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Research Article

ASPECTS OF MORPHOGENETIC TRAITS ASSOCIATED WITH PHYSIOLOGICAL COEFFICIENTS RELATED TO INCIDENCE OF OBESITY, HYPERTENSION, AND DIABETES MELLITUS

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ABSTRACT

The vulnerability to develop certain pathophysiological conditions may be linked to the morphogenetic traits of individuals. Hence, this study ascertained the relationship between some morphogenetic traits and physiological coefficients related to incidence of obesity, hypertension, and diabetes mellitus. Morphogenetic traits (height, weight, ABO blood group, Hitchhiker thumb, tongue rolling, and hand clasping) and physiological coefficients; body mass index, blood pressure (BP), random blood sugar (RBS), and fasting blood sugar (FBS) were measured during a free medical outreach in an institution in Eastern Nigeria. Seventy individuals participated; age (15–35 years), females: 36 (51.4%), males: 34 (48.6%), pre-obese (28.6%), obese 1 and 2 (2.9%, 2.9%), and BP (52.9% normal and 34.3% hypotensive). Twenty-five (35.7%) assayed FBS showed 1.4% diabetes, 17.1% pre-diabetes, and 17.1% normal, while 45 (64.3%) assayed RBS showed 57.1% normal and 7.2% pre-diabetes. There was significantly increased incidence of pre-diabetes and diabetes among tongue rollers when compared to non-tongue rollers ($p<0.05$). Incidence of obesity and hypertension was not significantly associated with tongue rolling. There was significant association between weight and incidence of obesity ($p<0.05$); no significant association with weight and incidence of hypertension and diabetes. There was also no association between height, ABO blood group, Hitchhiker thumb, hand clasping and incidence of obesity, hypertension, and diabetes ($p<0.05$). Conclusively, morphogenetic traits such as tongue rolling and body weight were associated with physiological coefficients related to incidence of diabetes and obesity, respectively, supporting the hypothesis that certain morphogenetic traits can be linked to the proneness of individuals to obesity and diabetes.

Keywords: Morphogenetic traits, Obesity, Hypertension, Diabetes mellitus, Physiological coefficients, Human variation

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INTRODUCTION

Human anatomical/physiological variations (both usual and unusual variations) result from mutations, gene flow, and sexual reproduction [1,2]. DNA mutation mediates genetic variation through alteration of the genes of persons in a population [3]. Gene flow gives rise to genetic variation as new persons with different combinations of gene move into a population, leading to movement of genes from one population to another [4]. Sexual reproduction enhances variable gene combinations in a population, leading to genetic variation [5,6]. Morphogenetic traits (physical observable traits that can be inherited either in a single gene or multifactorial pattern) play a role in genetic variation because morphogenetic traits are inherited from parent to offspring and give rise to various human anatomical/physiological variations. Examples of human morphogenetic traits include; height, weight, hand clasping, eye, and hair color. [7]. Several studies have associated various morphogenetic traits to other morphogenetic traits, different anatomical/physiological variations, and the vulnerability of an individual to certain pathophysiological conditions. ABO blood group was associated with the left hand clasping, body weight was associated with obesity, relationship between ABO blood groups and susceptibility to malaria was also reported, etc. [7-10].

Physiological coefficients related to obesity include height, body weight, and weight circumference as obesity can be determined from body mass index (BMI) expressed as kg/m^2 [11]. Height and weight are morphogenetic traits that can be transferred from parents to offspring [7]. Hypertension and diabetes mellitus are pathophysiological conditions related to alteration in homeostasis of blood pressure (BP) and blood sugar level resulting to its increase in the body [12,13]. The relationship between morphogenetic traits and incidence of obesity, hypertension, and diabetes mellitus is not fully elucidated. This study tends to evaluate the hypothesis that some morphogenetic traits could be an influencing factor over the proneness of individuals toward incidence of obesity, hypertension, and diabetes mellitus. Hence, this study was designed to ascertain the relationship between some morphogenetic trait (height, weight, ABO blood group, Hitchhiker thumb, tongue rolling, and hand clasping) and physiological coefficients (BMI, BP, random blood sugar [RBS], and fasting blood sugar [FBS]).

METHODS

Study design and sampling

This is a cross-sectional study; simple random technique [7] was used to select volunteered participants during a free medical outreach conducted by 200 level medical students of Gregory University Uturu (an institution in Eastern Nigeria). Total of 70 volunteered subjects participated in the study.

Ethics

This study was performed in accordance to basic principles of ethics; participants were informed of the relevance and procedure of the study, consent was obtained, and subjects' confidentiality was maintained.

Data collection

Sociodemographics (age, sex…) were obtained using a questionnaire [14,15]. Height (m) was measured using a stadiometer, weight (kg) was measured with human weighing balance, and BMI was expressed in kg/m^2 and was used to classify subjects into: Underweight (BMI <18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (BMI ≥25 kg/m^2), pre-obese (25–29.9 kg/m^2), obese

class 1 (30–34.9 kg/m^2), obese class 2 (35–39.9 kg/m^2), and obese class 3 (BMI ≥40 kg/m^2) [11]. Morphogenetic traits such as ABO blood group, tongue rolling, hand clasping, and hitchhiker thumb were performed as described by [7,16]. BP (mmHg) was measured using digital sphygmomanometer; outcome from the measurement was used to classify the volunteers into hypotension (BP <90/60 mmHg), normal (BP <120/80 mmHg), pre-hypertension (BP: 120/80–139/89 mmHg), hypertension stage 1 (BP: 140/90–159/99 mmHg), and hypertension stage 2 (BP ≥160/100 mmHg) [12,17]. Accu-Chek glucometer was used to measure the blood glucose level; FBS was evaluated on individuals that have not eaten as at the time of the evaluation, while those that have eaten were assayed for RBS. The outcome of the evaluation was used to classify the volunteered subjects as; normal (FBS <100 mg/dL), pre-diabetes (100–125 mg/dL), and diabetes (FBS >125 mg/dL). RBS assays were classified into normal (RBS <140 mg/dL), pre-diabetes (RBS <200 mg/dL), and diabetes (RBS >200 mg/dL) [18,19].

Data analysis

Data obtained were statistically analyzed using SPSS version 25; frequency and percentage analysis was ascertained. Crosstab was used for association between variables and chi-square (X^2) test was used to ascertain statistical significance at $p<0.05$.

RESULTS AND DISCUSSION

Subjects profile

Seventy (70) individuals within the age of 15–35 years participated in the study; about 36 (51.4%) were females while 34 (48.6%) were males. The height of participants ranged 1.4–1.9 m with weight range of 44–106 kg and BMI (17.2–37.5 kg/m^2). Greater percentage (51.4%) had O^+ followed by A^+ (25.7%). Most of the participant (74.3%) had hitchhiker thumb present in both thumbs, greater proportion (52.9%) being tongue rollers and 65.7% exhibiting right-hand clasping. Higher proportion 45 (64.2%) had (RBS: within 91–165 mg/dL) and 25 (35.7%) had (FBS: within 85–137). BP variations within systolic: 80–141 mmHg and diastolic: 52–110 mmHg were also observed (Table 1).

Table 1: Subjects profiles, morphogenetic traits, physiological coefficients of obesity, hypertension, and diabetes

Variables	Frequency, n (percentage, %)	Total, n (%)
Sex		
Male	36 (51.4)	70 (100)
Female	34 (48.6)	
Coefficients of obesity	Range	
Age	15–35 years	
Height	1.4–1.9 m	
Weight	44–106 kg	
BMI	17.2–37.5 kg/m^2	
Coefficients of hypertension	Range	
SBP	80–141 mmHg	
DBP	52–110 mmHg	
Coefficients of diabetes	Range	Total, n (%)
RBS	91–165 mg/dL	45 (64.3)
FBS	85–137 mg/dL	25 (35.7)
Blood groups		
A+	18 (25.7)	70 (100)
AB+	5 (7.1)	
B+	9 (12.9)	
O-	2 (2.9)	
O+	36 (51.4)	
Hitchhiker thumb		
Present in both	52 (74.3)	70 (100)
Present in one	4 (5.7)	
Absent in both	14 (20.0)	
Tongue rolling		
Yes	37 (52.9)	70 (100)
No	33 (47.1)	
Hand clasping		
Right	46 (65.7)	70 (100)
Left	24 (34.3)	

SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Association between morphogenetic traits and physiological coefficients related to obesity

BMI which is a physiological coefficient of obesity expressed as kg/m^2 was used to place individuals into the following; underweight (BMI <18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (BMI ≥25 kg/m^2), pre-obese (25–29.9 kg/m^2), obese class 1 (30–34.9 kg/m^2), obese class 2 (35–39.9 kg/m^2), and obese class 3 (BMI ≥40 kg/m^2) [11]. Among the 70 volunteered participants, 44 (62.9%) had normal BMI, underweight–1(1.4%), overweight–1(1.4%), pre-obese 20 (28.6%), obese class 1–2 (2.9), obese class 2–2 (2.9), and obese class 3–0 (0.0). There was significant association between weight and incidence of obesity ($p<0.05$). No significant association was observed between other morphogenetic traits (height, ABO blood groups, Hitchhiker thumb, tongue rolling, and hand clasping) and incidence of obesity at $p<0.05$ (Table 2). This finding supported reports of the previous studies that showed association between body weight and incidence of obesity [9,11].

Association between morphogenetic traits and physiological coefficients of hypertension

BP expressed as mmHg is a physiological coefficient related to hypertension, it was used to classify participants into; hypotension (BP <90/60 mmHg), normal (BP <120/80 mmHg), pre-hypertension (BP: 120/80–139/89 mmHg), hypertension stage 1 (BP: 140/90–159/99 mmHg), and hypertension stage 2 (BP ≥160/100 mmHg) [12,17]. Among the 70 volunteered participants, 24 (34.3%) were hypotensive, 32 (52.9%) had normal BP, 5 (7.1%) had pre-hypertension, 3 (4.3%) had hypertension stage 1, and 1(1.4%) had hypertension stage 2. No significant association was observed between the studied morphogenetic traits (height, weight, ABO blood groups, Hitchhiker thumb, tongue rolling, and hand clasping) and incidence of hypertension at $p<0.05$ (Table 3). This finding suggests that the studied morphogenetic traits were not linked to the proneness of an individual to incidence of hypertension.

Association between morphogenetic traits and physiological coefficients of diabetes mellitus

Diabetes mellitus is a pathophysiological condition associated with impaired glucose homeostasis measured as either FBS or RBS expressed as mg/dL [13]. Among the 70 volunteered participants; 25 (35.7%) was assayed for FBS and classified into normal (FBS <100 mg/dL), pre-diabetes (100–125 mg/dL), and diabetes (FBS >125 mg/dL). 45 (64.3%) was assayed for RBS and classified into normal (RBS <140 mg/dL), pre-diabetes (RBS <200 mg/dL), and diabetes (RBS >200 mg/dL) [18,19]. FBS showed 1.4% diabetes, 17.1% pre-diabetes, and 17.1% normal, while RBS showed 57.1% normal and 7.2% pre-diabetes. There was significantly increased incidence of pre-diabetes and diabetes among tongue rollers when compared to non-tongue rollers ($p<0.05$). No significant association was observed between other morphogenetic traits (height, weight, ABO blood groups, Hitchhiker thumb, and hand clasping) and incidence of diabetes mellitus at $p<0.05$ (Table 4).

This finding suggests that tongue rolling can be linked to the proneness of individuals to diabetes mellitus; thus, tongue rollers may be more prone to diabetes than non-tongue rollers, while other morphogenetic traits measured in this study could not be linked to the proneness of an individual to diabetes mellitus. Although, several studies have been performed on association between tongue rolling and various anatomical/physiological variations [7,20,21]; this study was the first to demonstrate the association between tongue rolling and incidence of diabetes mellitus.

Despites the existence of several morphogenetic traits, the scope of this study was limited to evaluating the relationship between some

Table 2: Morphogenetic traits and obesity

Morphogenetic traits	**Physiological coefficients n (%)**						**X^2 (p-value)**
BMI variables	**Underweight**	**Normal**	**Overweight**	**Pre-obese**	**Obese 1**	**Obese 2**	
Height	1 (1.4)	44 (62.9)	1 (1.4)	20 (28.6)	2 (2.9)	2 (2.9)	6.89 (0.96)
Weight	1 (1.4)	44 (62.9)	1 (1.4)	20 (28.6)	2 (2.9)	2 (2.9)	73.27 (0.000)*
Blood groups							
A+	0 (0.0)	11 (15.7)	0 (0.0)	6 (8.6)	1 (1.4)	0 (0.0)	13.19 (0.87)
AB+	0 (0.0)	4 (5.7)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	
B+	0 (0.0)	4 (5.7)	1 (1.4)	3 (4.3)	0 (0.0)	1 (1.4)	
O-	0 (0.0)	1 (1.4)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	
O+	1 (1.4)	24 (34.3)	0 (0.0)	9 (12.9)	1 (1.4)	1 (1.4)	
Hitchhiker thumb							
Present in both	1 (1.4)	33 (47.1)	1 (1.4)	14 (26.9)	2 (2.9)	2 (2.9)	6.54 (0.77)
Present in one	0 (0.0)	2 (2.9)	0 (0.0)	2 (2.9)	0 (0.0)	0 (0.0)	
Absent in both	0 (0.0)	9 (12.9)	0 (0.0)	4 (5.7)	0 (0.0)	0 (0.0)	
Tongue rolling							
Yes	1 (1.4)	23 (32.9)	0 (0.0)	9 (12.9)	1 (1.4)	2 (2.9)	4.08 (0.54)
No	0 (0.0)	21 (30.0)	1 (1.4)	11 (15.7)	1 (1.4)	0 (0.0)	
Hand clasping							
Right	1 (1.4)	28 (40.0)	0 (0.0)	4 (5.4)	0 (0.0)	2 (2.9)	10.61 (0.06)
Left	0 (0.0)	16 (22.9)	1 (1.4)	16 (22.9)	2 (2.9)	0 (0.0)	

*Values are statistically significance at $P<0.05$, n: Frequency, %: Percentage

Table 3: Morphogenetic traits and hypertension

Morphogenetic	**Physiological coefficients n (%)**					**X^2 (p-value)**
BMI variables	**Hypotension**	**Normal**	**Pre-hypertension**	**Hypertension1**	**Hypertension2**	
Height	24 (34.3)	37 (52.9)	5 (7.1)	3 (4.3)	1 (1.4)	8.41 (0.75)
Weight	24 (34.3)	37 (52.9)	5 (7.1)	3 (4.3)	1 (1.4)	18.09 (0.11)
Blood groups						
A+	7 (10.0)	8 (11.4)	1 (1.4)	1 (1.4)	1 (1.4)	16.53 (0.41)
AB+	1 (1.4)	2 (2.9)	1 (1.4)	1 (1.4)	0 (0.0)	
B+	4 (5.7)	5 (7.1)	0 (0.0)	0 (0.0)	0 (0.0)	
O-	1 (1.4)	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	
O+	11 (15.7)	22 (31.4)	2 (2.9)	1 (1.4)	0 (0.0)	
Hitchhiker thumb						
Present in both	19 (27.1)	26 (37.1)	3 (4.3)	3 (4.3)	1 (1.4)	4.28 (0.83)
Present in one	2 (2.9)	2 (2.9)	0 (0.0)	0 (0.0)	0 (0.0)	
Absent in both	3 (4.3)	9 (12.9)	2 (2.9)	0 (0.0)	0 (0.0)	
Tongue rolling						
Yes	12 (17.1)	21 (30.0)	1 (1.4)	2 (2.9)	1 (1.4)	3.59 (0.46)
No	12 (17.1)	16 (22.9)	4 (5.7)	1 (1.4)	0 (0.0)	
Hand clasping						
Right	13 (18.6)	26 (37.1)	5 (7.1)	1 (1.4)	1 (1.4)	6.29 (0.18)
Left	11 (15.7)	11 (15.7)	0 (0.0)	2 (2.9)	0 (0.0)	
Left	3 (4.3)	4 (5.7)	0 (0.0)	13 (18.6)	4 (5.7)	

*Values are statistically significance at $P<0.05$, n: Frequency, %: Percentage

Table 4: Morphogenetic traits and diabetes mellitus

Morphogenetic	**Physiological coefficients n (%)**					**X^2 (p-value)**
	FBS			**Random blood sugar (RBS)**		
BMI variables	**Pre-diabetes**	**Normal**	**Diabetes**	**Normal**	**Pre-diabetes**	
Height	12 (17.1)	12 (17.1)	1 (1.4)	40 (57.1)	5 (7.2)	5.47 (0.99)
Weight	12 (17.1)	12 (17.1)	1 (1.4)	40 (57.1)	5 (7.2)	11.08 (0.75)
Blood groups						
A+	4 (5.7)	3 (4.3)	0 (0.0)	10 (14.3)	1 (1.4)	25.61 (0.18)
AB+	0 (0.0)	1 (1.4)	0 (0.0)	4 (5.7)	0 (0.0)	
B+	2 (2.9)	1 (1.4)	0 (0.0)	5 (7.1)	1 (1.4)	
O-	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.4)	
O+	5 (7.1)	7 (10.0)	1 (1.4)	21 (30.0)	2 (2.9)	
Hitchhiker thumb						
Present in both	8 (11.4)	9 (12.9)	1 (1.4)	30 (42.9)	4 (5.8)	3.91 (0.95)
Present in one	0 (0.0)	1 (1.4)	0 (0.0)	3 (4.3)	0 (0.0)	
Absent in both	4 (5.7)	2 (2.9)	0 (0.0)	7 (10.0)	1 (1.4)	
Tongue rolling						
Yes	10 (14.3)	3 (4.3)	1 (1.4)	16 (22.9)	1 (1.4)	13.75 (0.02)*
No	2 (2.9)	9 (12.9)	0 (0.0)	24 (34.3)	4 (5.7)	
Hand clasping						
Right	9 (12.9)	8 (11.4)	1 (1.4)	27 (38.6)	1 (1.4)	7.01 (0.22)
Left	3 (4.3)	4 (5.7)	0 (0.0)	13 (18.6)	4 (5.7)	

*Values are statistically significance at $P<0.05$, n: Frequency, %: Percentage, FBS: Fasting blood sugar, RBS: Random blood sugar

morphogenetic traits (height, weight, ABO blood group, Hitchhiker thumb, tongue rolling, and hand clasping) and physiological coefficients (BMI), BP, RBS, and FBS, which may also not be the only physiological coefficients related to incidence of obesity, hypertension, and diabetes mellitus. Sample size was limited to the population of the volunteered individuals that participated in the free medical outreach conducted by 200 level medical students in the institution.

Considering the observed relationship between tongue rolling and diabetes mellitus which suggests that tongue roller may be more prone to diabetes mellitus than non-tongue rollers, it is recommended that;

1. Further studies be carried out in higher population, tribe, and ethnicity
2. More studies of this kind should be performed on diabetes mellitus population in different health facility, countries, and continent
3. Association studies of tongue rolling with other morphogenetic traits, anatomical/physiological coefficients as well as pathophysiological conditions should be performed
4. Good nutritional habits are recommended for avoidance of diabetes mellitus especially for the tongue rollers based on the report from this study.

CONCLUSION

This study demonstrated for the 1st time that the morphogenetic trait (tongue rolling) could be linked to incidence of diabetes mellitus as tongue rollers may be more prone to diabetes than non-tongue rollers. This study also supported reports on the association between weight and obesity as such was observed in the findings. Hence, this report supported the hypothesis that certain morphogenetic traits can be associated with the proneness of an individual to some pathophysiological conditions such as obesity, hypertension, and diabetes mellitus; although no significant association was observed between morphogenetic traits measured in this study and hypertension.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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The study was performed without financial support.

DATA AVAILABILITY

- Data will be made available on reasonable request.

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