summary is presented regarding the survey that was conducted on facial anthropometric measurements and their association with self-expressed behaviours. This will help identify research gaps, as well as determine solutions for future directions in this area.

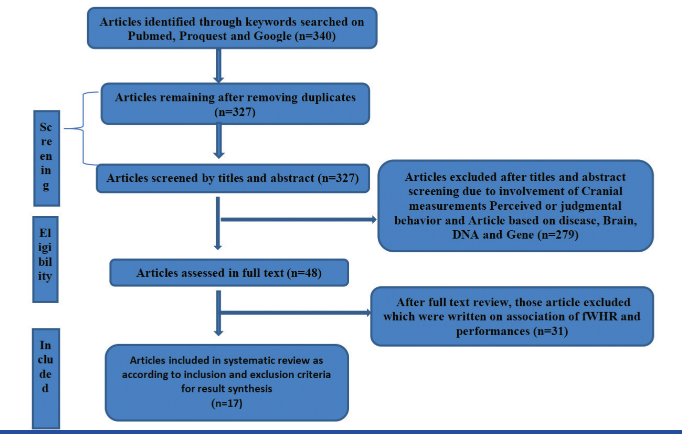
Anthropometric measures: The facial measurements taken for this study were fWHR, bizygomatic width, forehead length, forehead width, forehead slant, facial index and upper facial index.

Self-expressed behaviour: In present survey, only those behaviours that were expressed by the individuals themselves were included, such as responses to questionnaires, game activities, etc., along with traits like impulsiveness, trait dominance, reciprocation, physical aggression, assertiveness, types of dominance style, personality traits, aggression and sensitivity to self-reliance. The review presents the results of the included studies in tabular form with subjective items, including statistical results and a meta-analysis was conducted where required.

Risk of bias assessment: In present review, the Newcastle-Ottawa Quality Assessment Scale has been used. The scale has been adapted from the Newcastle-Ottawa Quality Assessment Scale (S1 Text) for the quality assessment of cross-sectional studies in systematic reviews [22]. This scale has three domains: selection, comparability and outcome assessment. Each domain has been assigned a scoring scale for measurement. The Selection domain has a maximum of 5 points, the Comparability domain has 2 points and the Outcome Assessment domain has 3 points, for a total of 10 points.

The selection domain consists of the representativeness of the population, sample size, non-response rate and screening tool. The Comparability domain investigates potential confounders, while the Outcome domain evaluates the assessment of outcomes and statistical tests. The questions were modified based on the studies included in present review and grading was assigned to each domain. The scale was selected from a study and modified after mutual discussion among the authors.

The flow diagram of the article selection process using Preferred Reporting Item for Systemic and Meta Analyses (PRISMA) guidelines has been depicted in [Table/Fig-2].



[Table/Fig-2]: Flow diagram of the article selection process using PRISMA guidelines.

The grading of study quality was adjusted according to the studies included for the results synthesis of the current systematic review. To evaluate the impact of selected studies, a 1-10 point scale was provided: studies scoring 9-10 points were considered very good, those scoring 7-8 points were classified as good, studies scoring 5-6 points were deemed satisfactory and those scoring 0-4 points were considered unsatisfactory [23].

RESULTS

A total of 17 studies qualified for the inclusion criteria of present review and were included in the present systematic review [Table/Fig-3] [2,4-6,16,17,24-34].

Risk of bias assessment: The risk of bias assessment was conducted using the Newcastle-Ottawa Quality Assessment Scale. The scores of each study are mentioned in the table/figure below

S. No.	Authors	Place/Year	Objective	Anthropo-metric mea-surements	Self-expressed behaviours	Tools of behavioural measurement	Population	Study type	Total sample size	Conclusion	Quality assess-ment scores
1	Tiwari SC et al., [2]	UP, India/ 2004	To identify the risk factors which catalyse indulgence in professional criminal behaviour for profiling future habitual criminals.	Facial index and upper facial index	Recidivistic criminality	Hostility and direction of hostility questionnaire, Rorchach Inkblot Test	Recidivistic criminals and control (Prisoners)	Case control	Total 750 (250=Major Offences, 250=Minor Offences, 250=Neighbours of Subjects)	Level of impulsiveness is significant variable between experiment group and control 1 for facial index and with control 2 also for Upper facial index	9/10
2	Carre J and McCormick C [4]	Canada/ 2008	To examine the extent to which the face width-to-height ratio predicted dominance and aggressive behaviour.	fWHR	Trait dominance and penalty minutes per game	International Personality item pool scale Goldberg et al., 2006	Professional Hockey Players	Cross-sectional	M=37 F=51	Individual differences in the Facial Width-To-Height Ratio (fWHR) predicted reactive aggression in men, but not in women	9/10
3	Stirrat M and Perett D [24]	UK/2010	To explore whether male variation in facial-width ratio relates to (a) cooperation in economic games and (b) trust judgments of others.	fWHR	Reciprocation	Binary choice version of trust game	Students	Cross-sectional	M=36 F=107	Association persists in male only	9/10
4	Carre JM et al., [25]	USA/2013	To observe the associations between FWHR, brain activation and variation in self-reported aggression in men.	fWHR	Physical aggression moderated with amygdala activity	Buss-Perry Aggression Questionnaire	Healthy sample	Cross-sectional	M=28 F=36	Positive correlation between right amygdala activity and aggression in high fWHR but not in Low fWHR in Men	9/10
5	Wilson V et al., [5]	UK/2013	To test the association of personality traits with fWHR, face width/lower-face height and lower face/face height ratio in capuchins.	fWHR	Assertiveness, openness, attentiveness, neuroticism and sociability	Hominoid Personality Questionnaire	Capuchins Monkey	Cross-sectional	M=35 F=29	(Positive association between fWHR and Assertiveness) Greater the lower face/face height will give greater Attentiveness and Neuroticism	7/10
6	Lefevre CE et al., [26]	UK/2014	To examine within-species links between fWHR and dominant behaviour in brown capuchin monkeys aged between 2 and 40 years.	fWHR	Assertiveness	Hominoid Personality Questionnaire	Capuchins Monkey	Cross-sectional	M=35 F=29	Positive association in male and female	9/10
7	Borgi M and Majolo B [27]	UK/2016	To analyse the correlation between fWHR and female dominance style using phylogenetic-controlled analyses and standard multiple regression.	fWHR	Dominance style	Classification of Macaque Species from despotic to tolerant (Thierry 2000)	Rhesus Macaques	Cross-sectional	M=72 F=73	Dominance style was negatively correlated for male and female	8/10

8	Guerrero Apolo JD et al., [28]	Spain/2018	To investigate the relationship between the angle of inclination of the forehead and impulsiveness.	Forehead slant (FID)	Impulsiveness	Short scale of Impulive Behaviour (UPPS-P), Baratt Impusiveness scale-11, Zuckerman Sensation seeking scale	Car drivers	Cross-sectional	M=105 F=26	Significant association between FID and impulsiveness	7/10
9	Gabarre Mir J et al., [6]	Spain/2017	To study the influence of bizygomatic arch, when compared to bigonial arch, on the individual's independence/ gregariousness or expressiveness/ alexithymia.	Bizygomatic width	Personality traits	16 PF, Attitude and Cognitive Strategies (AECS), Sociable Misanthropic scale, TAS-20, EES	General population	Cross-sectional	M=82	Bizygomatic arch in contraction are more independent and display a reduced capacity to join in with a group compared with the group of subjects who have the bizygomatic arch in expansion	6/10
10	Beltman N [29]	Netherlands/ 2018	To find a connection between facial structure (fWHR) and company performance in European large companies and to compare this to the results from the US study.	fWHR	Firm financial performance	Firm performance	CEOs	Descriptive	CEOs of 28 companies	No association	8/10
11	Gabarre Armengol C et al., [17]	Spain/2019	To study the relationship of the difference between the bizygomatic and bigonial width {Width Difference (WD)} and psychological characteristics; self-reliance, the ability to describe, exhibit and express emotions and coldheartedness.	Bigonial-Bizygomatic Width Deference (WD)	Personality traits	16 PF Questionnaire (16 PF), Scale of Emotional Expressivity (EES), Toronto Alexithymia scale (TAS 20), The Alexethimia On-line Questionnaire (OAQ), Psychopathic Personality Inventory (PPI)	General population	Cross-sectional	M=55 F=15	WD positively associated with TAS 20, OAQ and PPI in male and female except EES	8/10
12	Altschul DM et al., [30]	UK/2019	To examine the relationship among facial morphology, age, sex, dominance status and personality dimensions Confidence, Openness, Assertiveness, Friendliness, Activity and Anxiety in rhesus macaques (Macaca mulatta).	fWHR and facial Lower Height- Full Height ratio (fLHFH)	Dominance status	Hominoid Personality Questionnaire	Rhesus Macaques	Cross-sectional	Two samples age wise 81 individuals= <8 year 28 individuals= >8 years	Assertiveness was associated with higher fWHR and fLHFH and Confidence was associated with lower fWHR and fLHFH, but all these associations were consistent only in individuals less than 8 years	8/10
13	Martin JS et al., [31]	USA/2019	To investigate the association of fWHR with agonistic and affiliative dominance behaviour across males and females.	fWHR and mandibular line	Agonistic and affiliative dominance	Hominoid Personality Questionnaire, Normalised David's Score	Bonobos Monkey	Cohort	M=15 F=23	Association in male and female	7/10
14	Gulcen B et al., [32]	Turkey/ 2020	To study the correlation of aggressive behaviour and multiparametric anthropometric measurements of the craniofacial region in a study group consisting of university students.	Multiple anthropometric	Types of aggression	Buss-Perry Aggression Questionnaire	18-38 years students	Cross-sectional	M=147 F=156	F-I, UF-I and TFH-FW-I related with higher scores of verbal and general aggression, while F-I and UF-I related with higher physical aggression scores and UF-I and TFH-FW-I related with indirect aggression in male	10/10
15	Guerrero Apolo JD et al., [16]	Spain/2020	To investigate the correlation between impulsiveness, cortical thickness and slant of forehead in healthy adults.	Forehead slant	Impulsiveness and brain cortical thickness	Short scale of Impulsive Behaviour (UPPS-P), Baratt Impulsiveness scale-11, Zuckerman Sensation seeking scale	Healthy sample	Cross-sectional	M=30 F=18	Positive association between impulsiveness and forehead slant	6/10

16	Sato S et al., [33]	Japan/2021	To investigate the relationship between fWHR and sporting successes at the individual athlete level.	fWHR	Aggressive behaviour	Field -goal attempts (FGA), Fouls, Sporting success ratings (EFF)	Professional Basket ball Players	Cross-sectional	M=482	Positively associated with FGA and EFF	8/10
17	Hongpeng LV et al., [34]	China/2022	To explore the possible correlations between fWHR or mandibular morphology and personality traits.	fWHR and mandibular line angle	Sensitivity and self-reliance	16 PF Personality factor	Students	Cross-sectional	M=226 F=678	Significant negative correlation between social boldness and bilateral mandibular line angle Apprehension and vigilance significantly negatively correlated with bilateral mandibular line angle	10/10

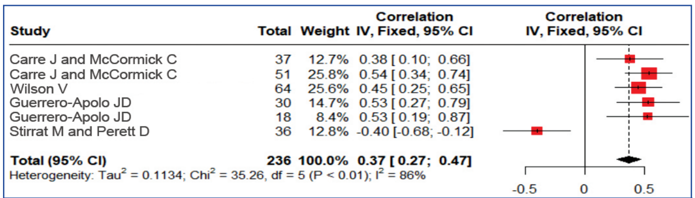
[Table/Fig-3]: Publication chart year-wise depicting the association between facial measurements and self-expressed behaviours [2,4-6,16,17,24-34].

[Table/Fig-4] [2,4-6,16,17,24-34]. The quality of seven studies was rated as very good, with an overall score of 9 and above.

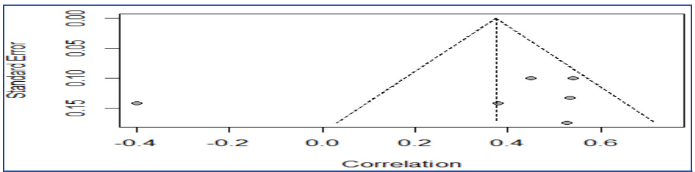
A total of four studies were included in this meta-analysis [Table/Fig-5,6] [4,5,16,24]. Among them, Carre J and McCormick C chose 37 male and 37 female participants, while Guerrero Apolo JD et al., included 30 male and 18 female participants and calculated the correlation coefficient separately [4,16]. Stirrat M and Perett D calculated the correlation coefficient for combined male and female participants [24] and Wilson V et al., conducted a study on 64 animals, involving a total of 236 subjects [5]. The weighted assignment of each study ranged from 8.4% to 25.8% and the correlation coefficients of these studies varied from 0.38 to 0.53, except for Stirrat M and Perett D study, which showed a negative correlation of -0.40. The overall coefficient for all studies was r=0.37, with a 95% CI of (0.27, 0.47) and p<0.01, indicating a moderate positive correlation. Despite the overall positive correlation, the present meta-analysis revealed significant heterogeneity among the studies, as evidenced by Tau^2 (0.1134) and I^2 (86%), indicating substantial diversity in outcomes.

Name of the authors	Selection				Comparability	Outcome		Interpretation
	Representativeness of sample	Sample size	Non response rate	Ascertainment of screening/ assessment tool	Potential confounders investigation	Assessment of outcome	Statistical test	
Tiwari SC et al., [2]	1	1	1	2	2	1	1	Very good
Carre J and McCormick C [4]	1	0	1	2	2	2	1	Very good
Stirrat M and Perett D [24]	1	0	1	2	2	2	1	Very good
Carre JM et al., [25]	1	0	1	2	2	2	1	Very good
Wilson V et al., [5]	1	0	1	2	0	2	1	Good
Lefevre CE et al., [26]	1	0	1	2	2	2	1	Very good
Borgi M and Majolo B [27]	1	1	1	2	0	2	1	Good
David Guerrero Apolo JD et al., [28]	1	1	1	2	0	1	1	Good
Gabarre Mir J et al., [6]	1	0	1	2	0	1	1	Satisfactory
Beltman N [29]	1	0	1	1	2	2	1	Good
Gabarre Armengol C et al., [17]	1	0	1	2	2	1	1	Good
Altschul DM et al., [30]	1	0	1	2	2	1	1	Good
Martin JS et al., [31]	1	0	1	2	2	0	1	Good
Gulcen B et al., [32]	1	1	1	2	2	2	1	Very good
Guerrero Apolo JD [16]	1	0	1	2	0	1	1	Satisfactory
Sato S et al., [33]	1	1	1	1	2	1	1	Good
Hongpeng LV et al., [34]	1	1	1	2	2	2	1	Very good

[Table/Fig-4]: Newcastle Ottawa quality assessment scale [2,4-6,16,17,24-34].



[Table/Fig-5]: Statistical presentation meta-analysis in selected articles [4,5,16,24].



[Table/Fig-6]: Graphical presentation of statistical meta-analysis in selected articles.

DISCUSSION

The objective of present study was to review the literature regarding the association of various facial anthropometric measurements with self-expressed behaviours and to determine the extent to which self-expressed behaviours were associated with facial measurements. The first objective was achieved by compiling the data from 17 studies in ascending order by year, while the second objective was accomplished through a meta-analysis of four relevant studies.

In present review, the fWHR in men was positively correlated with aggression [4,25] and the association between these two was enhanced by right amygdala activity in humans [25]. In bonobo monkeys, it was noted that after controlling for body weight, age and sex, fWHR was positively associated with both affiliative and agonistic dominance, with little evidence found for sex-specific links between fWHR and these types of dominance [31]. In capuchin monkeys, fWHR was positively associated with assertiveness and alpha status in both males and females, while a greater value of the lower face/face height ratio was related to higher levels of neuroticism and attentiveness [5,26]. Age in capuchins played a role in assessing the association between fWHR and the Lower-Height/Full-Height ratio (fLHFH) with personality traits such as assertiveness and confidence. Assertiveness was associated with higher fWHR and fLHFH, while confidence was associated with lower fWHR and fLHFH; however, all these associations were consistent only in capuchins younger than eight years of age. The study revealed that fWHR and fLHFH were not consistently associated with sex or dominance status and compared to younger individuals, fewer associations were noted between fWHR and fLHFH for individuals older than eight years [30]. These findings were consistent with a study demonstrating a positive correlation between salivary testosterone concentrations and ratings of facial masculinity [35], as evidence reported that testosterone directly modulates craniofacial growth in humans [36]. The style of dominance varied among different species of the genus Macaca and when these dominances were associated with fWHR, despotic females had higher fWHRs than species that were socially tolerant [27]. The present study was not consistent with the theory of sexual dimorphism based on the effects of testosterone on craniofacial growth.

Sato S et al., conducted a study on professional basketball players and operationalised previously explored behaviours [33]. The study demonstrated that fWHR was significantly associated with Field Goals Attempted (FGA) and Efficiency (EFF) while controlling for minutes of play and body mass index. However, there was no significant association between the number of fouls committed (aggression) and fWHR [33]. Goetz SM et al., found that the positive fWHR-aggression association was more pronounced among individuals with low social status, supporting the notion that masculine behaviours are rooted in the desire to achieve high status, a desire that is stronger when individuals' current status is low [37]. Similarly, Welker KM et al., showed that the association between fWHR and risk-taking only existed among low-status individuals [38].

These studies have opened new areas for research in relational and social science fields, enhancing understanding of the interacting mechanisms among facial anthropometry, behaviour, desires and the social status of individuals. In another study, facial ratios predicted aggression but not trait dominance in men, even when aggression was measured by penalties per game; however, no association was found in women among hockey players [4]. In a trust game, male participants with higher facial-width ratios (wide faces) were more likely to exploit their counterparts' trust than male participants with lower facial-width-to-height ratios, but again, no correlation existed in women [24]. For the first time, Beltman N reported that fWHR and business performance were not associated, as behaviour might be controlled or restricted by the rules of the firm or company, highlighting the importance of confounders [29].

One component of fWHR, bizygomatic width, has been studied due to its close association with testosterone and indirectly with aggression [18]. The comparison of widths at the bizygomatic and bigonial arches demonstrated that males with a contracted bizygomatic arch were more independent and displayed a reduced capacity to join a group compared to subjects with an expanded bizygomatic arch; the latter cooperated more readily and found it easier to connect with the group [6]. Gabarre Armengol C et al., extended his previous research to both male and female subjects, calculating the WD of bizygomatic and bigonial widths and correlating them with personality traits. He found a significant relationship between emotional expression and alexithymia, as well as between WD and self-reliance [17].

In addition to fWHR and its components, forehead inclination has also been used to identify traits in individuals. Those with a greater backward slant of the forehead were found to be more impulsive than people with a lesser degree of forehead slant [28]. Kini AS and Kumar CNR reported that people with wide foreheads had intuitive natures and strong imaginations, while individuals with lengthy foreheads achieved permanent success. Square forehead individuals were considered honest and sincere [39]. Conversely, Tutsoy O and Gongor F concluded that wide foreheads were a sign of intuition and strong imagination, normal foreheads indicated balance and talent and individuals with narrow foreheads were very careful, punctual and possessed strong mathematical skills. Their methods were based on a three-stage algorithm: first, the face was detected from images using the Viola-Jones algorithm; next, crucial facial distance measurements were taken using a geometric-based facial distance measurement technique; and finally, facial distances were evaluated with physiognomy science to interpret the characteristic properties of the person based on mouth-chin, nose-forehead and eyes-cheeks facial measurements [40].

Most of the research has focused on fWHR or facial height, which is why a study was conducted on medical students from China, selecting the mandibular line angle as a new facial measurement. The analysis revealed that scores of self-reliance and sensitivity were negatively correlated with fWHR in males. Similarly, scores of social boldness in males were negatively correlated with bilateral mandibular line angles, while scores of vigilance and apprehension in females were negatively correlated with bilateral mandibular line angles [34].

Impulsiveness in recidivistic criminals showed a significant association with facial index and upper facial index. To generalise this study in the judiciary, samples from different jails were recommended [2]. As previous research has been restricted to only one or two facial measurements, a study was planned that included multiple craniofacial ratios and aggression in university students. The present study revealed that frontal, upper facial and total facial height-to-width indices were correlated with both general and verbal aggression. Additionally, frontal and upper facial indices correlated with physical aggression, while upper facial and total facial height-to-width indices were correlated with indirect aggression, but only in males [32], which seemed inconsistent with a previous study [4].

Limitation(s)

The limitation of present review is that it did not address the moderating factors that might affect the extent of the association between facial anthropometry and self-expressed behaviour. It also did not reveal the underlying causal factors of this association.

CONCLUSION(S)

The present review demonstrated a moderate positive correlation between facial features and self-behaviour. Facial morphology appeared to be associated with personality domains, which might act as a signal of status in humans and capuchins. The association between behaviours and facial anthropometry was more pronounced in males, with little or no association found in females. This data could be useful for researchers to extend this information to the next level by investigating the underlying causal mechanisms behind this association, which could be neuronal, hormonal, or genetic. In the present review, the behaviours in the included studies were assessed using questionnaires, which created a chance for performance or outcome reporting bias. Therefore, in the future, behaviours could be assessed by trained psychologists or sociologists. The meta-analysis suggested a moderate positive correlation among the studies, but the presence of substantial heterogeneity warrants cautious interpretation and calls for further investigation into the diverse outcomes observed across the included studies. If this review helps researchers explore new techniques for identifying personality traits or behaviours based on facial features, those facial measurements could serve as morphometric markers for personality identification.

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