IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 14, Issue 12 Ver. VI (Dec. 2015), PP 83-89
www.iosrjournals.org

Correlation between Blood group, Hypertension, Obesity, Diabetes, and combination of Prehypertension and Pre-Diabetes in School Aged Children and Adolescents in Port Harcourt.

Arthur Nwafor Chuemere[1], Oluwadare Joyce Olorunfemi[1], Jonah Uzoma Nwogu[2], Owate Faith Mmom[3], Emmanuel Onuka Agbai[4] and Vitalis Voh Vurey[4]

[1]*Department of Human Physiology, Faculty of Basic medical Sciences, College of Health Sciences, University of Port Harcourt, P.M.B. 5323, Port Harcourt, Rivers State, Nigeria.*
[2]*Department of Educational Management, Faculty of Education, University of Port Harcourt, P.M.B. 5323, Port Harcourt, Rivers State, Nigeria.*
[3]*Information and Communication Technology Centre, University of Port Harcourt, P.M.B. 5323, Port Harcourt, Rivers State, Nigeria.*
[4]*Department of Human Physiology, Faculty of Basic Medical Sciences, Madonna University, P.M.B. 48, Elele, Port Harcourt, Rivers State.*

Abstract:
Background: *There is little information regarding childhood and adolescent obesity, hypertension and diabetes epidemical situation and ABO blood group risk factors in Nigerians. The present study aimed to explore the association and distribution of ABO blood group and the risk of hypertension, diabetes, obesity, and coexistence of prehypertension and pre-diabetes among school aged children and adolescents and its future uses for programming health plans.*
Methods: *The cross-sectional population-based descriptive study covered 1620 (female 847 or 53.3% and male 773 or 47.7%) public school aged children 14.0±3.0 years, and a total of 1000 samples (males 510 or 51%, females 490 or 49%,) aged 21.0±2.2 years from a private university from October 2014 through March 2015 in Port Harcourt. ABO blood group based on blood pressure, blood glucose and body mass index were determined and correlated for each other. Mean and standard deviation values were computed using one-way ANOVA; and Pearson's correlation analyses were used for comparison between groups.*
Results*: The frequency distribution of ABO blood group of the children was 64.8%, 18.3%, 12.5% and 4.3% and adolescents 43.9%, 31.4%, 19.0% and 5.7% for blood groups O, A, B, and AB respectively. Result showed that the association and distribution of hypertension, obesity or diabetes risks, as well as the differences in the cumulative mean values for body mass index, blood pressure and blood glucose with ABO blood group sublets were not statistically significant (>0.05). Overall, cumulative prevalence of childhood overweight-obesity, hypertension and diabetes was 6.1%, 2.4% and 0.0% and adolescents 10.8%, 9.4% and 0.1% respectively. Whereas the incidence of coexistence of prehypertension and pre-diabetes among school aged children (6.5%) was much lower than that of adolescents (10.6%). Correlation studies revealed much lower cumulative incidence of obesity, diabetes and hypertension with concurrent high prevalent of underweight/undernourishment, hypoglycaemia and hypotension among school children compared to adolescents.*
Conclusion: *The finding of the present study was that we could not find any evidence in favour that particular ABO blood group sublets was more susceptible to developing hypertension, obesity and diabetes together with coexistence of prehypertension and pre-diabetes.*
Key words: *ABO blood group, BMI, blood pressure, blood glucose, low income/poverty, school children, adolescent*

I. Introduction

In recent years, there has been increasingly important medical interest in the alarming rise in the prevalence of childhood and adolescent obesity, hypertension and diabetes. Though these are largely studies from the Western populations [1]-[8], there have been relatively few of such studies for the sub-Sahara African regions, Nigeria, specifically. Most importantly, the predisposing factors has been associated with multifactorial and complex factors which are also the characteristics of all age - children, adolescents, and adults, as well as both genders and racial/ethnic groups. These factors are either non-modifiable such as genetic endowment, race, age and sex or are modifiable by behavioural or other interventions such as over-nutrition, physical inactivity and lack of exercise, harmful levels of alcohol and tobacco use or environmental factors [5],[9]-[11].

The ABO system is one of such genetic make-up of an individual that will provide much valuable information for early detection of vulnerable groups. Certain studies suggest that those carrying the ABO blood group sublet A [12] [13], group B [14]-[16], group O [17]-[19] have greater risk of developing hypertension. On the contrary, some studies [20], [21] could not find evidence in favour of subjects with ABO blood group being susceptible to hypertension

Likewise, it has also been reported that blood group A [22], group O [23], group B [24], [25] are significantly common in patients with diabetes mellitus type 2. Moreover, women who are blood group B are likely to develop type 2 diabetes than other blood groups [26]. Additionally, those carrying blood groups A [9], and B [15] are prone to developing hypertension and obesity, while group O individuals develop overweight and obesity [27]. Though various studies have evaluated probable relationship between ABO blood groups and pathologies, such associations remain controversial and/or inconclusive. As far as the genetic-make up of an individual is concern, the ABO system becomes clinically significant as an intriguing field for detailed research.

This research aims to ascertain tendency to developing hypertension, diabetes, and obesity risks with ABO blood groups among children and adolescents from which valuable information for early detection of vulnerable younger age individuals for programming disease interventions. Additionally, to assess the relationship of pre-hypertension, pre-diabetes and blood type of the cohort from which our understanding of the mechanic of association of blood pressure, blood glucose and body mass index in health and disease may emerge. To the best of our knowledge, this study is among the first in Nigeria and Port Harcourt, Niger delta region, specifically, aimed at exploring the ABO system as possible predisposing risk factors for pathology among school aged children and adolescents. Port Harcourt is a cosmopolitan city in the mist of heavy oil and gas flares in the Niger Delta region, and the exposed populations live with potentially toxic chemically unrelated compounds in the polluted environment.

II. Materials And Methods

2.1 Study population

A sample of 1650 subjects (males 773 or 47.7% and females 847 or 52.3%) ranging in age from 7 to 21 years with mean age (±SD) of 14.0±3 years were randomly selected among public secondary school children in Obio/Akpo local government area, Port Harcourt, Rivers State. On the other hand, 1000 students (males 510 or 51%, and females 490 or 49%) aged 16 to 30 with mean age (±SD) of 21.0±2.2 years from a private self-financing University also in Port Harcourt were recruited for the study. A cross-sectional descriptive/stratified blocked randomization method and structured questionnaires with optional questions to suit the population of study needs were employed for the study from October 2014 through March 2015. All the subjects gave their consent for participation and all ethical standards were strictly adhered to as previously reported [11].

2.2 Data Collection

The ABO blood group system, blood pressure type, random blood glucose and body mass index were obtained based on standard guidelines [28] and correlated for each other. To determine the blood group type, the finger prick was obtained with lancet under aseptic conditions. Blood group was determined by standard methods[29] using antisera and classified according to ABO blood group classifications as blood group A, B, AB and O respectively. Random blood glucose level of the participants were performed based on the glucose – oxidase principles using the digital glucometer as described elsewhere [11], [23].The results were classified: low (<3.9 mmoI/L), normal (3.9 – 7.7 mmoI/L), pre-diabetic (7.8 -11.0) mmoI/L, diabetic (≥11.0 mmoI/L). Blood pressure was measured in the sitting position using a standard manual mercury sphygmomanometer and appropriate cuff sizes as previously described elsewhere [11] and classified as: low (<90/60 mmHg), normal (91/61 - 120/80 mmHg) prehypertension (121/81–139/89 mmHg), and hypertension (≥140 mm Hg SBP and /or ≥90 mm Hg DBP). A person's body mass index was determined by calculating the ratio between the body weight in kilograms and height in meters squares (kg/m^2) where underweight <18.5kg/m^2, normal 18.5 - 24.9 kg/m^2, overweight 25-29.9 kg/m^2 or obese ≥30kg/m^2.

Limitation: The present study had several limitations, including absence of Caucasian-based subjects, relative small sample size, random blood samples obtained by glucometer were converted to mmol/L by dividing by factor 18, and the rhesus factors were not put into consideration. The major strength of this work is that the samples came from a population of more or less similar behavioural, environmental and socio-economic strata.

No conflicts of interest, financial or otherwise, are declared by the author(s).

2.3 Statistical Analysis

Mean and standard deviation values were computed using Statistical Package for Social Science (SPSS) version 20.0. The results were analyzed by applying ANOVA, logistic regression analysis. Data were also subjected to Pearson's correlation analysis. Percentages for independent variables were calculated; $p<0.05$ was considered statistically significant.

III. Results

The frequency distribution of ABO blood groups in the population of 1,620 school aged children was O, 64.8%; A, 18.3%; B, 12.5% and AB, 4.3%; with ratio : 15:4:3:1 respectively. Whereas for the 1,000 adolescent subjects, the distribution of blood type O, A, B and AB was 43.9%, 31.4%, 19.0% and 5.7%; with ratio: 8:6:3:1 respectively.

3.1 Distribution of measured parameters with age and ABO blood group of the cohort.

Proportionate incidence of pathology risks, as well as cumulative mean values for association and distribution of body mass index, blood glucose or blood pressure with ABO blood group and age of the cohort are depicted in Tables 1 - 8. With the exception of both the systolic and diastolic blood pressures and body mass index, random blood glucose of the children progressively increase with increasing years in age. Overall, the measured physiological parameters with age and the cumulative mean values (±SD) for blood pressure - (systolic blood pressure/diastolic blood, mmHg), blood glucose level (RBG; mmol/L), and body mass index (BMI; kg/m^2) of the population fall approximately in the range defined as normal (Tables 1-2), and the differences were not statistically significant (>0.05).

3.2. Assessment of association and distribution of hypertension, diabetes, obesity and ABO blood groups of the cohort.

To further elucidate the data for tendency of developing pathology risks, as well as to understand the mechanic of association between body mass index, blood glucose, blood pressure, and blood type, individuals in each of the measured parameters were correlated with each other as explained in Tables 3- 8.

3.2.1. Correlation of body mass index with the ABO blood groups and blood glucose

There was direct proportionality between the distribution of body mass index in each of the ABO blood group sublets (Table 3) and the correlation of body mass index with blood glucose (Table 4). In all the ABO blood group sublets, there was a decreasing tendency of developing diabetes with an increase in body mass index. In the same group, pre-diabetes increased with increasing body mass index. The body mass index in the range 25-29.9kg/m^2 defined as overweight was much prevalent among normoglycaemic. Besides, the cumulative incidence of childhood underweight/undernourishment (23.5%) was high with concurrent low incidence of overweight (10.1%) and obesity (2.0%). While in adolescents, the incidence of overweight (19.8%) was much higher than underweight/undernourishment (4.1%) and obesity (1.7%).

3.2.2. Correlation of blood pressure with the ABO blood groups and body mass index

The distribution of blood pressure with the ABO blood group sublets (Table 5) was also directly proportional with the association of blood pressure and body mass index (Table 6). The AB blood group children had less chance of getting hypertension. There was a decreasing tendency in all ABO blood groups, of developing hypertension with an increase in body mass index. Whereas the tendency of developing prehypertension increased in the range of body mass index 25-29.9kg/m^2 defined as overweight. For the adolescent population in particular, the incidence of hypertension also increased with body mass index defined as overweight. In all, the incidence of prehypertension was markedly higher in body mass index range of 25-29.9kg/m^2 defined as overweight more than those defined as normal weight and obesity.

Meanwhile, cumulative incidence of children normotensive was 74.6% with hypotensive (11.2%) being much higher than hypertensive (2.2%). In contrast, there was a decrease in cumulative incidence of adolescent normotensive (63.6%) and hypotensive (7.8%) with concurrent increase of pre-hypertensive (19.3%) and hypertensive (9.4%).

3.2.3. Relationship of blood pressure with the ABO blood groups and blood glucose

More so, the association and distribution of blood pressure with ABO blood group sublets (Table 7) directly corresponded with the correlation of blood pressure and blood glucose (Table 8). The AB blood group school children had no chance of pre-diabetes. On comparison of blood glucose with blood pressure in the ABO blood group, there was an increasing tendency of pre-diabetes than diabetes. In the normal blood glucose range of 3.9-7.7 mmol/L, the tendency of developing prehypertension was much higher than hypertension. Even in the same group, there was increased tendency of developing hypertension in the blood glucose range 7.8-11.0 mmol/L defined as pre-diabetes. There was however, high cumulative incidence of childhood/adolescent hypoglycaemic than pre-diabetes and diabetes.

The prevalence of childhood overweight-obesity, hypertension and diabetes was 6.1%, 2.4% and 0.0%, while that of the adolescent was 10.8%, 9.4% and 0.1% respectively. Furthermore, the incidence of coexistence of prehypertension and pre-diabetes (6.5%) among school aged children was much lower than that of

adolescents (10.6%). Interestingly, overall, no particular ABO systems was more predisposed to either hypertension, diabetes or obesity (>0.05).

Generally, the differences in the measured parameters between males and females were not statistically significant (p>0.05).

Table 1.Mean value and standard deviation for the physiological variables with age of cohort

School aged children(N=1650)				Adolescent (N=1000)			
Age range(yr.)	Blood pressure (mmHg)	Body mass index (kg/m^2)	Blood glucose (mmol/L)	Age range(yr.)	Blood pressure (mmHg)	Body mass index (kg/m^2)	Blood glucose (mmol/L)
7-9	110.2±12/ 70.6±10	21.7±3.2	4.2±0.8	16-18	113.1±16/ 73.3±12	22.2±2.6	5.0±1.1
10-12	112.1±/ 68.2±9.1	20.7±3.4	4.5±0.7	19-21	112.1±16/ 73.2±12	22.6±2.9	5.1±1.0
13-15	111.3±11.6/ 69.2±9.7	20.7±3.6	4.7±0.6	22-24	113.4±16/ 74.2±12	23.2±3.7	5.1±1.0
16-18	111.6±11.8/ 69.5±10.5	21.4±8.4	5.2±0.8	25-27	114±17/ 74.0±15	23.7±3.7	5.3±1.3
19-21	109.0±11/ 68.4±11.2	20.7±3.4	5.4±1.0	28-30	120±18/ 75.1±16	24.4±2.1	6.0±1.2
Overall mean	111.0±11.5/ 69.2±10	21.0±3.5	4.8±0.8	Overall mean	114.5±17/ 74.0±13	22.9±4.7	5.2±1.1

Table 2. Mean value and standard deviation of the physiological variables with ABO blood groups

	% subjects		Mean Body Mass Index (BMI; kg/m^2)		Mean blood glucose (RBG; mmol/L)		Mean blood pressure (SBP/DBP; mmHg)	
Blood group	Children (N=1650)	Adolescent (N=1000)	children	Adolescent	children	Adolescent	Children	Adolescent
A	18.3	31.4	20.7±3.3	23.7±7.0	4.8±0.9	5.2±1.1	111.2±10.8/68 .4±10.1	113.6±15/ 72.2±12.7
B	12.5	19.0	21.0±3.6	22.6±2.7	4.6±0.8	5.1±0.9	107.6±9.5/67. 6±9.1	114.4±16/ 74.3±11.5
AB	4.3	5.7	22.0±4.5	21.9±3.8	4.9±0.9	5.3±1.1	110.0±12.3/69 .0±10.0	114.4±19/ 75.9±12.6
O	64.8	43.9	21.0±3.4	22.5±2.8	4.8±0.8	5.1±1.2	111.2±11.6/69 .3±10	115.9±20/ 73.8±15.1
Total			21.0±3.5	22.9±4.7	4.8±1.0	5.2±1.0	111.0±11.5/69 .0±10.0	114.5±17/ 74.0±13

Table 3.Percent distribution of body mass index in all blood groups

	Classification of body mass index (BMI, kg/m^2)							
Blood group	Underweight (<18.5)		Normal weight (18.5-24.9)		Overweight (25-29.9)		Obese (>30)	
	Children	Adolescent	Children	Adolescent	Children	Adolescent	Children	Adolescent
A	4.4	0.9	12	23.8	1.7	5.5	0.2	1.2
B	3.5	0.3	7.7	14.9	1.2	3.8	0.2	0.0
AB	1.1	0.6	2.1	3.9	0.8	0.8	0.3	0.4
O	14.5	2.3	42.8	31.8	6.4	9.7	1.2	0.1
Total	23.5	4.1	64.5	74.4	10.1	19.8	2.0	1.7

Table 4.Percent association of random blood glucose and body mass index

	Classification of body mass index (BMI, kg/m^2)							
RBG(mmol/L)	Underweight (<18.5)		Normal weight (18.5-24.9)		Overweight (25-29.9)		Obese (≥30)	
	Childre n	adolescent	children	Adolescent	children	Adolescent	children	Adolescent
Low (<3.9)	23.5	4.1	=	4.5	=	=	=	=
Normoglycaemia (3.9-7.7)	=	=	64.5	69.9	10.1	19.6	1.1	=
Pre-diabetes (7.8-11)	=	=	=	=	=	0.2	0.9	1.6
Diabetes (≥11.0)	=	=	=	=	=	=	=	0.1
TOTAL	23.5	4.1	64.5	74.4	10.1	19.8	2.0	1.7

Table 5. Percent distribution of blood pressure in all blood groups

	Classification of blood pressure(SBP/DBP, mmHg)							
Blood group	Low (<90/<60)		Normotensive (91-120/61-80)		Pre-hypertensive (121-139/81-89)		Hypertensive (>140/>90)	
	Children	Adolescent	Children	Adolescent	Children	Adolescent	Children	Adolescent
A	2.4	1.2	13.5	22.6	2.0	5.3	0.4	2.3
B	1.5	0.8	9.3	12.2	1.4	4.0	0.4	2.0
AB	0.6	0.7	3.3	3.4	0.4	1.4	=	0.3
O	6.6	5.1	48.4	25.4	8.2	8.6	1.5	4.8
Total	11.2	7.8	74.6	63.6	12.0	19.3	2.3	9.4

Table 6. Percent association of blood pressure and body mass index

	Classification of blood pressure (SBP/DBP, mmHg)							
BMI(kg/m^2)	Low (<90/<60)		Normotensive (90-120/61-80)		Pre-hypertensive (121-139/81-89)		Hypertensive (≥140/≥90)	
	Children	Adolescent	Children	Adolescent	Children	Adolescent	Children	Adolescent
Underweight (<18.5)	11.2	4.1	12.3	=	=	=	=	=
Normal weight (18.5-24.9)	=	3.7	61.6	63.6	2.9	7.2	=	=
Overweight (25-29.9)	=	=	0.7	=	9.0	12.1	0.4	7.7
Obese (≥ 30)	=	=	=	=	0.1	=	1.8	1.7
TOTAL	11.2	7.8	74.6	63.6	12	19.3	2.2	9.4

Table 7. Percent distribution of blood glucose in all ABO blood groups.

	Classification of blood glucose (RBG, mmol/L)							
Blood group	Low(<3.9)		Normoglycaemia (3.9-7.7)		Pre-diabetes (7.8-11.0)		Diabetes (>11.1)	
	Children	Adolescent	Children	Adolescent	Children	Adolescent	Children	Adolescent
A	2.7	2.7	15.4	28.1	0.2	0.6	-	=
B	1.3	1.5	11.1	17.3	0.1	0.2	-	=
AB	1.1	0.2	3.2	5.2	-	0.2	-	0.1
O	8.8	4.2	55.4	38.9	0.6	0.8	-	=
Total	13.9	8.6	85.2	89.5	0.9	1.8	-	0.1

Table 8. Percent association of random blood glucose and blood pressure

	Classification of Random blood glucose (mmol/L)							
BP (mmHg)	Low (<3.9)		Normoglycaemia (3.9-7.7)		Pre-diabetes (7.8-10)		Diabetes (≥11)	
	Children	Adolescent	Children	Adolescent	Children	Adolescent	Children	Adolescent
Low (<90/<60)	8.0	7.7	3.1	0.1	=	=	=	=
Normotensive (90-120/61-80)	6.0	0.9	68.6	62.7	=	=	=	=
Pre-hypertensive (121-139/81-89)	=	=	12.0	19.3	=	=	=	=
Hypertensive (≥140/≥90)	=	=	1.5	4.1	0.9	1.8	=	0.1
TOTAL	14	8. 6	85.2	89.5	0.9	1.8	=	0.1

IV. Discussion

Overweight and obesity, diabetes as well as high rates of blood pressure, also known as hypertension are generally considered to be affected by genetic make-up, blood type, more specifically, of an individual. Finding of differential association and distribution of the incidence of hypertension, diabetes or obesity together with prehypertension and pre-diabetes risks with particular ABO blood group, are explained by the data in Tables 1 to 8. Indeed no particular blood type was more predisposed to either hypertension, diabetes or overweight and obesity. The observation of direct and/or indirect proportionality of body mass index with blood glucose, blood pressure or susceptibility of pathology with particular ABO blood group shown in Tables 3 to 8, may underscore the complex mechanism of genetic factor-linked related distribution of some blood groups in the development of pathophysiology of hypertension, diabetes or obesity and the associated complications in

humans. This study to the best of our knowledge, is the first type among a random sample of school aged children and adolescents, specifically, in Port Harcourt, Rivers State in the Niger Delta region of Nigeria. Percentage distribution of ABO blood groups in this study concurs with the generally accepted frequency.

In this cohort study, the observation of the likelihood of childhood blood glucose (diabetes) increase with years of age, though conforms with previous findings [9], [11], the cumulative mean value and standard deviation for blood glucose, blood pressure, and body mass index fall approximately in the range defined as normal. As evidenced, the cumulative prevalence of overweight, hypertension, and obesity are in contrast to increase in the prevalence in school aged children (13.5 ± 1.7 years), identified as ethnic minority children[1].

Meanwhile, in persons three to 18 years of age, the prevalence of prehypertension is 3.4 % and hypertension 3.6 % [30]. As demonstrated in the present study, the increase in blood pressure level defined as prehypertension was much higher than that of hypertension. Also, as high as 9%-12% of pre-hypertensive, and as well as 7.7% adolescent hypertensive are overweight. The preponderance of the evidence may suggest probably signs of early target organ damaged once children/adolescent become adults or evolution of epidemic of cardiovascular risks and the associated complications [1] [3] [31] in the population. Furthermore, the observation of an increase in prevalence of coexistence of prehypertension and pre-diabetes of 6.5% and 10.6% with raised body weight of 10.1% and 19.8% in children and adolescents respectively, conform to the suggestion of probable adverse effect which may progress to full hypertension and diabetes [11, 32-33]. Higher prevalence of coexistence of prehypertension and pre-diabetes of 17.5% has been reported for adults [11]. Our study further demonstrated cumulative prevalence of childhood overweight-obesity, hypertension and diabetes of 6.1%, 2.4% and 0.0% and of adolescent of 10.8%, 9.4% and 0.1% respectively, which, however, was in contrast to the high incidence in the adult population of 28.8%, 18.2% and 24% respectively [11]

In the present study, we observed low cumulative incidence of hypertension with overweight and obesity, in contrast to high incidence of hypertension of 29.4%, 50.1% and 70.0% in normal weight, overweight and obesity groups respectively among primary school children aged 6 to 8 years in China [8]. Aside, we also documented low cumulative incidence of hypertension and obesity and no evidence in favour of diabetes with concurrent high prevalent of underweight / undernourishment, hypoglycaemia, and hypotension, among school aged children. The high underweight / undernourishment, hypoglycaemia, and hypotension may be a reflection of our public schools which attracted school aged children from impoverished low-income socio-economic class [34]. Similar but much higher increase prevalent (41%) of underweight/undernourishment over obesity and overweight has been reported in school aged children 11 to 14 years in India [27].

V. Conclusion

We could not find evidence of association and distribution of diabetes, hypertension or obesity together with combination of prehypertension and pre-diabetes risks in favour of particular ABO blood group sublets in school aged children and adolescents.

Acknowledgments

The authors wish to thank Briggs Lolo Williams, Abdullah Halimat Sadia, and Ekine Kalada Diepiri for the technical assistance.

Reference

[1]. Sorof JM, Lai D, Turner J, Poffenbarger T and Portman RJ(2004) Overweight, Ethnicity, and the Prevalence of Hypertension in School-Aged Children. Pediatrics 113 (3) 475 -482
[2]. Lifestyles statistics team, Health and Social Care Information Centre. Statistics on Obesity, Physical Activity and Diet: England 2014. www.hscic.gov.uk
[3]. Ogden CL, Carroll MD, Kit BK, Flegal KM (2014) Prevalence of childhood and adult obesity in the United States, 2011-2012. Journal of the American Medical Association 311(8):806-814.
[4]. Riley M and Bluhm B (2012) High Blood Pressure in Children and Adolescents Am Family Physician. 85(7):693-700.
[5]. High Blood Pressure in African-Americans. American Heart Association, Inc 2015
[6]. U.S. Department of health and human services, National Institute of Diabetes and Digestive and Kidney Diseases (2014): What African Americans with Diabetes or High Blood Pressure Need to Know
[7]. Diabetes in the UK 2012: Key statistics on diabetes
[8]. Wang J, Zhu Y, Jing J, Chen Y, Mai J, Wong SHS, O'Reilly J and Ma L (2015).Relationship of BMI to the incidence of hypertension: a 4 years' cohort study among children in Guangzhou, 2007–2011. BMC Public Health: **15**:782
[9]. Nemesure B, Wu S, Hennis A and Leske C (2006). Hypertension, type 2 diabetes, and blood groups in a population of African ancestry .Ethnicity and Disease: 16:822-829
[10]. Egwurugwu JN, Nwafor A (2013). Prolonged exposure to oil and gas flares ups the risks for hypertension. American Journal of Health Research. 1 (3):65-72.
[11]. Nwafor A, Mmom FC, Obia O, Obiandu C, Hart VO and Chinko BC (2015).Relationship between blood pressure, blood glucose and body mass index and coexisting prehypertension and prediabetes among rural adults in Niger Delta Region, Nigeria. British Journal of Medicine & Medical Research. 9(7): 1-12.
[12]. Ismagilov MF and Petrova SE (1981) ABO blood group system and vegetative-vascular disorder in children. Zh nevropatol Psikhiatr 81(10) 1487-8

[13]. Platt D, Muhlbery W and kiehl l(1985) ABO blood group system, age, gender, risk factors and cardiac function. Arch gerontol geriatr: 4(3):79-81
[14]. Sachdev B (2011) Prevalence of hypertension and associated risk factors among nomad tribe groups. Antro-com. 7(2):181-189.
[15]. Chandra T and Gupta A (2012). Association and distribution of hypertension, obesity and ABO blood groups in blood donors. Iranian J. Pediatric Hematology and Oncology: 12(2): 140-145
[16]. Bhattacharyya S, Ganaraja B and Ramesh BM (2010). Corrrelation between the blood groups, BMI and prehypertension among medical students. J. Chinese Clinical Medicine 51(2): 78-82
[17]. Nasreen AR (2006) Blood groups and hypertension. J. Bagh Coll Dentistry 18(2): 68-70
[18]. Kaur M (2014) Association between ABO blood group and hypertension among post-menopausal females of North India. Anthropologist, 17(2): 677-680.
[19]. Nishi K, Gupta NK, Sharma SC (2012). Study on the incidence of hypertension and migraine in ABO blood groups. ISCA Journal of Biochemical Sciences: 1(2): 12-16.
[20]. Tabatabale AH and Ali-Madadi M (2012): Possible association between ABO and Rh (D) blood groups and hypertension. Pak J Med Sci: 28(1):235-237.
[21]. Gillum RF (1991). Pressure and obesity in adolescent. J Natl Med Assoc: 83(8): 682- 8
[22]. Kucevic I, Vasic J, Svorcan JZ, Radisic B (2013)Evaluation of ABO blood groups distribution in patients with diabetes mellitus Type 2 from Serbia. Serbian Journal of Experimental and Clinical Research 14(3):
[23]. Nwafor A. and Onugha P.I. (2001) Association of ABO and Rh Blood groups, haemoglobin genotype and diabetes mellitus in Diabetic and non-diabetic sticklers in a population of Nigerians. Afri. J. AppI. Zoo and Environ. Biol. 3: 26-30.
[24]. Bener A and Yousafzai MT (2014). The distribution of the ABO blood groups among the diabetes mellitus patients. Nigerian Journal of Clinical Practice: 17 (5): 565
[25]. Moinzadeh F, Najafabady GM and Toghiani (2014).Type 2 diabetes mellitus and ABO/Rh blood groups. Journal Research Medical Sciences 19(4):382
[27]. Fagherazzi G, and Clavel-Chapelon F (2014) ABO and Rhesus blood groups and risk of type 2 diabetes from the large E3N cohort study. Diabetologia 10:
[28]. Krishnakanth GVS, Lad UP and Satyanarayana P(2012)Correlation between obesity & ABO Blood Group in School going Children in India. Indian Journal of Basic & Applied Medical Research; 1(4): 280-284
[29]. International Diabetes Federation (2011). Diabetes atlas, fifth edition: www.diabetesatlas.org
[30]. Dacie JV and Lewis SM (1984) In Practical Haematology. Churchill Livingstone Ltd, Edinburgh, pp. 337-383.
[31]. Hansen ML, Gunn PW, Kaelber DC. (2007) Underdiagnosis of hypertension in children and adolescents. JAMA. 298 (8):874–879
[32]. Brookes, L (2007). The Epidemiology of Hypertension: Latest Data and Statistics. Medscape. Nov 16, 2007.
[33]. Li C, Ford ES, Zhao G, Mokdad AH. Prevalence of pre-diabetes and its association with clustering of cardiometabolic risk factors and hyperinsulinemia among US adolescents: NHANES 2005–2006. Diabetes Care 2009; 32:342–347.
[34]. CDC. National diabetes fact sheet: national estimates and general information on diabetes and prediabetes in the United States, 2011 [pdf 2.7M]. Atlanta, GA: U.S. Department of Health and Human Services.
[35]. National Center for Health Statistics. Health, United States, 2011: With Special Features on Socioeconomic Status and Health. Hyattsville, MD; U.S. Department of Health and Human Services; 2012.