Association of cheiloscopic patterns and second digit:fourth digit with academic performance among junior secondary students in Zaria, Nigeria

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ABSTRACT

Background: Academic performance is a term used for students based on how well they are doing in their studies. It is the outcome of education; the extent to which a student, teacher or institution has achieved their educational goals, while 2D:4D is the ratio of second (Index) to fourth (Ring) digit length. **Aim:** The study aimed to determine the relationship between 2D:4D and cheiloscopic pattern with academic performance. **Materials and Methods:** The study was conducted using 362 junior secondary school students age ranging from 9-20 years, and without obvious abnormality on their lips and digits. Their academic records from the first and second term results for a given session were taken and classified into high, average and low academic performance. The obtained data were analyzed using a chi square test. **Results:** The association between lip print patterns with academic performance was significant for both sexes with low academic performance being high with decrease in reticular lip print pattern, while the long vertical and branched type lip print pattern increased with decrease in academic performance in females. In males, the percentage frequency of the reticular lip print pattern increased with higher academic performance while the percentage frequency of undifferentiated type lip print pattern decreased with higher academic performance. There was no association between the 2D:4D and academic performance; however, there was sexual dimorphism. **Conclusion:** In conclusion, cheiloscopic patterns could be used in identification and as a predictor of students' academic performance for better academic planning and success while 2D:4D has no association with academic performance.

Key words: 2D:4D, academic performance, association, cheiloscopic pattern and students, second digit:fourth digit

INTRODUCTION

Second digit (2D):fourth digit (4D) is the ratio of 2D to 4D length. It is a sexually dimorphic trait that has been known for over 100 years with men on average, having lower 2D:4D than women do.[1-3] 2D:4D is established by the 13th week after conception and therefore, the dimorphism is found in the fetus and as well as in children,[4-7] and it is unaffected by puberty.[8] It appears to be universal across ethnic groups[9] and has been shown to exist in Mammals and primates.[10] 2D:4D ratio has been positively associated with prenatal estrogen and negatively associated with prenatal testosterone.[9,11] A paper published in 2011 by Zhengui and Cohn reported the 2D:4D in mice as being controlled by the balance of androgen to estrogen signaling and this is said to occur during a narrow window of digit development, the outcome remains unchanged after this

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period of development.[12] In human studies, the formation of the digits in utero is thought to occur by 13 weeks and the bone-to-bone ratio remains consistent from this point into adulthood.[13] During this period of development, if the fetus is exposed to androgens at levels which are thought to be sexually dimorphic, the growth rate of the 4th digit is increased. This can be observed by analyzing the 2D:4D of opposite sex dizygotic twins where the female twin has been exposed to excess androgens from her brother in utero, and so has a significantly lower 2D:4D.[14] This observation has not been made in adults as there has been no correlation between the sex hormone levels and the individual's 2D:4D,[15] and this implies that it is strictly the exposure in utero that causes this phenomenon. In the last few decades, the 2nd to 4th digit ratio has received increased research attention in psychology. These findings highlight the contributions of a German psychologist, Hans-Dieter Rosler, an early, unnoticed, predecessor of modern 2D:4D research. He classified the hand types into radial (longer index than ring finger), ulna (reverse pattern) intermediate hand types which reflects higher (more female-typical), lower (more male-typical), and intermediate 2D:4D, respectively. In recent years, many papers have been published highlighting the relationship between 2D:4D and human traits and behaviors.

The digit ratio is the ratio of the length of different digits or fingers. This is measured from the midpoint of bottom crease where the finger joins the hand to the tip of the finger.[16] The 2D:4D is calculated by dividing the length of the index finger of the right or left hand to the length of the ring finger of the same hand. A longer index finger will give a ratio higher than 1, while a longer ring finger will give a ratio of <1. In most individuals, the 2nd digit is typically shorter in both male and females; however, the difference between the lengths of the two digits is greater in females than in males. Studies show that a greater number of men have a shorter index finger than ring fingers than do women and this was noted in scientific literature as far back as the 1800s.[1,3]

In Nigeria, public discussions frequently focus on educational standards which have been seen as falling over the years. The public's unhappiness and anger becomes more apparent following the annual release of the West African Senior School Certificate Examination and National Examination council results.[17] It is often sensed that student performance does not match the government and parental investment in academic performance. Academic performance refers to students' academic achievement at the end of a chosen period. It assesses how the students deal with their studies, cope with or accomplish task and assignments given to them by their teachers or instructors. Individual differences in academic performance have been linked to difference in intelligence and personality.[18] Academic performance is also the outcome of education, the extent to which a student, teacher or an institution has achieved their set educational goals.[19] Performance in school is assessed in different ways. The most common method used is by grading subjects studied by the students. Students demonstrate their knowledge in different ways mostly by taking written and oral tests, doing practical assignments, performing presentations, turning in homework, and participating in class activities and discussions. Educators, trainers, and researchers have long been obsessed with understanding the factors contributing effectively to the quality of performance of students or learners. These factors are inside and outside school and the affect students' quality of academic achievement. Some of these factors may be categorized under the following: Student factors, family factors, school factors, and peer factors.[20] In Nigeria, State and Federal Ministries of Education are charged with monitoring schools academic achievements, and so devise methods of measuring success to create plans for improvements in academic performance.

Human personality can be traced early in the mother's womb, and it is reflected in fingerprints.[21] Everyone's fingerprints are unique, and so one can understand each person's innate potential, personality, and preferences by analyzing dermatoglyphics patterns of the individual. Lip prints like finger prints are normal skin markings, fissures in the form of wrinkles and grooves. They are present in the transition zone of the human lip between the inner labial mucosa and outer skin. Like finger prints, they are unique and differ from person to person.[22] The study of these prints present on the part of the vermilion border of the human lip is known as cheiloscopy.[23] This lip prints were first reported by the anthropologist Fischer who was the first to describe it in 1902.[24] The lip possesses furrows that can be classified into various types for identification purposes. Lip prints are unique and do not change during the life of an individual.[25-27] This feature allows lip prints to be put to use in various aspects of life especially in forensic medicine where it is used as an identification tool for crime detections. Between 1968 and 1971, two Japanese scientists, Suzuki and Tsuchihashi, carried out researches that revealed that the arrangement of lines on the vermilion is unique for individual and can be used for identification. Since then, researchers have shown that lip prints differ between sexes;[28] they have attributed the intersected type to be prominent in boys while the branched type prominent in girls.[28] They have also shown that lip prints vary among twins.[25,28-30] The lip prints of parent and offspring appear to be similar but not identical, which implied that lip print can be inherited.[31] Shakeshaft of the Institute of Psychiatry at King's College London and a lead author wrote, "Children differ in how easily they learn at school, our research shows that differences in students' educational achievement owe more to nature than nurture." He further stated, "this does not mean that genetics explains 60% of an individual's performance, but rather that genetics explains 60% of the

differences between individuals, in the population as it exists at the moment." He summarized that heritability is not fixed and if environmental influences change, then the influence of genetics on educational achievement may change too.[32]

This study sought to determine the association between 2D:4D and cheiloscopic patterns with academic performance.

MATERIALS AND METHODS

Ethical approval was obtained from the University Ethical Committee and informed consent obtained from the study subjects and the school authority. The study was carried out using two secondary schools located in Zaria; these were life-line academy and demonstration secondary schools. In each of the school, two term results of the students were collected to access each student's academic performance along with the fingerprint and lip print of these students. Only subjects free from any pathology on the lips and finger as well as no obvious genetic or congenital anomalies were included in this study. The age of the study population was between 9 and 20 years with a total population size of 362 consisting of 194 male and 168 females.

Academic performance was assessed using the average of the overall score in percentage for the subjects in the first and second terminal examination of the 2012/2013 academic session. The overall score consists of all the continuous assessment test and assignments done within the term and the scores on all the subjects obtained during the terminal examinations. Scores of the pupils in four major subjects, namely, Mathematics, English Language, Integrated Science, and Social Studies were obtained from the class examination register. They were graded as high (above 75%), average (between 50% and 74%) and low (<50%). The score of <50% was regarded as poor academic performance as adopted by Ibekwe *et al*.[33] For males, they were 56, 119, and 18 students in the low, average, and high performance groups, respectively, while for the females, they were 45, 96, and 27 students in the low, average, and high performance groups, respectively.

For the lip print collection, the subjects were made to sit in a relaxed position and after cleaning the lip with a cotton wool soaked in the methylated spirit; lip stick was applied on the lips and imprinted on a white paper in a single motion. The imprinted white paper was labeled and clipped to the questionnaire of the student to avoid mix up. The lip prints were studied carefully using the magnifying lens (×5) to reveal the furrows of the lip to identify and classify according to Suzuki and Tsuchihashi.[28]

Employing the dental formula generally used, the lip prints were divided into four quadrants and recorded as right upper quadrant, left upper quadrant, right lower quadrant, and left lower quadrant. The data were then presented for analysis. The pattern of Suzuki and Tsuchihashi was used in the presentation of the data, and the classification is as follows:

- Type I: Clear-cut grooves running vertically across the lip (complete vertical)
- Type I′: The grooves are straight but disappear half way instead of covering the entire breadth of the lip (incomplete vertical)
- Type II: The grooves are branched
- Type III: The grooves are reticular
- Type IV: The grooves are intersected
- Type V: The grooves do not fall into any of the above and cannot be differentiated morphologically.

Second digit:fourth digit data collection

Measurement were made, using digital Vernier calipers and classified based on Hans-Dieter Rosler method; radial (longer index than ring finger) is Type I, ulnar (longer ring than index finger) is Type III, and intermediate hand types is Type II.[7] The study participants were made to sit across a table from the examiner with the right elbow resting on the table top and the right palm facing upward at about 45°. The finger's basal crease was identified (the major crease at the base of the digit that is nearest to the palm). With the fingers in full extension, the fixed limb of the caliper was placed on the on the midpoint of the basal crease while the sliding limb of the caliper was extended past the end of the finger, then retracted gradually until it lay gently at the midline distal tip of the fingertip skin and the digital reading was recorded to the nearest 0.01 mm. The procedure was then repeated for the fourth finger on the same hand, after which both fingers were measured for the second time to confirm accuracy using the exact same protocol. After measuring 2D and 4D on the right hand, the protocol was repeated for the left hand. After collecting all 4 finger lengths in duplicate, finger (s) for which the measurements were discrepant by >1.00 mm were measured two more times to confirm accuracy. For each finger, we calculated the average of the measurements obtained, and we calculated the 2D:4D ratio as 2D divided by 4D.[34] For males, Type I was 12 and 21 left and right, respectively, Type II was 1 and 3 for left and right, respectively, while Type III was 181 and 170 for left and right hands, respectively. For females, Type I was 21 and 18 left and right, respectively, Type II was 11 and 8 for left and right, respectively, while Type III was 136 and 142 for left and right hands, respectively.

RESULTS

The data collected were analyzed using the Chi-square test. The results obtained are presented below; the *P* value was set at $P < 0.05$. It was observed that for the lip print pattern for both sexes, the long vertical type showed the highest percentage frequency, and this was followed by the reticular and the branched type while the least was the intersected

type [Tables 1-3]. Table 1 shows association between lip print pattern and academic performance in males; the undifferentiated lip print pattern was highest in the low academic performance (23.11%) while the reticular pattern was lowest in the same group (11.56%) when compared to average and high academic performance groups. It was observed that low academic performance was associated with low percentage frequency of the reticular lip print pattern in both sexes [Tables 1 and 2].

Table 2 shows there exists an association between academics performance and lip print patterns of females. In Table 2, it was observed that there is an increase in academic performance with decrease in the percentage frequencies of the both branched and long vertical lip print patterns [Table 2].

Table 3 analyzes both sexes together, and here it also shows association between lip prints pattern with academic performance. From this table, it can be seen that academic performance increases with decrease in the percentage frequency of the long vertical lip prints patterns. It is also observed that academic performance increases with increase in the percentage frequency of the reticular lip prints pattern with the least being 13.28% in the low academic performance group [Table 3].

Results for the association of second digit:fourth digit with academic performance

The Chi-square test results of the observed frequencies of these variables were not significant using a one-tail test; hence, there is no association between 2D:4D and academic performance. The results for male [Tables 4 and 5] and females [Tables 6 and 7] are presented.

From Tables 8 and 9, sexual dimorphism is obvious with the males having lower 2D:4D ratio than the females and the difference is statistically significant. The frequency of Type I and II 2D:4D pattern was more in the females than in males showing frequencies of 11.61% and 5.65% for females compared to 8.51% and 1.03% for the males, respectively [Table 8]. The same is also seen on Table 9 which shows the mean and standard deviation of the 2D to 4D ratio (2D:4D). The values are lower for both right and left hands reading 0.927 ± 0.065 and 0.941 ± 0.064, respectively, compared to the females with 0.967 ± 0.067 and 0.945 ± 0.065 for the right and left hands, respectively, and the difference is highly significant at $P < 0.001$.

Table 1: Association between male lip prints pattern with academic performance

Pattern	High academic performance (%)	Average academic performance (%)	Low academic performance (%)
Long vertical	30 (40.00)	189 (39.38)	99 (44.00)
Branched	11 (14.67)	82 (17.08)	37 (16.44)
Reticular	21 (28.00)	136 (28.33)	26 (11.56)
Intersected	2 (2.67)	23 (4.79)	11 (4.89)
Undifferentiated	11 (14.67)	50 (10.42)	52 (23.11)

n=194, χ^2=37.889, df=8, P<0.05

Table 2: Association between female lip prints pattern with academic performance

Pattern	High academic performance (%)	Average academic performance (%)	Low academic performance (%)
Long vertical	34 (30.91)	133 (34.73)	72 (39.34)
Branched	16 (14.55)	78 (20.37)	38 (20.77)
Reticular	24 (21.82)	98 (25.59)	29 (15.85)
Intersected	8 (7.27)	19 (4.96)	10 (5.46)
Undifferentiated	28 (25.46)	55 (14.36)	34 (18.58)

n=168, χ^2=15.583, df=8, P<0.05

Table 3: Association between lip prints pattern of both sex with academic performance

Pattern	High academic performance (%)	Average academic performance (%)	Low academic performance (%)
Long vertical	64 (34.60)	322 (37.31)	171 (41.91)
Branched	27 (14.60)	160 (18.54)	75 (18.38)
Reticular	45 (24.32)	234 (27.12)	55 (13.48)
Intersected	10 (5.41)	42 (4.87)	21 (5.15)
Undifferentiated	39 (21.08)	105 (12.17)	86 (21.08)

n=362, χ^2=44.049, df=8, P<0.05

Table 4: Association between male right second digit:fourth digit with academic performance

2D:4D type	High academic performance	Average academic performance	Low academic performance
I	1	13	7
II	0	2	1
III	18	104	48

n=194, χ^2=1.151, df=4, P>0.05, 2D=Second digit; 4D=Fourth digit

DISCUSSION

The study of cheiloscopy and 2D:4D has not enjoyed significant patronage among researchers in Nigeria as available data suggest. However, some studies have been done in the last 7 years relating them to certain parameters of the body.[11,35] In our study, it was observed that for the lip print pattern of both sexes, the long vertical type showed the highest percentage frequency, this was followed by the reticular and the branched type; this partially agrees with the study of lip print pattern among Punjabi population in which they found Type I (clear-cut vertical grooves that

run across the entire lip) to be the predominant pattern in both males and females, 44.64% and 40%, respectively, and this was followed by Type II (branched grooves), 21.43% in males and 22% in females.[36] Our findings revealed that females had more of the intersected and branched type lip print pattern compared to the males. This is at variance with the works done in 1970 and 1974 which showed that the intersected type is more in boys while the branched type prominent in girls.[28,30] In this study, the percentage frequency of intersected lip print pattern in high, average, and low academic performing students were 5.41%, 4.87%, and 5.15%, respectively, for both sexes [Table 3] while the values obtained in males group were 2.67%, 4.79%, and 4.89% for the high, average, and low academic performances, respectively, and this is lower than that of the females which were 7.27%, 4.96%, and 5.46% for high, average, and low academic performances, respectively; this shows the females have higher intersected pattern compared to the males. Our study subjects also had predominantly long vertical lip print pattern in both sexes which differs from studies in other areas. A study in the state of Karnataka, in India, found that Type IV (reticular grooves) was the predominant type while the study done by in Mumbai, India, found that Type I was predominant in the lower lip among the female subjects and this partially agrees with our study.[37] This variance can be explained by the ethnic difference in the subjects studied. In another study done by on Indo-Dravidian subjects, who are not quite the same as subjects from the state of Karnataka, they found that the predominant lip print type was Type III (intersecting grooves) showing that differences exist in patterns even in the same geographical area.[27] In a study done in Nnewi, Nigeria, the lip print patterns were classified according to Renaud's classification and type J pattern (horizontal grooves with other forms) was found to be predominant in both male (18.3%) and female (22.2%) and there was no statistically observed difference between male and female in individual lip print types.[38] No study was seen on lip prints with academic performance for use in comparing with the outcome of this study. Our work also shows that the branched lip print type is more predominant in females groups in both high, average, and low academic performance, respectively, (14.595%), (18.54%), and (18.382%) than in males group (14.667%), (17.083%), and (16.444%).

Table 5: An association between male left second digit:fourth digit with academic performance

2D:4D type	High academic performance	Average academic performance	Low academic performance
I	0	7	5
II	0	1	0
III	19	111	51

n=194, χ^2=2.626, df=8, P>0.05. 2D=Second digit; 4D=Fourth digit

Table 6: An association between female right second digit:fourth digit type with academic performance

2D:4D type	High academic performance	Average academic performance	Low academic performance
I	3	6	9
II	0	7	1
III	24	83	35

n=168, χ^2=8.942, df=4, P>0.05. 2D=Second digit; 4D=Fourth digit

Table 7: An association between female left second digit:fourth digit type with academic performance

2D:4D type	High academic performance	Average academic performance	Low academic performance
I	2	10	9
II	2	6	3
III	23	80	33

n=168, χ^2=3.413, df=4, P>0.05. 2D=Second digit; 4D=Fourth digit

The 2D:4D did not show any association with the academic performance in both males and females students. 2D:4D is therefore is not an indicator of academic performance in both sexes. The ratio however showed sexual dimorphism and agrees with several works from different authors globally. In some studies done in Nigeria using different ethnic groups, the findings were similar to those from other parts of the world. In a study done on the Ebira Ethnic Nationality of Nigeria, Andoni (Obolo) groups of Ijaw ethnic nationality in Nigeria and on the Igbo's and Yoruba's,[35,39,40] the results all showed sexual dimorphism

Table 8: Percentage frequency of second digit:fourth digit type with hand and sex

2D:4D type	Male right 2D:4D (%)	Male left 2D:4D (%)	Total (%)	Female right 2D:4D (%)	Female left 2D:4D (%)	Total (%)
I	12 (6.18)	21 (10.82)	33 (8.51)	18 (10.72)	21 (12.50)	39 (11.61)
II	1 (0.51)	3 (1.55)	4 (1.03)	8 (4.76)	11 (6.55)	19 (5.65)
III	181 (93.29)	170 (87.63)	351 (90.46)	142 (84.52)	136 (80.95)	278 (82.74)
Total	194	194	388	168	168	336

2D=Second digit; 4D=Fourth digit

Table 9: Mean and standard deviation of the second digit:fourth digit of right and left hands for both sexes

Group name	*n*	2D:4D mean (cm)	*P*
Male right 2D:4D	194	0.927±0.065	*P*<0.001
Male left 2D:4D	194	0.941±0.064	
Female left 2D:4D	168	0.967±0.067	
Female right 2D:4D	168	0.945±0.065	

2D=Second digit; 4D=Fourth digit

and this supports the theory that 2D:4D ratios have been reported to be negatively correlated with testosterone levels and positively associated with estrogen levels in adults.[7]

CONCLUSION

From the study, it can be concluded that there is an association between lip print patterns with academic performance in both sexes. The studies suggest the reticular lip print pattern as a marker in determining the academic performance for both sexes. It was observed that low academic performance was associated with low percentage frequency of the reticular lip print pattern in both sexes. In the case of the females, the long vertical and branched type lip print pattern increases with decrease in academic performance while the undifferentiated lip print pattern in this group increases with increase in academic performance. In males however, the percentage frequency of undifferentiated type lip print pattern decreases with increase academic performance. The study also showed no association between 2D:4D and academic performance.

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Conflicts of interest
There are no conflicts of interest.

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