Association between Handedness, Digit Ratio and Personality Traits among Adult Hausa Ethnic Group in Jigawa State, North Western Nigeria

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ABSTRACT

This study explored the relationship between handedness, 2D:4D ratio, and personality traits among the Hausa ethnic group in Jigawa State, Nigeria. Data from 500 participants aged 18-30 were analysed using a cross-sectional design and simple random sampling, confirming Hausa ethnicity and Nigerian origin. Handedness was assessed via the Edinburgh Handedness Inventory questionnaire, while the 2D:4D ratio was measured with a Vernier caliper. Personality traits were evaluated using the Big Five Inventory questionnaire. Significant associations were found between the 2D:4D ratio and openness to experience, neuroticism, and consciousness. Right-handedness (RHD) exhibited positive associations with openness to experience, consciousness, and agreeableness, while left-handedness (LHD) correlated with neuroticism. Simple linear regression revealed RHD as a significant predictor of openness to experience ($R^2 = 31\%$), consciousness ($R^2 = 49\%$), and agreeableness ($R^2 = 18\%$), while LHD predicted neuroticism ($R^2 = 22\%$). Additionally, the 2D:4D ratio emerged as a predictor of openness to experience ($R^2 = 17\%$), neuroticism ($R^2 = 8\%$), consciousness ($R^2 = 13\%$), and agreeableness ($R^2 = 17\%$). These findings underscore the influence of both cultural and biological factors on individual personality differences, with implications for mental health interventions in diverse populations.

Keywords: 2D:4D ratio, handedness, Hausa ethnic group, Jigawa state, personality traits

INTRODUCTION

Personality traits are enduring and relatively stable patterns of thoughts, feelings, and behaviours that shape an individual's unique way of interacting with the world, forming a fundamental aspect of their identity[1]. Psychologists have developed various models to categorise these traits, with the Five-Factor Model (also known as the Big Five) being one of the most recognised [2]. This model encompasses five broad dimensions: Openness to Experience, reflecting curiosity and creativity; Conscientiousness, indicating organisation and responsibility; Extraversion, capturing sociability and assertiveness; Agreeableness, representing kindness and empathy; and Neuroticism (or Emotional Stability), revealing emotional resilience or susceptibility to negative emotions [3]. These dimensions provide a comprehensive framework for understanding the multifaceted nature of personality traits, offering insights into how individuals differ in their characteristic behaviours and responses across diverse situations, including their handedness and 2D:4D ratio [4].

Handedness refers to the dominant hand preference in performing tasks [5]. In contrast, the 2D:4D ratio refers to the relative lengths of the second digit (index finger) and the fourth digit (ring finger) [6]. Both handedness and 2D:4D ratio have been suggested as potential prenatal hormonal exposure markers, particularly testosterone [7, 8].

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Numerous studies have examined the relationship between handedness and personality traits, with some indicating that left-handed individuals may exhibit different personality characteristics than right-handed individuals [9 - 11]. For example, left-handedness has been associated with creativity, divergent thinking, and higher levels of neuroticism [12]. Conversely, right-handedness has been linked to better verbal abilities and more traditional personality traits [13].

The 2D:4D ratio, on the other hand, has been proposed as a proxy for prenatal testosterone exposure. A lower ratio (index finger shorter than the ring finger) is believed to reflect higher prenatal testosterone levels [7]. A higher ratio (index finger longer than the ring finger) suggests lower prenatal testosterone levels [7]. Studies exploring the 2D:4D ratio have found associations with various traits, such as aggression, spatial ability, and specific personality dimensions [14, 15].

Most studies on the 2D:4D ratio, handedness, and personality traits have been conducted in Western populations [16-18], leaving a notable gap in our understanding of how these relationships manifest within distinct cultural contexts like the Hausa ethnic group of Jigawa State, in North-western Nigeria. The Hausa population, predominantly residing in this region, is known for its rich cultural heritage, and studying their unique characteristics can provide valuable insights into the interplay between biology and culture. Understanding the potential links between handedness, 2D:4D ratio, and personality traits among the Hausa ethnic group can contribute to our knowledge of these associations' universality or cultural specificity. Moreover, it may shed light on the role of prenatal hormone exposure in shaping personality development, particularly within this cultural context.

Therefore, this study investigated the association between handedness, 2D:4D ratio, and personality traits among the Hausa ethnic group in Jigawa State, Northwestern Nigeria. This study's significance lies in its potential to provide insights into the interplay between biology, culture, and personality traits within a specific ethnic group, with implications for psychology, anthropology, public health, and the broader study of human diversity.

MATERIALS AND METHODS

Study design, setting, and ethical statement

The cross-sectional study was conducted at the College of Health Science and Technology, Jahun, in Jigawa State, from January to December 2017. The College was chosen due to its unique advantage of hosting students representing all twenty-seven local

governments (LG) within the state, ensuring a diverse participant pool. At least 18 to 19 subjects were selected per LG. This broad representation enhances the generalizability of findings to the entire Hausa ethnic group in Jigawa State. Also, it enhances the reliability and validity of the study's findings. In addition to confirming ethnicity and originality through verifying the first parental generation, participants with any apparent deformities that could compromise the anthropological profile or other ethnicity were excluded from the study. Further inclusion criteria involved participants aged 18-30 years.

The Research Ethics Committee of Ahmadu Bello University, Zaria, approved the study protocol (ABUCHUSR/2017/UG/005), and participants signed written informed consent before data collection. Also, explanations of the techniques used to take the anthropometric measurements were provided. The anonymity and confidentiality of study data were guaranteed.

Sample size determination

The sample size for this study was obtained using the formula [19]:

$$[n = z^2pq/d^2]$$

Where:

n= the desired sample size

z= the standard normal deviation, usually set at 1.96 ($\approx$2.0)

p= the proportion in the target population when no work is available is taken as 50% (0.5)

q= 1.0-p =0.5

d= degree of accuracy desired, usually set at 0.05

Therefore, n= $(1.96)^2(0.5)\ (0.5)/\ (0.05)^2 = 384$

However, 500 participants were selected using simple random sampling and recruited to increase the generalizability of the result.

Measurement of digit length

The lengths of the second digit (index finger) and fourth digit (ring fingers) were measured from the fingertip to the midpoint of the basal crease on the ventral surface of the hand, using a digital Vernier caliper according to the previously reported protocol

[20]. The 2D:4D ratio was obtained by dividing these values. Both hands' fingers were measured twice to establish the measurements' repeatability. The mean of the duplicate measurements was taken for the right and the left hand and divided to calculate the 2D:4D ratio of the right and left hands separately.

Anthropometric measurement errors

This study employed precision measures to assess intra- and inter-observer measurement errors as outlined [21]. These measures include Absolute Technical Error of Measurement (aTEM), Relative Technical Error of Measurement (rTEM), Coefficient of Reliability (Rr), and Coefficient of Variation (Cv).

To calculate aTEM, the following formula was applied:

i. $\qquad$ aTEM $= \sqrt{\Sigma (m_1 - m_2)^2 / 2n}$

Here, 'n' represents the number of participants being measured, while 'm_1' and 'm_2' correspond to the first and second measurements.

Subsequently, rTEM was computed using the formula:

ii. $\qquad$ rTEM $= (aTEM / VAV) \times 100$

Where 'VAV' signifies the variable average value, essentially the mean of the two measurements.

The calculation of Rr involved the following formula:

iii. $\qquad$ Rr $= 1 - (aTEM^2 / SD^2)$

In this equation, 'SD' is the standard deviation of all measurements.

Finally, Cv was determined using the formula:

iv. $\qquad$ Cv $= (SD * 100) / X$

Where 'X' represents the mean of all measurements.

Determination of hand preference

The standardised Edinburgh Handedness Inventory questionnaire (EHI) (Cronbach's alpha 0.99) was employed to ascertain hand preference. The participants were presented with ten distinct tasks, each requiring a preference for either the right or left hand. These tasks included drawing, writing, throwing, using tools like opening jars, handling knives without forks, using scissors, employing a spoon, striking matches, and brushing teeth. In the

questionnaire, respondents were instructed to mark their preferred hand for each task by placing a "1" in either the right-hand column (RH) or the left-hand column (LH). If their preference for a particular hand was so strong that they would only use the other hand when necessary, they were instructed to mark a "2" in the relevant column. In cases where they felt equally comfortable with both hands, they marked "1" in both columns (1 | 1). To calculate the overall hand preference, the points from each column were summed to obtain the cumulative total (CT) (CT = RH + LH) and difference (D) (D = RH - LH). The final result (R) was calculated using R = D / CT * 100. The interpretation of the result is as follows:

- Left-Handed: R < -40

- Ambidextrous: $-40 \leq R \leq +40$

- Right-Handed: R > +40.

Assessment of personality traits

The Five-Factor Inventory questionnaire, known as NEO-FFI, is a concise version of the NEO-PI designed to efficiently and accurately assess adult personality traits. This model identifies five key dimensions: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. Respondents rate statements on a scale to measure their alignment with these traits, providing valuable insights into their personality characteristics. High scores on each dimension indicate specific personality tendencies, such as creativity, responsibility, sociability, compassion, or emotional stability, while low scores reflect contrasting traits. Participants rate 25 items on a five-point scale, ranging from 1 for "strongly disagree" to 5 for "strongly agree." To interpret the results, the scores for each factor are summed, resulting in a total score of 25 for each individual. A score of ≥ 12.5 indicates a higher level of that trait, while < 12.5 suggests a lower score. Completing the NEO-FFI typically takes 10-15 minutes.

Data analysis

The Shapiro-Wilk test was used to determine the normality of data. Results of descriptive statistics were expressed as mean ± SD (for continuous variables) or frequencies/percentages (for categorical variables). Pearson correlation and chi-square were used to determine the associations between 2D:4D/handedness and personality traits. Simple linear regression analyses were used to predict personality traits (outcome variable) from 2D:4D/handedness (predictor variables). Before running the simple linear regression, all possible 2-way interactions, multicollinearity, model

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assumptions (normality, linearity, and homoscedasticity), and outliers were checked using plots of residuals. Data were coded and analysed using SPSS version 28 (statistical product for service solution) software (IBM, New York, USA), and $P < 0.05$ was set as the level of significance.

RESULTS

The intra and inter-observer absolute TEM, relative TEM (<1.5%), coefficient of reliability (0.98), and coefficient of variation (<5.0%) for the measured digit lengths were within the acceptable limits. Hence, the table was not presented.

Table 1 provides vital descriptive statistics and frequency distributions for various variables in the dataset, giving insight into the sample participants' characteristics and attributes. The participants comprise 288 males and 211 females aged 18-30 years.

Table 1: Descriptive statistics of the demographics, 2D: 4D ratio, handedness, and personality traits of the study population (n = 500)

Variables	Frequency (%)	Mean (SD)
Age (Years)		21.95 (3.14)
R2D:4D		0.96 (0.04)
L2D:4D		0.96 (0.05)
Sex		
Male/Female	288 (57.8)/211 (42.2)	
Personality Traits		
Openness to experience		
[LS/HS]	27 (5.4)/473 (94.6)	
Neuroticism		
[LS/HS]	288 (45.6)/272 (54.4)	
Consciousness		
[LS/HS]	37 (7.4)/463 (92.6)	
Extroversion		
[LS/HS]	96 (19.2)/404 (80.8)	
Agreeableness		
[LS/HS]	18 (3.6)/482 (96.4)	
Handedness		
Right handedness	267 (53.4)	
Left-handedness	68 (13.6)	
Ambidextrous	165 (33.0)	

LS: Low score; HS: High score

Table 2 presents correlations between 2D:4D ratios and different personality traits. A significant negative correlation was observed between the R/L 2D:4D ratio and openness to experience, indicating that as the 2D:4D ratio increases, openness to experience tends to decrease. Similarly, significant positive correlations between the R/L2D:4D ratio and neuroticism and consciousness were observed, indicating that as the 2D:4D ratio increases, neuroticism/consciousness tends to increase. However, extroversion and agreeableness did not correlate significantly with the 2D:4D ratios.

Table 2: Association between 2D:4D ratio and personality traits (n = 500)

Variables	R2D:4D ratio	L2D:4D ratio
Openness to experience	-0.132*	-0.530*
Neuroticism	0.090*	0.086**
Consciousness	0.260**	0.080*
Extroversion	-0.019	-0.008
Agreeableness	-0.081	-0.029

R: Right; L: Left; D: Digit;

*$P < 0.05$; **$P < 0.01$

The association between "handedness" and "personality traits" is presented in Table 3. A statistically significant association was observed between RHD and openness to experience, consciousness, and agreeableness ($P<0.05$, adjusted residual >1.96). Similarly, LHD was significantly associated with neuroticism ($P<0.05$, adjusted residuals >1.96). However, extroversion did not affect handedness ($P>0.05$, adjusted residual <1.96).

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Table 3: Association between handedness and personality traits (n=500)

Variable	Handedness			χ^2 (df)	P- value
	RHD n (%)	LHD n (%)	AMD n (%)		
Personality traits					
Openness to experience [LS/HS]	15 (5.6)/252 (94.4)	5 (7.4)/63 (92.4)	7 (4.2)/158 (95.8)	9.429 (2)	0.022*
Adjusted residual [LS/HS]	-1.3/4.2	0.6/-1.1	0.4/0.1		
Neuroticism [LS/HS]	117 (43.8)/150 (56.2)	34 (50.0)/34 (50.0)	77(46.7)/88 (53.3)	7.942 (2)	0.036*
Adjusted residual [LS/HS]	1.4/-1.1	1.6/2.4	0.7/1.3		
Consciousness [LS/HS]	16 (6.0)/251 (94.0)	7 (10.3)/61 (89.7)	14(8.5)/151 (91.5)	3.886 (2)	0.049*
Adjusted residual [LS/HS]	0.9/3.6	0.1/1.2	0.2/1.6		
Extroversion [LS/HS]	56 (21.0)/211 (79.0)	10 (14.7)/58 (85.3)	30(18.2)/135 (81.8)	1.537 (2)	0.464
Adjusted residual [LS/HS]	0.9/1.7	0.3/1.3	0.3/1.2		
Agreeableness [LS/HS]	9 (3.4)/258 (96.6)	3 (4.4)/65 (95.6)	6(3.6)/159 (96.4)	4.170 (2)	0.038*
Adjusted residual [LS/HS]	0.1/4.5	0.2/0.6	0.1/1.5		

LS: Low score; HS: High score; RHD: Right handedness; LHD: Left handedness; AMB: Ambidextrous

*$P < 0.05$

Table 4 provides the results of several simple linear regression analyses for predicting personality traits using handedness and 2D:4D as predictor variables. The unstandardized coefficient for RHD as a predictor variable (X-intercept) and [O] as an outcome variable (Y-intercept) is 0.108, which suggests that a one-unit increase in the RHD related to [O] is associated with an increase of 0.108 units in the openness to experience personality trait, holding other variables constant. The model explains 31.0% of the variance in openness to experience, and the regression model is statistically significant (F = 12.35, P = 0.026). Similarly, the same interpretation for the following predictor variables [outcome variables]: LHD [N], RHD [C], RHD [A], 2D:4D [O], 2D:4D [N], 2D:4D [C], and 2D:4D [A] ($P < 0.05$) as in table 3. However, handedness and 2D:4D did not significantly predict extroversion personality traits ($P > 0.05$).

Table 4: Predictors of personality traits (n = 500)

Predictor variables	Outcome variables	Unstandardized B	R square	F-value	*P*-value
Handedness					
RHD	O	0.108	0.310	12.35	0.026*
LHD	N	0.071	0.220	9.12	0.032*
RHD	C	-1.036	0.490	25.62	0.001*
RHD	A	0.010	0.180	11.01	0.042*
Digit ratio					
2D: 4D ratio	O	-9.869	0.170	8.77	0.030*
2D: 4D ratio	N	7.751	0.080	4.16	0.042*
2D: 4D ratio	C	2.194	0.130	6.33	0.017*
2D: 4D ratio	E	-1.561	0.0001	0.17	0.080
2D: 4D ratio	A	-6.146	0.170	3.29	0.011*

Digit: Digit; O: Openness to experience; N: Neuroticism; C: Consciousness;

E: Extroversion; A: Agreeableness

*$P < 0.001$

DISCUSSION

The present study conducted amongst the adult Hausa ethnic group of Jigawa State, Northwestern Nigeria, aimed to explore the relationship between handedness, the 2D:4D finger length ratio, and personality traits. The findings reveal intriguing correlations between the 2D:4D ratio and specific personality traits. Firstly, the negative correlation between the 2D:4D ratio and openness to experience suggests that individuals with lower 2D:4D ratios (indicating a relatively longer ring finger) tend to exhibit greater openness to novel experiences and ideas. This aligns with previous studies, which have also suggested links between finger ratios and cognitive traits [22]. Secondly, the positive correlation between the 2D:4D ratio and conscientiousness (r = 0.260) implies that those with higher 2D:4D ratios (indicating a relatively longer index finger) may demonstrate a greater sense of responsibility and organisation. Lastly, the positive correlation between the 2D:4D ratio and neuroticism suggests that individuals with longer index fingers may be more prone to experiencing negative emotions and anxiety, although this correlation is relatively weak. It is important to note that these findings should be interpreted cautiously as they might not fully align with previous studies conducted in different populations [22-24], which genetic, cultural, or environmental factors could influence. Further research is needed to replicate and validate these associations in diverse populations and to understand the underlying mechanisms driving these relationships.

The study's findings indicate that right-handedness (RHD) is positively associated with three personality traits: openness to experience, consciousness, and agreeableness. This suggests that right-handed individuals tend to exhibit higher levels of these traits. Openness to experience reflects an inclination toward curiosity, creativity, and receptiveness to novel ideas, which might align with the precision and orderliness often associated with right-handed individuals [25]. Consciousness, characterised by organisation, responsibility, and goal-oriented behaviour, may connect with right-handedness, reflecting a preference for structured and orderly approaches to life [26]. Agreeableness, which indicates friendliness, cooperativeness, and empathy, could be linked to the social norms and conventions that right-handed individuals might more naturally adhere to [27]. In contrast, left-handedness (LHD) shows a significant association with neuroticism, implying that left-handed individuals tend to exhibit higher levels of emotional instability, anxiety, and negative affect. This could be attributed to societal factors, as left-handed individuals historically faced challenges and bias in a predominantly right-handed world, potentially leading to increased stress and anxiety.

The study's findings reveal significant associations between hand dominance (RHD - right-hand dominance and LHD - left-hand dominance) and various personality traits. Specifically, RHD was found to be a significant predictor of openness to experience ($R^2 = 31\%$), consciousness ($R^2 = 49\%$), and agreeableness ($R^2 = 18\%$). These results suggest that individuals with right-hand dominance tend to

exhibit higher levels of consciousness and openness to new experiences while displaying more agreeable personalities. On the other hand, LHD was found to be a significant predictor of neuroticism ($R^2 = 22\%$), indicating that left-handed individuals may have a greater propensity for neurotic tendencies. Previous studies have reported varying associations, with some indicating no significant link between handedness and personality traits [28-30]. In contrast, others have suggested potential correlations [31, 32], though not always consistent across traits. These discrepancies may be attributed to study methodologies, sample sizes, and cultural factors. Therefore, the current study's findings contribute valuable insights to the existing literature, highlighting distinct connections between hand dominance and specific personality traits. However, further research is needed to corroborate and better understand these relationships in diverse populations and settings.

These findings may have important implications, particularly for mental health interventions within culturally diverse populations. Our results suggest that interventions addressing personality traits and mental health outcomes may need to be tailored to account for cultural and biological factors. For example, interventions could consider the role of handedness as a potential factor to inform screening and treatment approaches.

One limitation of our study is the cross-sectional design, which limits our ability to draw firm conclusions about causality and the temporal relationships between the variables. Future research could address this limitation by using longitudinal designs to examine the dynamics between handedness, 2D:4D ratio, and personality traits over time more closely. Another limitation is our focus on only one ethnic group, the Hausa community in Jigawa State, Nigeria. Future studies should extend beyond this population to understand how these relationships vary across ethnicities and cultures.

Conclusion

This study uncovers a significant link between handedness, 2D:4D digit ratio, and personality traits within the Hausa community of Jigawa State, Northwestern Nigeria, highlighting the complex interplay of biology and culture in shaping individual differences. These findings emphasize the need to consider biological and cultural factors in mental health assessments and interventions, offering a more nuanced understanding of personality in culturally diverse populations.

Author contributions

NA wrote the original manuscript draft. MM conceptualise the research idea and methodology. SHL, AI, BAH, IT LMB, IM, BSA, AI AUA, and SJB did a literature search, data collection and analysis, and prepared the bibliography. MM reviewed and modified the final draft of the manuscript. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare that they have no conflicts of interest

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