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Determination of type of asymmetry in hand dimensions and its relationship with body mass index

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Abstract

Several documented evidences have indicated high influence of diseases on developmental instability measurable by asymmetry, there is however scarcity of reports on the type of asymmetry in hand and limited attempts to determine its relationship with body mass index (BMI) especially among Hausa population. The study was aimed to determine type(s) of asymmetry in hand dimensions and its relationship with BMI from selected tertiary institution in Kano metropolis, Nigeria. The study was cross sectional type which involved a total of 398 students (204 males and 194 females). The hand dimensions (digits length, palmer length and hand breadth) were measured using standard protocol. Body mass index was calculated from the measured height and weight. Asymmetry was determined as right-hand dimension minus left hand dimension (A = R-L). One sample t test was used to determine the type of asymmetry in hand dimensions. Pearson's correlation was used to determine the correlation between the asymmetry and BMI. The results of the study showed that digit length, hand breadth and palmar length exhibited directional asymmetry (DA). The degree of the DA was more expressed in index digit followed by middle digit and the least was the ring digit. The nature of DA in the hand dimensions was left warded except for the hand breadth which was observed to be right warded. There was no significant correlation observed between asymmetry in hand dimensions with BMI. In conclusion, there were no significant correlations between hand asymmetry and BMI among the studied Hausa population and hand dimensions exhibited directional type of asymmetry, as such may not be used as a surrogate indicator of developmental instability.

Keywords

Asymmetry, Body Mass Index, Hand dimension, Hausa ethnic group.

Introduction

Bilateral asymmetry refers to dissimilarity of parts on either side of a straight line or plane, or about a center or axis. Asymmetry of an individual is measured as the right minus the left value of the bilaterally paired trait. Departures from symmetry in bilateral structures have the potential to elucidate the effects of genetic and physiological, but also mechanical factors, during growth and development (Van Valen, 1962; Palmer, 1994; Gawlikowska-Sroka *et al*., 2013). Humans show bilateral symme-

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try in paired morphological traits such as ear size, digit length and breast volume. Three types of biological asymmetry exist in nature; fluctuating asymmetry, directional asymmetry, and antisymmetry. Fluctuating asymmetry (FA) is characterized by small random deviations from perfect bilateral symmetry. Directional asymmetry (DA) is characterized by a symmetry distribution that is not centered around zero but is biased significantly, towards larger traits either on the left or the right side (e.g the consistent asymmetry of the thoracic organs in humans and upper limb dimensions. Antisymmetry is characterized by being centered around a mean of zero (Van Valen, 1962; Palmer, 1994; Battles, 2009).

The existence of high influence of diseases on developmental instability measurable by asymmetry is a well-established phenomenon (Palmer, 1994; Palmer and Strobeck, 1986; Palmer and Strobeck, 2003), and as such, asymmetry is been used by proxy as a pointer to different types of stresses including environmental and occupational stress as well as developmental instability (Van Valen, 1962; Palmer, 1994; Gutnik et al., 2015). However, there is paucity of data on the type(s) of asymmetry in hand dimensions among Hausa population which might provide an insight on nature and extent of developmental instability prevalent among the Hausa. BMI, an established indicator of body adiposity and predictor of a cluster of genetic diseases has also been linked to developmental and evolutionary stress. We hypothesized in the present study that BMI and hand asymmetry are similar, being morphometric traits with developmental stress as common determinant. We therefore conducted this study to determine the type(s) of asymmetry in hand dimension and its correlation with BMI. This study which is first of its kind among the Hausa ethnic group of Kano may provide an insight on the asymmetry pattern in hand dimension and its relationship with BMI.

Materials and methods

The study was carried out at Bayero University Kano (BUK), College of Health Science (CHS) which comprises of four Faculties; Allied Health Sciences, Basic Medical Sciences, Clinical Sciences and Dentistry and Yusuf Maitama Sule University Kano (YMSUK), Faculty of Basic Medical Sciences (FBMS).

The study design was cross-sectional type. Using simple random sampling, a total of 398 (204 males and 194 females) of students of the CHS BUK and YMSUK Faculty of Basic Medical Sciences aged between 18 to 30 years participated in the study. Included participants are the registered students of BUK, CHS and YMSUK, FBMS which are physically fit and have no any physical malformation especially in their hands. Only student that belong to Hausa ethnic group was included. Informed consent was also gained from the participants before participation. The study was conducted in accordance with Helsinki declaration.

The sample size for study was determined using a standard formula (Cochrane, 1977):

$$n = \frac{Z^2 Pq}{d^2}$$

Where; n= minimum sample size, z= standard normal deviation with confidence interval of 95% (±1.96), p= proportion in the target population (50%) 0.5, q= 1-p, 1-0.5= 0.5, d = sampling error which is 5% (0.05).

$n = \frac{(1,96)^2 \times 0,5 \times 0,5}{0.05^{\ 2}} = 384$ (this was the minimum number of participants needed for the study).

The bio-data (age, sex, and location of the birth of the participants and ethnicity) were collected using structured proforma. The anthropometric parameters were measured from the participants and also recorded in the proforma.

Height was measured as a vertical distance from the standing surface to the vertex of the head using a stadiometer (RGZ, 160). Body weight of the subjects was measured using digital weighing scale (Omron, China). BMI was calculated as a ratio of weight in kg to the height per m^2. The lengths of the digits, hand breadth and palmer length were measured using vanier caliper (Neiko 01407A) (Figure 1) as described as adopted from Manning et al. (1998); Umar et al. (2016) and Asuku et al. (2017).

An asymmetry index, differences between left (L) and right (R) was used. This was determined by the formulae: A = R – L. The existence of DA was detected by subjecting the mean value of asymmetry against mean of zero using one sample *t*-test. An asymmetry is directional if mean value of signed symmetry differs significantly from zero; otherwise, it is considered as FA. The nature of the asymmetry was based on the sign of asymmetry. If R – L resulted in positive value then asymmetry is considered as right warded asymmetry (that is the right dimension is greater than the left) and if R – L resulted in negative value then asymmetry is considered as left warded asymmetry (that is the left dimension is greater than the right).

The data were expressed as mean ± standard deviation and range (minimum and maximum). One sampled t test was used to determine the type of asymmetry for each dimension. Pearson's correlation was used to determine the correlation between the hand dimension asymmetry and BMI. The data were analyzed using the Statistical Package for Social Sciences (SPSS) software version 20. $P < 0.05$ was considered as level of significance.

Results

Table 1 shows the descriptive statistics of the age, BMI and hand parameters of the students of BUK, CHS and YMSUK, FBMS. The mean age and BMI of the study population were 21.67±2.54 years and 20.23±3.55 kg/m^2 respectively. It was observed that in the all hand parameters, left hand dimensions showed higher values compared to the right-hand dimensions except in left thumb and left-hand breadth where the right-hand dimension was higher.

Table 2 shows type and nature of asymmetry in hand parameters among Hausa student of BUK, CHS and YMSUK, FBMS. The asymmetries were found to be left warded (negative asymmetry), where most of left-hand dimensions measurements were larger compared to the right, except for hand breadth. The mean hand asymmetries were significantly greater than zero. It was observed that all the hand asymmetry was directional asymmetry (DA) types. The degree of the directional asymmetry was more expressed in index digit followed by middle and the least was the ring digit.

Table 1. Descriptive Statistics of Age, Body Mass Index and Hand Parameters

Variables	Mean± SD	Min	Max
Age (years)	21.67±2.54	18.00	30.00
Body mass index (kg/meter square)	20.23±3.55	13.76	40.58
Right thumb (mm)	63.96±5.29	41.92	78.72
Right index (mm)	70.53±5.15	45.73	85.45
Right middle (mm)	79.56±5.67	53.21	96.17
Right ring (mm)	73.66±5.79	46.62	89.45
Right little (mm)	58.59±5.59	30.29	91.60
Right hand breadth (mm)	79.71±6.27	61.81	113.40
Right palmar length (mm)	107.83±6.99	70.03	125.33
Left thumb (mm)	64.63±5.34	40.60	82.56
Left index (mm)	71.52±5.47	47.11	90.50
Left middle (mm)	80.36±5.99	55.01	97.66
Left ring (mm)	74.17±5.98	46.16	90.93
Left little (mm)	58.94±5.29	33.01	71.95
Left hand breadth (mm)	79.06±6.26	55.35	95.35
Left palmer length (mm)	108.55±6.89	85.32	127.04

Table 2. Type of asymmetry in hand parameters among Hausa student of BUK, CHS and YMSUK, FBMS.

Variables	Mean	SEM	t Value	*P* Value	Type of Asymmetry	Nature
Thumb asymmetry	-0.67	2.65	-5.03	<0.001	DA	Left warded
Index asymmetry	-1.01	2.15	-9.34	<0.001	DA	Left warded
Middle asymmetry	-0.79	2.16	-7.35	<0.001	DA	Left warded
Ring asymmetry	-0.49	2.24	-4.42	<0.001	DA	Left warded
Little asymmetry	-0.35	2.31	-3.04	<0.001	DA	Left warded
Hand breadth asymmetry	0.64	2.63	4.87	<0.001	DA	Right warded
Palma length asymmetry	-0.70	3.45	-4.07	<0.001	DA	Left warded

DA; directional asymmetry, the mean asymmetry was tested against mean of zero

Table 3 shows the correlation of hand asymmetry with BMI among Hausa students of BUK, CHS and YMSUK, FBMS. It was observed that there was no significant .correlation between hand asymmetry with BMI in males. Similarly, there was no significance correlation between hand parameters asymmetry with BMI in females.

Table 3. Relationship of Hand Asymmetry with BMI among Hausa student of BUK, CHS and YMSUK, FBMS.

Variables (mm)	Correlation coefficient	
	Male BMI (kg/m²)	Female BMI (kg/m²)
Thumb asymmetry	-0.0114	0.0871
Index asymmetry	0.0021	-0.0371
Middle asymmetry	-0.0185	-0.0181
Ring asymmetry	-0.0775	-0.0775
Little asymmetry	0.0696	-0.0519
Hand breadth asymmetry	0.1359	-0.0700
Palmar asymmetry	-0.0111	-0.0047

Discussion

Bilateral asymmetry is one of the least understood aspects of the hand parameters. The measure of asymmetry which has mainly been used in population and genetic studies is the right and left differences (Gawlikowska-Sroka *et al*., 2013). The present study evaluated the existence and type of asymmetry with respect to the hand parameters and its relation to BMI among the Hausa population of Kano state. All the parameters showed directional type of asymmetry. This finding was similar with the previous study (Livshits *et al*., 1998). In humans a typical example of DA is found in upper limb dimensions (Livshits *et al*., 1998). This DA among *Homo sapiens* is mainly interpreted as effects of handedness (Steele, 2007). It was also reported that hand parameters especially the digits exhibited directional type of asymmetry; therefore, the hand parameters may not be a good indicator of developmental instability and stress, which is measured by proxy with any structure that exhibited fluctuating type of asymmetry (Palmer and Strobeck, 1986; Palmer and Strobeck, 2003). It can be suggested that asymmetry in hand dimensions especially among Hausa population should not be consider as good indicator of developmental stress and instability.

Additionally, other conditions explained by FA such as failure of affected organism to maintain developmental homeostasis (Palmer and Strobeck, 1986; Thornhill and Moller, 1998) may also not be explained by asymmetry in hand parameters. However, since perfect symmetry of bilateral traits is said to represent ideal development, while asymmetry including DA represents an inexact presentation of developmental design (Tomkinson, 2000). Therefore, it can be appreciated that DA is developmentally controlled and likely to have adaptive significance and generally thought to have adaptive basis and the asymmetry is just a norm not just as a result of imprecise development (Van and Valen, 1962).

There is no significant correlation between the hand asymmetry and BMI among the study population. This may be explained by the fact the hand exhibited directional asymmetry rather than fluctuating type. Most of the previous studies correlated the asymmetry with health indices (Fink *et al*., 2014) were based on FA not DA. Even among FA contrasting results were reported. For example, it was reported that

FA was associated with health, using seven health measures: BMI, waist/hip ratio, systolic blood pressure, total blood cholesterol, cardiorespiratory fitness, periodontal disease, and a number of medical conditions (Barry *et al.*, 2003). These associations were demonstrated to be independent of each other, and were robust to the confounding influences of exercise (Barry *et al.*, 2003). However, it was also documented that FA was not associated with waist/ hip ratio, BP, BMI, cholesterol, fitness, or periodontal disease when investigated in both univariate and multivariate models (Milne *et al*, 2003).

In another context, it should be noted that a well-developed, symmetrical phenotype indicates the ability of an individual to oppose the challenges of developmental stress in particular the environments (Møller and Swaddle, 1997). Therefore, asymmetry in general is imprecision of the developmental process both *in utero* and postnatally. It is also important to emphasize that different populations are exposed to different environmental conditions which may result in different expression of effect of environmental stress. Genetic variation is also another factor that may lead to difference in the manner an organism response to environmental stressor. Therefore, the expression of DA in hand dimensions among the Hausa population as well as absence of correlation of hand asymmetry with BMI may not be absolute and similar in comparison with other populations with different genetic and environmental conditions.

In conclusion, the measured hand dimensions exhibited directional type of asymmetry as such may not be used as good indicator of developmental instability by proxy among Hausa ethnic group. There is also no significant correlation between hand asymmetry with BMI among the Hausa population studied. Hence, may not be a good marker of generalized adiposity and its abnormal health related consequences.

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Conflict of interest

No existing or potential conflict of interest.

References

Asuku, A.Y., Danborno, B., Akuyam, S.A., Timbuak, J.A., Adamu, L.H. (2017). Relationship of second-to-fourth digit ratio with metabolic syndrome indices and serum biomarkers in Hausa ethnic group of Kano, Nigeria. J. Exp. Clin. Anat. 16:103-10.

Barry, J., Milne, Jay-belsky., Richie., Poulton, W., Murray, T., Avshalom, C. and Jules, K. (2003). Fluctuating asymmetry and physical health among young adult. Evol. Hum. Behav. 24: 53-63.

Battles, H., T. (2009). Long bone bilateral asymmetry in the nineteenth-century Stirrup court cemetery collection from London, Ontario. Can. Study. J. Anthropol. 21: 1–15.

Cochran, W. G. (1977). Sampling techniques (3rd ed.). New York: John Wiley & Sons.

Fink, B., Weege, B., Manning, J., T. and Trivers, R. (2014). Body symmetry and physicalstrength in human males. American Journal of Fluctuating and directional asymmetry in young human males: Effect of heavy working condition and socioeconomic status. Am. J. Phys. Anthropol. 143: 112–120.

Gawlikowska-Sroka, A., Dabrowski, P., Szczurowksi, J. and Staniowski, T. (2013). Analysis of interaction between nutritional and developmental instability in mediaeval population in Wroclaw. Anthropol. Rev. 76: 51–62.

Gutnik B, Skurvydas A, Zuoza A, et al. Evaluation of bilateral asymmetry between upper Limb masses in right-handed young adults of both sexes. Percept Mot Skills. 2015; 120(3):804–815.

Livshits, G., Yakovenko, K., Kletselman, L., Karasik, D. and Kobyliansky, E. (1998). Fluctuating asymmetry and morphometric variation of hand bones. Am. J. Phys. Anthropol. 107:125–136.

Manning, J. T. and Fraser. (1998). Evolution of human hand. Measurement of Hand, 12: 47-58.

Milne, B. J., Belsky, J., Poulton, R., Thomson, W. M., Caspi, A. and Kieser, J. (2003). Fluctuating asymmetry and physical health among young adults. Evol. Hum. Behav. 24: 53–63.

Møller, A. P, and Swaddle J. P. (1997). Asymmetry. Development. Stab. Evol. 23:138-11.

Palmer, A. R. (1994). Fluctuating asymmetry analyses: a primer In: Markow TA, editor, Developmental instability: its origins and evolutionary implications. Dordrecht, Netherlands: Kluwer; p. 335–364.

Palmer, A. R. and Strobeck, C. (1986). Fluctuating asymmetry: Measurement, analysis, patterns. Ann. Rev. Ecol. Syst. 17: 391–421.

Palmer, A. R. and Strobeck, C. (2003). Fluctuating asymmetry analysis revisted. In Developmental Instability, Causes and Consequences; Polak, M., Editor. Oxford University Press: Oxford, UK, pp. 279–319, ISBN-13: 978-0195143454.

Sizer, F. S, Piché, L. A, Whitney, E. N. and EWhitney. (2012). Nutrition: Concepts and Controversies. Toronto Canada. Cengage Learning, 21: 1983-92.

Steele, J. (2007). Handedness in past populations skeletal markers. Laterality, 5: 193–220.

Thornhill, R. and Moller, A. P. (1998). The relative importance of size and asymmetry in sexual selection. Behav. Ecol. 9: 546–551.

Tomkinson, G. R. (2000). Olds Ts. Inter. J. Sports Med. 21:545.

Umar, K.B., Danborno, B., Olorunshola, K.V., Adamu, L.H. (2016) Sexual dimorphism in hand grip strength and hand dimensions among Hausas. Ann. Bioanthropol. 4:90-5.

Van Valen L. (1962). A study of fluctuating asymmetry. Evol. 16(2):125–142.