The Journal of Anatomical Sciences
Email: anatomicaljournal@gmail.com

J. Anat Sci 14(1)

Body Circumferences, Body Mass Index, Waist-Hip-Ratio, and 2D:4D Ratios are Nutritional Screening Tools for Cardiovascular Diseases; A Study for Ethnic Minority in Developing Country

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ABSTRACT

Cardiovascular risk diseases (CVDs), which are among the most difficult health issues, are of global concern in emerging nations. However, among the ethnic minorities in Nigeria, the best screening tools for this nutritional relationship, including the hip and neck circumferences (HC and NC), waist-to-hip ratio (WHR), body mass index (BMI), second and fourth digit lengths (L2 and L4), and digit ratios have not been well presented. This study set out to identify local predictive models between dietary characteristics and digit lengths in the Idoma population, as well as to offer nutritional markers of CVDs. After receiving, filling out, and returning informed permission forms, 617 healthy Idoma individuals between the ages of 11 and 19 were randomly selected. The Ahmadu Bello University Zaria research committee provided an ethical report, and the study was carried out between February 11, 2021, and November 19, 2022. Digital stadiometer and inelastic measuring tape were used to measure the nutritional parameters, which include HC, NC, BMI, WHR, and L2, L4 and 2D:4D ratios, respectively.

When digit lengths and ratios (L2, L4, and 2D:4D) are known, none of the nutritional status screening tests used to identify CVDs in Idoma participants appeared to be outside of normal ranges, and the predictor (R2 Adjusted) was greater in females than in males (R^2 = 0.67 and 0.52, $P<0.05$). In conclusion, there is a connection between nutritional characteristics and the 2D:4D ratios in both sexes, and nutritional indicators demonstrated that the ethnic group is not at risk of CVDs.

Keywords: nutrition, ethnicity, cardiovascular disease, sex, regression models, stature

INTRODUCTION

Globally, basic medical and health professionals take nutritional evaluations and their research very seriously, particularly when the topics at hand are kids and teenagers. Finding long-lasting treatments for cardiovascular diseases (CVDs), which are a major cause of death in both industrialized and developing nations [1–3], is one of the difficulties facing scientists today. Nutrition and nutritional status are linked to CVDs. The main link between nutritional statuses and CVDs is provided by nutritional screening methods as NC, BMI, HC, and 2D:4D ratios [4–6]. The literature on body circumferences [7,8], digit lengths, and regression models to identify CVDs in extreme minorities in developing nations is, however, lacking.

Anthropometric, biochemical, and dietary assessments of nutritional status appear to be challenging [9]. The hardest part of this to comprehend is the idea behind its connection to testosterone levels [6,10], as the latter seem to raise levels of prenatal androgens. NC, HC, and WHR are anthropometric characteristics that have a positive relationship with digit ratios (2D:4D) [11], which are inversely correlated with testosterone levels and increase with increasing body circumference [12]. According to reports, males have bigger body circumferences and WHR than females, as well as lower 2D:4D ratios than females [5,11]. Although precise nutritional assessments for children and adolescents are extremely important for health policies [9], it has been challenging to quantify and document them.

A pandemic of damaged blood arteries with clots known as CVD is a cardiac condition that has killed a great number of individuals [3,13] . Anthropometric parameters for a searchlight into CVD include what a person eats and their access to energy. Lower digit ratios (2D:4D) in males likely to be prone to cardiovascular concerns such as myocardial infarction, hypertension, diabetes, and stroke [14–17]. This suggests that nutritional indicators predispose one to the CVD risk conditions.

There is promise despite the difficulties in anthropometric studies [9], particularly the choice of application between direct and indirect measurements, the optimal formula for data presentation, and screening instruments to investigate body compositions. This understanding is based on the ability of body circumferences and other anthropometric measurements to aid in investigations of adiposity [7,18,19]. Particularly around the waist and neck, adipose tissue and fatty deposits have drawn attention to the arterial blockage that causes heart failure, hypertension, and stroke [20–22]. Additionally, one of the earliest anthropometric methods used to study childhood and teenage obesity is body mass index (BMI), [16,23,24]. This is based on the idea that weight and height measurements are indicators of growth patterns and evaluations, in the previous works on school children and adolescents [25].

Worldwide, ethnic minorities have experienced marginalization, trauma, victimization, and relegation to the background [26]. Poor healthcare access and unfavorable government policies exist. Ethnic minorities are in danger of going extinct biologically if nothing is done because of the negative effects of the

government and insecurity [27]. CVDs of ethnic minorities have been poorly reported, despite the information on digit lengths as screening tools for nutritional studies [28].

Importantly, the quantity of prenatal androgens affects finger lengths (2D and 4D). There are reports that males have lower 2D:4D ratios than females, and that males have longer 2Ds than females do [10,11]. The application of whether hand (be it right or left-side) that can be employed, at what point of prenatal androgens can be administered for finger length extension, and whether the same biological mechanism can be used to explore weight and height, are contradictory studies about digit lengths [29]. A given group is thought to have 2D:4D ratios related to body circumferences [22]. Further connection between digit studies and cardiovascular risk disorders has been made possible by the hormonal influences that regulate body mass index, weight, and adiposity [30]. High BMI has been linked to advanced obesity [23,24], which can lead to chronic conditions like diabetes, renal problems, and edema.

Even community health professionals and international experts are baffled by the negative health implications of children's and teenagers' inadequate nutritional status. It is crucial that this study, which provides regional predictive models for the association between digit ratios (2D:4D) and nutritional indicators, puts ethnic minorities in the spotlight when nutritional screening tools for cardiovascular risk factors in children and adolescents are recognized.

MATERIALS AND METHODS

Idoma subjects (617) aged 11 to 19 years old that were males 59% (365) and females 252 (41%) got recruited randomly for this study in the 2020/2021 academic session. The subjects are indigenes of the Benue Valley in northern Nigeria who were secondary school students at the time of the study. Participants were served, filled, and returned the informed consent forms before the measurements were taken. Only those whose grandparents that are Idomas, physically healthy, and shown no deformities were included in the study. Ahmadu Bello University Zaria research committee approved the study.

Anthropometric Measurements: Subjects in climbed the digital stadiometer for the measurement of height and weight, as reported previously [9,31]. Nutritional parameters like the HC and NC were measured by the inelastic tape while the BMI and WHR were calculated as the indices for the subjects. Also, 2D:4D ratios was measured from the palmer creases of the second finger length and fourth finger length with digital Vernier caliper as the ratios. All measurements were in kg, mm and cm after the average of two measurements were taken as shown in figures 1 and 2 respectively. To prove that nutritional parameters like the NC, HC, and WHR as predisposing factors for CVDs can be predicted from the digit lengths, regression models were generated from the power of R^2 Adjusted method, which had been used for predictions [32].

Statistical Analysis: SPSS software (version 23.0 for windows; SPSS, Chicago, IL, USA) was used for data analysis. Description of data was done by the Student

t-test for means and standard deviation (SD). Simple Pearson's correlation analysis was used to establish the relationship between CVD predisposing indicators and digit ratios (2D:4D), and local models for digit lengths hand nutritional parameters by simple and multiple regression analyses. $P<0.05$ was considered statistically significant.

RESULTS

When this study was conducted using 617 Idoma subjects (in table 1), prevalence of obesity was higher in females 62 (24.6%) than in males 47 (12.9%), following previous criteria (16). Among the nutritional status indicators, the BMI (12.5%) appeared to be the most predisposing factor for CVDs while the NC was the least (11.2%). Strong observation appeared that more females were at the risk of CVDs than in males. All appeared to be statistically significant ($p<0.05$).

Sex differences (Table 2) in accordance with previous reports (5,7) occurred in 2D:4D and nutritional screening tools. Mean male 2D:4D ratio was significantly lower than mean female 2D:4D. The difference was statistically significant for both hands 2D:4D ratio (0.93 and 0.92, $p<0.05$). Mean male BMI was significantly lower than mean female BMI while mean male WHR was significantly higher than female WHR. (18.2+0.08 and 18.92+0.10; 0.48+0.05 and 0.47+0.06). Apart from WHR, the difference was significant for BMI in both sexes.

Correlations between 2D:4D ratios and body measurements (**Table 2**) reported association between digit ratios and body measures for nutritional screening tools that predisposes one for CVDs. In school boys, there was weak but significant positive association between right-hand 2D:4D with WHR, HC, NC, and BMI. Moreover, HC and WHR were found to correlate significantly negatively with left-hand 2D:4D ratio. In this study, no significant associations exist between the 2D:4D and body measures. The highest correlation coefficients between body measurements were found for NC and body weight, in both boys and girls.

Regression models **(Table 5)** reported strength of relationship between nutritional screening tools and digit lengths with ratios (2D:4D). It predicted nutritional screening tools (NSTs) better in female than in male, as the coefficient power was lower in male than in females, and statistically significant (R^2 Adjusted = 0.67 and 0.52, $p<0.05$).

DISCUSSION

In accord with our hypothetical statements, we found that nutritional screening tools such as NC, HC, WHR, and BMI were positively correlated with digit lengths L2 and L4 and 2D:4D ratios, and can be a signal to understand cardiovascular risk diseases among the Idoma (extreme ethnic minorities in Nigeria) population. This association was present in both school boys and girls and statistically significant. This may be due to the sexual dimorphic relationship of body fat and adipose tissues in men and women, which is known to be closely linked to sex-steroid hormonal differentiations [32], and thus influences cardiovascular disease activities [1,3].

Previous studies suggested some body compositions such as NC, BMI, HC, and WHR as a simple screening measure for

identifying nutritional statuses such as overweight, undernutrition, and obese individuals [5,7,25,33]. Our results of positive correlations between nutritional screening tools and digit lengths was by age-sex control, and data also suggest that the association is stronger in men than in women. Nutritional screening tools such as WHR and BMI as a measure of body fat distribution have been reported to have a high predictive value for cardiovascular risk factors [25,34,35].

Putative marker for prenatal testosterone (2D:4D) ratio and nutritional status indicators like the WHR, NC, and BMI suggest that low androgen levels in men are associated with a greater risk of obesity and other related nutritional issues, especially in children and adolescents. So, this result on the positive correlation between 2D:4D ratios and selected nutritional indicators suggests that digit ratio is a strong pointer for nutritional assessment like the undernutrition, overweight, and obese in both men and women, and may thus be an additional simple screening measure for CVDs. Being overweight or obese predisposes one to risk factor for CVDs associated with nutritional screening variables. Previously [5,11], reported that men with low 2D:4D ratios tend to have their first heart-related issues later in life than men with high 2D:4D ratios. The present findings of associations between 2D:4D ratios and nutritional screening indicators such as HC, NC, and BMI in both schoolboys and girls aged 11 to 19 years in the extreme ethnic minority in northern Nigeria suggest a possible predisposition towards CVDs through the digit lengths, especially the 2D:4D ratios, which serves as proxy to early sex-steroid characterization as reported elsewhere [6].

CONCLUSION

The current findings supported the notion that for two ethnic minorities living in underdeveloped nations, body composition and digit ratios (2D:4D) act as indicators of cardiovascular disease. As local reference data is supplied for ethnicities, this study will contribute to the body of knowledge on emerging health issues to identify cardiovascular risk factors.

Funding Statement: No funding

Author Contribution: Above listed authors contributed to the design, conduct, and analysis and manuscript production.

Declaration of Competing Interest: The authors do not have any conflicts of interest related to this publication

ACKNOWLEDGMENTS

We also thank the principals of St Francis Colleges Otukpo and Oju Local Government Areas, Jesus College Otukpo, and Federal Government Science and Technical Otukpa. We appreciate the Department of Anatomy and its staff members for their support during the postgraduate program. Also, the contributions from the students of the aforementioned secondary schools who made themselves available for data collections.

Table 1: Anthropometric characteristics of subjects with adverse nutritional screening indicators to cardiovascular diseases (CVDs) of Idoma ethnic group in Nigeria

		Baseline (N = 617)	Male (N = 365)	Female (N = 252)	P value
Variables	**Value**	**n**	**n**	**n**	
Hip circumference (cm)	>90.50	75 (12.2%)	81(22.2%)	90 (35.7%)	<0.001
Neck circumference (cm)	>29.76	69 (11.2%)	79 (21.6%)	78 (30.95)	<0.001
Waist-to-hip ratio	>0.91	71 (11.5%)	83 (22.74)	87 (34.5%)	<0.001
Body mass index	>25.01	77 (12.5%)	47 (12.9%)	62 (24.6%)	<0.001

N; number of subjects, D; digit, SEM; standard error of mean, *; p<0.05, **p<0.001 as statistical significance.

Table 2: Sex differences of digit lengths, ratios (2D:4D) and nutritional screening tools in Idoma ethnic group in Nigeria

	Baseline (N = 617)		Male (N = 365, 59.2%)		Female (N = 252, 40.8%)	
Variables	**Mean**	**SEM**	**Mean**	**SEM**	**Mean**	**SEM**
Hip circumference (cm)	90.50	0.03	90.55	0.06	90.43	0.07
Neck circumference (cm)	29.76	0.02	29.75	0.04	29.78	0.05
Waist-to-hip ratio	0.48	0.06	0.48	0.05	0.47	0.06
Body mass index	18.80	0.04	18.72	0.08	18.92	0.10
Right 2 digit length (cm)	66.62	0.18	70.24	0.32	66.18*	0.36
Right 4 digit length (cm)	70.85	0.17	74.46	0.35	69.73	0.35
Right digit ratio (2D:4D)	0.93	0.01	0.93	0.01	0.94	0.01
Left 2 digit length (cm)	66.49	0.20	71.26	0.36	66.02	0.40
Left 4 digit length (cm)	71.08	0.19	74.74	0.36	69.88**	0.43
Left digit ratio (2D:4D)	0.92	0.01	0.92	0.01	0.93**	0.02

N; number of subjects, D; digit, SEM; standard error of mean, *; p<0.05, **p<0.001 as statistical significance.

Table 3: Corsrelation coefficient of the relationship between digit lengths, 2D:4D ratios, and nutritional indicators of cardiovascular diseases in Idoma males

N = 365						
	Right 2d	Right 4d	Right 2d:4d	Left 2d	Left 4d	Left 2d:4d
Hip circumference (cm)	-0.01	-0.03	0.25	-0.07	-0.03	-0.29
Neck circumference (cm)	-0.01	0.03	0.34	0.02	0.00	0.024
BMI (body mass index)	0.004	-0.002	0.37	0.01	-0.01	0.33
WHR (waist-to-hip ratio)	-0.01	-0.04	0.41	-0.02	-0.002	-0.36

*P<0.05; **P<0.001 (significance levels), D (digit)

Table 4: Correlation coefficient of the relationship between digit lengths, 2D:4D ratios, and nutritional indicators of cardiovascular diseases in Idoma females

N = 252						
	Right 2d	Right 4d	Right 2d:4d	Left 2d	Left 4d	Left 2d:4d
Hip circumference (cm)	0.03	0.04	0.08	0.08	0.07	0.03
Neck circumference (cm)	-0.06	-0.01	-0.10	-0.03	-0.004	-0.09
Body mass index	0.05	0.06	0.01	0.01	0.04	-0.07
Waist-to-hip ratio	-0.03	-0.04	0.09	-0.05	-0.05	0.01

*P<0.05; **P<0.001 (significance levels), D (digit)

Table 5: Multiple Linear Regression Equations of nutritional screening tools on digit lengths, digit ratios (2D:4D) among sexes in Idoma ethnicity, Nigeria

Equation	**F**	**R**	**Adjusted R^2**	**p**
Male (n= 365)				
NST= 17.67+0.65*(R2D)+0.314*(R4D)	8.79	0.457	0.207	<0.001
NST= 17.55+0.14*(L2D)+0.553*(L4D)	7.63	0.474	0.223	<0.001
NST= 13.62+1.20*(R2D:4RD)+15.38*(L2D:L4D)	6.22	0.181	0.52	<0.001
Female (n=252)				
NST= 15.65+0.72*(R2D)-0.430*(R4D)	7.067	0.132	0.014	0.001
NST= 16.66-0.03*(L2D)-14*(L4D)	2.081	0.072	0.003	0.125
NST=12.84+3.98*(R2D:4RD)+6.50*(L2D:L4D)	3.644	0.095	0.67	0.027

NST = nutritional screening tools, R^2 = coefficient of determination, p<0.05 indicates significance.

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