Relationship between Ratio of Second and Fourth Digit and Obesity Traits among Different Ethnic Groups in Ilorin, North Central Nigeria

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Abstract

Digit ratio (2D:4D) denotes the relative length of the second and fourth digits. There are contradicting reports on its relationship with ethnicity/race, whereas convincing studies show it is related to obesity. This cross-sectional study was undertaken to demystify ethnic difference in 2D:4D ratio and to analyze its relationship with obesity among adults in Ilorin Nigeria. The cross-sectional study included 701 individuals. Finger lengths were measured with electronic calipers and other anthropometric traits were measured with standard procedure. Student t test and one-way ANOVA were used to detect differences among groups and relationship was computed with Pearson correlation. The receiver operator characteristic curves were used to detect the diagnostic effect of 2D:4D for obesity. The obtained results showed sexual dimorphism in 2D:4D ratio and other anthropometrics at p < 0.01. Obesity was associated with significantly higher mean of 2D:4D in both genders (female 0.9814 ± 0.012:0.9700 ± 0.012; male 0.9700 ± 0.010:0.9592 ± 0.010 at p < 0.001). The area under the curve was 0.753 (95% CI 0.677-0.829, p < 0.01) and 0.798 (95% CI 0.756-0.804, p < 0.01) in female and male R2D:4D respectively for obesity, implying that 2D:4D might be a surrogate marker for obesity in future. No significant difference was found in 2D:4D among different ethnic groups studied (p >0.05); this result proved that there was no ethnic specificity in 2D:4D ratio among study participants. Thus, it can be reported that the digit ratio was related to high 2D:4D, but this cannot be said for different ethnic groups. The results imply that 2D:4D might be a good surrogate indicator for obesity, but not ethnicity.

Keywords: digit ratio, ethnic, obesity, sexual dimorphism, surrogate

Introduction

The ratio of second-to-fourth digit lengths (2D:4D) has been highlighted as a potentially useful phenotypic marker of steroid exposure inside uterus in vertebrates (Berenbaum et al., 2009). The relationship between 2D:4D and some adult behavioral and physiological consequences had been reported by McIntyre (2006). Evidence for an association between 2D:4D and reproductive success (Auger and Eustache, 2011) and breast cancer risk and age at onset of breast cancer (Muller et al., 2012) had been also shown. Even more, 2D:4D had been implicated in identifying risk of cardiovascular diseases (Manning and Bundred, 2001; Fink et al., 2003; 2006). Many studies have shown a relationship between 2D:4D and obesity measure (Finks et al., 2003; 2006; Alba et al., 2012; Oyeyemi et al., 2014). Since 2D:4D was determined prenatally and relatively stable throughout the life span (Malas et al., 2006; Trivers et al., 2006), it can be assumed it could be used as a putative marker for obesity at any stage in life.

Ilorin is usually known as a city of peace and harmony; the capital of Kwara State, North Central Nigeria, it lies on longitude 4.15˚E and between latitudes 4.35˚N and 8.30˚N of the Equator. Apart from the indigenous people who are predominantly Yoruba and the Yoruba speaking Fulanis residing in the town, there are other people of various tribes and ethnic groups such as the Hausas, Igbos, Nupe, Barubas, Igbonimas Okun-Yorubas among others, who are immigrants and settled in the town (Atomode, 2009). Thus, the city consists of divergent individuals from all parts of the country. The diversity of Nigerian population provides a unique opportunity to study the morphogenetic variations amongst the endogenous sub-populations and groups consisting of different tribes, languages and religious beliefs, living in different geographical and ecological conditions.
conditions. These sub-populations offer opportunities to study the anthropometric digit variations amongst these groups and tribes.

Previous studies suggested Body Mass Index (BMI), Waist-Height-ratio (WHtR) and Neck Circumference (NC) as simple screening measures for identifying overweight and metabolic syndrome (MetS) (Onat et al., 2009; Ashwell et al., 2012). Studies reported a significant relationship between 2D:4D and obesity measures (Fink et al., 2003; 2006; Kyriakidis et al., 2010), which implies that 2D:4D could be a proxy for obesity and MetS.

Earlier reports showed that 2D:4D might be affected by ethnicity (Manning et al., 2004; 2007) and latitude of the study area (Loehlin et al., 2006). Studies in this country reported no significant difference in 2D:4D among Yoruba and Igbo (Oladipo et al., 2009) and Igbo and Urhobos (Oladipo et al., 2006). But Gwunireama and Ihemelandu. (2010) had a contradictory result by reporting ethnic differences in 2D:4D in Andoni and Ikwerre ethnic groups within same geographical location in Niger delta and a recent report stating no significant difference in 2D:4D among men in Italy (Ancona) and Romania (Oradea) (Tomulescu and Nicoras, 2015). Also, a study in China reported no significant differences in the 2D:4D between Han and ethnic minorities (Xu and Zheng, 2015).

Since there are contradicting results, it was sought to highlight the difference in 2D:4D among different ethnic groups residing in Ilorin and analyze its relationship with WHtR and BMI.

Materials and Methods

Subjects

A descriptive cross-sectional study design was used in this study. Multi-stage sampling technique was used in view of the large size of the study area to recruit 450 males (18-67 years old) and 251 females (18-55 years old) into the study. The study was carried out between February and August 2012 in Ilorin. Anthropometric variables and digit lengths were measured and data on socio-demographic characteristics were recorded into a structured questionnaire. All participants gave and signed a consent form before the study and the research was performed in accordance with the principle of Helsinki Declaration.

Finger length measurements

Digit length was measured as described by Manning et al. (1998). Briefly, participants were asked to keep their hands supine on the table surface with the palm facing up, the digits straight in the same plane and fingers opened in a posture of ease (not kept together tight under artificial pressure). Care was taken to ensure that details of major creases could be seen on the hands by removing finger ornaments. The length of each digit was measured on the ventral aspect of hand from the proximal crease to the tip of the second and fourth fingers. In cases where there were two creases at the base of ring finger, the most proximal crease was chosen for the measurement. The length of both left and right hands were measured using an electronic digital caliper (Fh, China) measuring to 0.01 mm with the pointers on the caliper just touching the middle point of proximal crease and tip of second and fourth fingers. All measurements of digit length were made twice with digits completely protracted. The average of the two measurements was taken. The digit ratio (2D:4D) was calculated by dividing the length of the 2nd digit by that of the 4th.

Anthropometric measurements

Body weight was measured to nearest 0.1 kg using a well-calibrated, mechanical personal scale (Camry scale, model BR-9011). The subjects were weighed barefoot, wearing minimal clothing (T-shirt and trousers or blouse and skirt, and underwear), with the feet together in the centre of the weighing scales and the head looking forward. The scales were checked before each measurement for zero adjustment and standardized.

Body height was measured to the nearest 0.1 cm using a portable stadiometer (Seca 213), which consisted of an anthropometer with a simple headboard. During height measurements, the subjects were made to stand upright without shoes and head held erect such that the external auditory meatus and the lower border of the eye were in one horizontal plane (Frankfurt plane). Back of the subjects were positioned against the instrument and heels touching the floor plate of the stadiometer with knees and legs together, and arms hanging naturally by the side. A movable headboard was brought against the crown of the head and the height measurement read off at maximum inspiration.

Body mass index (BMI) was calculated as weight (kg) divided by height (m) squared (kg/m²).

Waist circumference (WC) was measured midway between the lowest rib and the iliac crest after exhaling, with the person standing without suppressing the skin, using an inextensible tape (measured to the nearest 0.1 cm). The measurement of WC was performed one time for each subject.

The ratio of weight-height (WHtR) was calculated as WC (cm) divided by height (cm).

Neck circumference (NC) was measured in the midway of the neck, between the mid-cervical spine and mid-anterior neck to 0.5 cm, if palpable, just below the laryngeal prominence (Onat et al., 2009).

The study was explained to potential participants and they were informed that the survey was completely voluntary. Their consents were sought before they were allowed to participate in the study. Subjects with injuries or deformities in any of the digits and those that cannot stand upright were left out of the study. Individuals that are not living in Ilorin were also left out of the study.

Statistical analyses

Continuous variables were expressed as mean ± standard deviation (SD) and discrete variables as numbers and percentages. Differences were assessed by student t-test and one-way ANOVA, while Cohen’s d was used to calculate effect sizes of group differences. One-tailed Pearson correlation coefficients were used for assessing the relationship between 2D:4D, as well as body weight, BMI, NC and WHtR, and partial correlations were calculated in order to remove confounding effects of body weight. ROCs
mode was used to detect predicting 2D:4D cutoff for obesity. Statistical significance was accepted at P values less than 0.01 and 0.05. All statistical analyses were conducted using IBM SPSS (Statistical Package for Social Sciences, release 24.0) for Mac.

Results

Re-measurement reliability of 2D:4D

There was a strong significant correlation between 2D:4D calculated at first and second measurement of digit lengths (correlation coefficient: \( p < 0.01 \); right hand \( r_1 = 0.945 \); left hand \( r_1 = 0.931 \)) and intra class correlation coefficients (ICC) (95% CI) was 0.901 (0.799-0.942) and 0.892 (0.766-0.902) for right and left hand respectively at \( p < 0.01 \). Also, the differences in 2D:4D-between-individuals were much greater than the difference within-individual. The results of the current study showed that 2D:4D reflected real differences between individuals and there was a high re-measurement reliability. All the 2D:4D ratios used in the analyses were mean values of the first and second measurements. Means of right and left 2D:4D recorded in the hereby study were significantly correlated (\( r = 0.816 \), \( p < 0.01 \)).

Basic characteristics of the study subjects

The basic characteristics of the study population, anthropometric traits and digit ratio, stratified by gender are shown in Table 1. All anthropometric parameters measured were significantly higher in male than female respondents, except WHtR, but 2D:4D in both hands was higher in female. Since the analysed parameters were different based on gender, the analyses were stratified based on gender criteria.

Table 1. Characteristics of the study population

<table>
<thead>
<tr>
<th>Female (251)</th>
<th>Male (450)</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>25.90 (6.50)</td>
<td>29.19 (10.00)</td>
</tr>
<tr>
<td>R2D:4D</td>
<td>0.9724 (0.0129)</td>
<td>0.9618 (0.0111)</td>
</tr>
<tr>
<td>L2D:4D</td>
<td>0.9650 (0.0139)</td>
<td>0.9599 (0.0114)</td>
</tr>
<tr>
<td>BMI (kg/m(^2))</td>
<td>22.60 (4.61)</td>
<td>23.69 (5.29)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>59.49 (10.11)</td>
<td>67.81 (11.21)</td>
</tr>
<tr>
<td>NC (cm)</td>
<td>30.29 (4.98)</td>
<td>32.64 (5.05)</td>
</tr>
<tr>
<td>WHtR</td>
<td>0.4106 (0.061)</td>
<td>0.4180 (0.052)</td>
</tr>
</tbody>
</table>

Data are presented as mean (SD). Student T-test was used to compare geometric mean levels across obesity category.

As shown in Table 2, there was statistically significant higher anthropometrics within the obesity group when compared with normal in female and male at \( p < 0.01 \); this implied that obesity might be related to these traits in the hereby study individuals.

Results of the current study showed that 2D:4D reflected real differences between individuals and there was a high re-measurement reliability. All the 2D:4D ratios used in the analyses were mean values of the first and second measurements. Means of right and left 2D:4D recorded in the hereby study were significantly correlated (\( r = 0.816 \), \( p < 0.01 \)).

Discussion

The hereby study showed sexual dimorphism in 2D:4D ratio, with female having higher ratio than male; this result is incongruent with earlier studies from Nigeria and other parts of the world (Fink et al., 2006; Manning et al., 2007;
Data are presented as mean (SD). One-way ANOVA was used to compare geometric mean levels across obesity category.

L2D4D: Ratio of left-hand second to the fourth digit

Between 2D:4D ratios and BMI and WHtR suggest that support this measure. Moreover, the positive correlation between BMI and WHtR when body weight was controlled, and also WHtR when NHtR when sex was controlled, might serve as a noninvasive study for prenatal hor.

Significant positive correlations between BMI and WHtR were also buttressed by the significant correlation between 2D:4D and BMI, which was in agreement with the results of Fink et al. (2006).

Table 4. Differences in anthropometrics stratified by tribe

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th></th>
<th>Male</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>H (67)</td>
<td>(0.013)</td>
<td>0.9656</td>
<td>(0.014)</td>
<td>0.4104</td>
</tr>
<tr>
<td>L2D+4D</td>
<td>0.9630</td>
<td>0.9607</td>
<td>(0.012)</td>
<td>0.4138</td>
</tr>
<tr>
<td>L2D-4D</td>
<td>0.9663</td>
<td>0.9627</td>
<td>(0.012)</td>
<td>0.4102</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>0.9697</td>
<td>0.9516</td>
<td>0.9516</td>
<td></td>
</tr>
<tr>
<td>NC (cm)</td>
<td>0.9476</td>
<td>0.9516</td>
<td>0.9516</td>
<td></td>
</tr>
<tr>
<td>WHtR</td>
<td>0.9476</td>
<td>0.9516</td>
<td>0.9516</td>
<td></td>
</tr>
</tbody>
</table>

Data are presented as mean (SD). One-way ANOVA was used to compare geometric mean levels across obesity category.

H: Hausa, I: Igbo, Y: Yoruba, BMI: Body mass index; NC: Neck circumference; WHtR: Waist to height ratio; R2D4D: Ratio of right-hand second to fourth digit and L2D4D: Ratio of left-hand second to the fourth digit.

Table 5. ROC analysis for optimal cutoff point of digit ratio for obesity as measured by BMI.

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th></th>
<th>Male</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R2D4D</td>
<td>0.753</td>
<td>0.677-0.829</td>
<td>0.976</td>
<td>0.673</td>
</tr>
<tr>
<td>L2D4D</td>
<td>0.684</td>
<td>0.606-0.762</td>
<td>0.966</td>
<td>0.596</td>
</tr>
<tr>
<td>L2D4D</td>
<td>0.798</td>
<td>0.756-0.840</td>
<td>0.963</td>
<td>0.708</td>
</tr>
<tr>
<td>L2D4D</td>
<td>0.755</td>
<td>0.705-0.804</td>
<td>0.951</td>
<td>0.67</td>
</tr>
</tbody>
</table>

p was significant at the 0.01 level; AUC: Area under curve.

Conclusions

In conclusion, 2D:4D showed no ethnic differences amongst the Nigerian Igbo, Hausa and Yoruba tribes residing in Ilorin metropolis, implying that digit ratio might be determined by the environment rather than the ethnic group. Moreover, measurement of 2D:4D ratio at any stage in life could serve as a simple and practical measure of obesity and MetS risk factors among adult males in Ilorin North-central Nigeria.
References


