Little finger curvature: a morphogenetic trait inherited by Mendelian pattern among the IGBO ethnic group of Nigeria

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ABSTRACT
The bending inward of the little finger is a trait that is inherited from parents and its inheritance follows a pattern. This study therefore, was conducted to investigate the pattern of inheritance of the little finger curvature amongst the Igbo ethnic group of Nigeria using 1022 subjects from 315 families with 630 parents and 392 offspring were Igbos. Both couple in a family, their parents and grandparents were of Igbo origin. The little finger curvature was observed physically in the father, mother, and at least a child in each family and recorded. The results were analysed by testing the significance of the observed values to the expected values. On the assumption that offspring outcome conforms to Mendelian simple dominant-recessive monohybrid cross. Statistically chi-square test at p<0.05 was used for the test and the inheritance pattern of the little finger curvature was determined. The results showed that the little finger curvature observed in this study was genetically determined and follows Mendelian single gene dominant-recessive pattern with the allele for curved little finger dominant over the allele for straight little finger. The results that were gotten will be useful in forensic and genetic studies and might also be useful as a Medico-legal tool in settlement of parental dispute.

Keywords: Little finger, curvature, trait, Mendelian pattern, Igbo tribe.
1. INTRODUCTION

The little finger is the smallest finger of the human hand, opposite the thumb, next to the ring finger. It is composed of three phalanges joined by two interphalangeal joints; distal and proximal. The distal joint can cause inward inclination of the distal phalange towards the ring finger in some individuals while in others it is straight at 180° with the middle phalange at the joint (Port, 2007). These variations represent two phenotypical distinct alternate expressions called alleles (Mader, 2006). This different variation in the curvature of the little finger is inherited from the parents and found to follow a pattern.

Inheritance is the practice of passing on genetic characteristics from parents to offspring. There are four patterns in which these characteristics can be inherited. They include; Dominant-Recessive, Sex-linked, Multifactorial and Mitochondrial inheritance. Dominant-Recessive inheritance involves two pairs of contrasting allele on a locus whereby one allele (the dominant allele) masks the expression of the other allele which is the recessive allele when they are in a heterozygous form. Sex-linked inheritance occurs when the gene that encodes for the trait is located on the sex chromosome (that is the X and Y chromosomes). Multifactorial or polygenic inheritance is when the conditions are not caused by a single gene, but rather as a result of interplay between genetic factors and environmental factors. In mitochondrial inheritance, DNA located in the mitochondria transfers genetic materials to offspring especially the mother’s egg, thus only females can transmit the trait to offspring, and however, they pass it on to all their offspring (University of Vermont, 2002).

Clinodactyly is a medical condition resulting in a bend or curvature of the 5th fingers toward the adjacent 4th finger (Fuente, 2005). It is usually associated with other abnormalities in many genetic syndromes like keratosis Palmaris and plantaris and in approximately 80% of individuals with Down’s syndrome (Aguirre-Negrete et al., 1981). Although can occur as a fairly common isolated anomaly which often goes unnoticed. In normal individuals however, the fifth finger can curve towards the fourth finger. This study focused on healthy subjects without any abnormality.

A better understanding of the pattern in which little finger curvature is inherited within families of Igbobi tribe will provide a family data on the manner of its inheritance pattern. With known genetic constitutions of the parents the outcome of specific offspring ratios will be predictable (Adams et al., 2012). Hence the study will help genetics in settlement of parental dispute in the studied population.

2. MATERIAL AND METHODS

A total of 1022 subjects were used for this study. The sample comprised of 315 families with 630 parents and 392 offspring. Only families that had couples, their parents and grandparents from Igbobi tribes were included in the study. Relying on the consent of the families and subjects, with the subject standing in anatomical position, each subject was asked to place his/her hand on a flat levelled surface with the dorsum of the hand facing upwards and the little finger was observed from a superior point of view and recorded. Subjects with abnormalities of the little finger were excluded from the study.

Data gotten were grouped according to families. In each family, how the trait was combined in the parents to produce offspring were noted. The number of offspring, male and female offspring that lacked or exhibited a trait when both, only one and non of the parents exhibited the trait were recorded and presented in tables. These combinations were represented with Mendelian monohybrid crosses. The expected numbers of offspring were calculated based on the assumption that they follow or conform to single gene dominant-recessive Mendelian fashion.

The results were tested statistically using the chi-square with a p-value of less than 0.05 considered significant and Level of confidence set at 95%.

3. RESULTS

As shown in table 1 75.1% of the population had straight little finger while 24.9% had curved little finger. The distribution between the males and females were insignificant in the same allele.

Table 2 showed the total number of offspring, male offspring and female offspring that were observed when both parents had curved little finger curvature or straight little finger curvature, also when either of the parents had curved or straight little finger curvature and another, the alternative allele. The expected frequencies calculated from the observed on the assumption that curved little finger is the dominant allele were also shown.

In table 3, the tests for significance between the observed frequencies and expected frequencies for offspring number from the different parental combinations were calculated, on the assumption that each of the alternate alleles was dominant following Mendelian laws and crosses. There were insignificant difference on the assumption that curved little finger was dominant.

4. DISCUSSION

Little finger curvature showed variation in the percentage distribution of the two alleles within the population studied. Those with straight little finger were commoner with 75.1% than curved little finger with 24.9%. This is higher but consistent with the study done by Onyije et al., (2012) on the prevalence of bent little finger in South-South Nigeria were they found the prevalence to be 7.1% in the same geographical area with current study. The increase in prevalence noticed might be due to the difference in sample sizes of the two studies. The result was also far higher than the prevalence of 1%, curved little finger in a previous research by Armand et al., (1968). Curved little finger occurs at a higher frequency than straight little finger in a population with Down syndrome (Fuente, 2005). This is because the syndrome makes the proximal interphalangeal joint to bend towards the fourth finger which the gene for curved little finger causes.

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Straight little finger is slightly lower in males than females, without any significant difference. This is contrary with a study done in Japanese village where 0.63% of the females and 0.46% male shave curved little finger (Saito, 1963). The same is seen in South South Nigeria where 5.5% females and 1.6% males possessed curved little finger (Onyije et al., 2012).

Curved little finger was found to be caused by a single dominant allele (Alexander et al., 2003; Dutta, 1965; Hersh et al., 1953). In the current study, the observed offspring ratios in tables 2 and 3 were both insignificant at p<0.05 to the expected ratios on the assumption that curved little finger was dominant. When straight little finger was assumed to be dominant, the resultant offspring ratios from the two parental combinations were highly significant. Therefore curved little finger is dominant while straight little finger is recessive in Igbo tribe.

Table 1
Shows the Frequency, Percentage and Distribution of Little Finger Curvature

<table>
<thead>
<tr>
<th>Allele</th>
<th>Total Population</th>
<th>Males</th>
<th>Females</th>
<th>Fathers</th>
<th>Mothers</th>
<th>Offspring</th>
<th>Male Offspring</th>
<th>Female Offspring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight</td>
<td>1022</td>
<td>514 (50.5%)</td>
<td>506 (49.5%)</td>
<td>315</td>
<td>315</td>
<td>392</td>
<td>203 (51.8%)</td>
<td>189 (48.2%)</td>
</tr>
<tr>
<td>Curved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parents Little Finger Curvature Combinations</th>
<th>Total number of Offspring</th>
<th>Number of Male Offspring</th>
<th>Number of Female Offspring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight in Father and Curved in Mother</td>
<td>51 (33.5)</td>
<td>16 (33.5)</td>
<td>67</td>
</tr>
<tr>
<td>Straight in Mother and Curved in Father</td>
<td>47 (46.5)</td>
<td>46 (46.5)</td>
<td>93</td>
</tr>
<tr>
<td>Straight in Both Parents</td>
<td>188 (200)</td>
<td>12 (0)</td>
<td>200</td>
</tr>
<tr>
<td>Curved in Both Parents</td>
<td>12 (8)</td>
<td>20 (24)</td>
<td>32</td>
</tr>
<tr>
<td>TOTAL</td>
<td>298</td>
<td>94</td>
<td>392</td>
</tr>
</tbody>
</table>
Table 3  
Showing the Test for frequency of Little Finger Curvature Pattern among Igbo Tribe

<table>
<thead>
<tr>
<th>Parents Little Finger Curvature Combinations</th>
<th>If Straight is dominant</th>
<th>If Curved is dominant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chi-Test Value</td>
<td>Inference</td>
</tr>
<tr>
<td></td>
<td>Calculated Chi-Value</td>
<td>Critical Chi-Value</td>
</tr>
<tr>
<td>Straight in Father Curved in Mother</td>
<td>18.28</td>
<td>Significant</td>
</tr>
<tr>
<td>Straight in Mother Curved in Father</td>
<td>0.01</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Straight in Both Parents</td>
<td>38.51</td>
<td>Significant</td>
</tr>
<tr>
<td>Curved in Both Parents</td>
<td>4.50</td>
<td>Significant</td>
</tr>
</tbody>
</table>

Little finger curvature had also been reported to follow single gene dominant recessive Mendelian pattern (Onyije et al., 2012; Beckman, 1960; Malik et al., 2010). Our data in table 2 also agrees to that assertion. Using the transmission pattern observed by Mendel on the assumption that the allele for curved little finger is dominant designated (L) and that for straight little finger is recessive designated (l). So, an individual that expresses the curved little finger may be homozygous dominant (LL) or heterozygous dominant (Ll) while the individual that expresses straight little finger will be homozygous recessive (ll). Therefore, when both parents had curved little finger, the possible cross may be between two heterozygous dominant (Ll x Ll) resulting in an expected ratio of 3:1 of the offspring based on the observed results above. There is an insignificant difference with the observed ratio of 2:1. This discrepancy would have been due to the different genetic composition of the parents which might not have been heterozygous only.

Now taking the straight little finger to be recessive, the only expected cross is between two homozygous recessive parents (ll x ll) giving rise to only ll offspring. The 12 offspring with curved little finger (Table 2) is a deviation, but the number is insignificant at p<0.05 between the observed and expected ratio hence straight little finger is recessive in conformity with Mendelian cross. Therefore, suggesting that curved little finger is dominant while straight little finger is recessive.

The pattern of inheritance is not sex-linked because the occurrences of each allele of the trait are significant independent of another and are transmitted equally (that is; mother to son and daughter, father to daughter and son) without any gender predisposition. Polygenic inheritance might be argued due to the gradual variations in angles made at distal interphalangeal joint (Beckman et al, 1960). This is not true because these are different distributions of the curved allele.

5. CONCLUSION
The pattern of inheritance of the little finger curvature follows the Mendelian single gene dominant-recessive pattern with the curved little finger being the dominant allele and the straight little finger being the recessive allele.

SUMMARY POINTS
1. Little finger curvature is a morphogenetic trait that its physical expressions on individuals are genetically determined
2. Two distinct physical characteristics (curved and straight little fingers) are noticed in individuals in individuals. These are reflections of the paired alleles of a single gene which controls the phenotypic manifestations
3. The trait is transmitted from parents to offspring through the genotypic make up of the parents. This transmission is consistent with Mendelian fashion of inheritance when he experimented with pea plants.
4. The trait is a simple dichotomous genetic model that can lead to deterministic outcome
FUTURE ISSUES
The DNA of the parents and offspring should be done in subsequent studies to ascertain true parenthood. In future the study have designed an economic tool and method which with further research can be used to determine the genetic profile of an individual in Igbo of populations of Nigeria.

DISCLOSURE STATEMENT
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