Prevalence of over-nutrition and elevated blood pressure among primary school children in non-urban areas of mid-western Nigeria

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ABSTRACT
Aim: There is an emerging problem of over-nutrition (ON) and associated complications in developing countries. However, data are limited on the size of the problem in primary school children, particularly those in non-urban areas, and on the trend in Nigeria. The study aimed at determining the prevalence of ON and elevated blood pressure (EBP), and the association between them among primary school children in non-urban areas.

Materials and Methods: 1187 school children aged 6-11 years were recruited through multistage sampling. Their body mass index (BMI) and blood pressures were determined and classified using standard methods. The statistical significance of the difference between groups was determined using Yates’ corrected χ2 test or Fisher exact test as appropriate, with the level of significance set at p < 0.05.

Results: A total of 48 (4.0%) pupils had ON, and 69 (5.8%) EBP while 10 (0.8%) had both. The OR (95% CI) of hypertension in obese versus normal pupils was 28.59 (10.09, 80.99), p <<0.001. The OR (95% CI) of EBP in overweight or obese pupils (10/58, 17.2%) versus normal, thin or severely thin pupils (69/1129, 6.1%) was 3.2 (1.55, 6.60), p = 0.007.

Conclusion: The prevalence of ON and EBP among primary school pupils in non-urban areas are low but EBP is associated with obesity. Therefore, early intervention and preventive measures for over-nutrition which include increase in physical activity and reduction of sedentary lifestyle among others should be in place as part of the School Health Programme and community-based program. This could greatly limit the further emergence and reduce the associated burden of over-nutrition.

Key words: Elevated blood pressure; Interrelationship; Nigeria; Non-urban areas; Over-nutrition; Prevalence

INTRODUCTION
Childhood obesity is one of the most serious public health challenges of the 21st century,1,2 particularly in developed countries,1-3 which have a prevalence range of 6-19% among preschool children in such countries as the United Kingdom4 and the United States of America.5 Due to the increasing westernization of societies and changes in lifestyle,6 overweight and obesity have also become emerging problems in developing countries, in addition to the persistently high prevalence of under-nutrition.4,7 Thus in Nigeria and other African countries, the prevalence of overweight and obesity ranges from 0% to 23.4% depending on age group, location and method of assessment used.7,12

Over nutrition (ON) is associated with many problems, one of the most worrisome among which is the risk of elevated blood pressure (EBP) and resultant cardiovascular disease, which is associated with long-term morbidity and mortality.13-15 Studies from Nigeria and other African countries report a prevalence of hypertension of 1.2% - 12%.16-20 The wide range could be due to due to differences in the impact of stress, genetic heterogeneity and lifestyle changes.13,21-23

Several reports10,19,24-28 have evaluated the relationship between blood pressure and nutritional status as measured using body mass index (BMI) in developing countries. Among them, some19,27 show a significant correlation between BMI and both systolic and diastolic pressures while some20,28 show only a significant correlation of systolic pressure with BMI. However, most19,24,26,27 simply reported a higher prevalence of hypertension among overweight and obese children without specifying as to whether the hypertension is systolic, diastolic or both. Diastolic hypertension has been found to be a more
important predictor of morbidities and mortality especially among younger adult.  

Furthermore, only a few studies have investigated the relationship between nutritional status and blood pressure in childhood in recent times in African countries, particularly Nigeria although the emerging problem of ON could be expected to alter the extant pattern of blood pressure profiles in children in developing countries. In addition, few studies have addressed the prevalence of either ON or EBP in primary school children in non-urban areas where the majority of the population in developing countries reside. In this regard, targeting primary school pupils could be of assistance in breaking the tracking of childhood ON into adolescence and adulthood. In addition, early intervention could help reduce the consequences of both ON and EBP, both of which may be more amenable to treatment earlier than later in life.  

This study was done to reduce the information gap on the prevalence of ON and EBP in non-urban areas as well as to determine the extent to which the emerging trend of ON could have affected non-urban communities in developing countries. The information is expected to further contribute to the body of information on the relationship between the two disorders in developing countries.

MATERIALS AND METHODS

The study was a prospective, cross-sectional survey of primary school pupils carried out from June to September 2013, in Esan West Local Government Area, Edo State, Nigeria. EWLG has in socioeconomic transition, with large parts of the Local Government Area (LGA) changing from rural to semi-urban. One thousand, one hundred and eighty-seven pupils aged 6 – 15 years and in primary classes 1 – 6 were recruited using multistage random sampling. Thus, three political wards were randomly selected from 10, and 11 registered primary schools (representing 6/45 [13.3%] public and 5/25 [20%]) private schools in the LGA) were then selected from the three wards. One arm per school class was randomly selected by ballot. Two tracings were made at each point 5 minutes apart while the pupil was still sitting and relaxed, and with the feet on the floor. The pressure was taken with the right arm supported, and with the feet on the floor. The pressure was referred to ISTH for further evaluation.

All pupils with abnormal nutritional status and/or elevated blood pressure were referred to ISTH for further evaluation. Two trained Research Assistants measured the pupils’ weights and heights. Weight was measured using Seca digital electronic scale, with the subjects barefooted, in underwear or light sportswear, without a belt and wristwatch, and after urination.  

The Subject stood with the two feet together on the scale placed on a level solid floor, and the weight was read to the nearest 0.1 kg after the displayed reading had become stable. The scale was calibrated using 6 kg dumb-bells. Height was measured to the nearest 0.1 cm, with a portable Prestige Stadiometer. The Subject stood erect with the bare feet kept together and the occiput, shoulders, buttocks and the heels placed against the perpendicular part of the stadiometer, looking straight ahead with the external auditory meatuses on the same horizontal plane as the lower borders of the eye sockets, the Frankfort horizontal plane. Gentle pressure was then applied upwards to the bony prominences just behind the ears to stabilize the head, the head rest brought to rest on the head of the Subject and the pointer read off. BMI was calculated using the formula weight (in kg)/height (in m)², and interpreted using the 2007 WHO growth reference chart into:

- Obesity (>+2 SD)
- Overweight (>±1SD to ≤+2SD)
- Normal (-2SD to ±1SD)
- Thinness (<2SD to ≥-3SD)
- Severe thinness (<-3SD).

Blood pressure (BP) was measured by one of the Authors on the right arm with Accoson’s mercury sphygmomanometer, using the auscultatory method, with the cuff bladder length covering 80% to 100% of the arm circumference. The BP was taken after 5 minutes of rest with the Subject sitting with the back and right arm supported, and with the feet on the floor. The pressure was measured with the antecubital fossa at heart level, using Classic II Littman’s stethoscope to auscultate the Korotkoff sounds. Systolic blood pressure (SBP) was determined by the onset of the “tapping” Korotkoff sounds (K1) and diastolic blood pressure (DBP) by the fifth Korotkoff sound (K5), “the disappearance of Korotkoff sounds”. The stethoscope was placed over the brachial artery pulse, proximal and medial to the antecubital fossa, and below the bottom edge of the cuff, i.e., ≈2 cm above the antecubital fossa. Two BP readings were taken 5 minutes apart while the pupil was still sitting and relaxed, and the average taken as the blood pressure as in previous studies. Using a standard blood pressure percentile chart based on gender, age, and height, the percentile of the pupil’s SBP and DBP measurements was determined and interpreted as:

- Normal (BP <90th percentile)
- Prehypertension (BP between the 90th and 95th percentile)
- Hypertension (BP ≥ 95th percentile).

The pupils were classified into early (6 - 8 years old) and late (9 – 11 years old) school age. The nutritional status of the pupils was classified based on BMI into normal, under nutrition (thinness and severe thinness) and over nutrition (overweight...
and obesity) using WHO reference standards. Blood pressure status was classified into normal and elevated blood pressure (prehypertension and hypertension) using appropriate standards.

**Statistical Analysis**

Data were analyzed using Open Epi Info Version 3.01. The frequencies of discrete variables were compared using Yates’ corrected $\chi^2$ test or Fisher’s exact test as appropriate. Multiple means were compared using one-way analysis of variance (ANOVA) while multiple rates/frequencies were compared using group $\chi^2$ test. The level of statistical significance was set at $p < 0.05$.

**RESULTS**

Nine hundred and two (76%) pupils were Ishans, 56 (4.7%) Ibobis, 51 (4.3%) Binis and 47 (4.0%) Etsakos while 131 (11%) were of other ethnic stocks. One thousand, one hundred and sixty-five (98.1%) were Christians, 19 (1.6%) Muslims and two (0.2%) African traditional religionists while one (0.1%) had no religion. Five hundred and fifty-nine (47.1%) pupils were of early school age and 628 (52.9%) of late school age. There were 607 (51.1%) boys and 580 (48.9%) girls, giving a M: F ratio of 1:1. The mean (SD) age of males was significantly higher than that of females (8.7 (1.6) years versus 8.5 (1.6) years; $p = 0.032$). Six hundred and forty-eight (54.6%) pupils were in public and 539 (45.4%) in private schools, giving a public: private school ratio of 1.2:1. There was no significant difference between the mean (SD) age of pupils in public and private schools (both = 8.6 (1.6) years; $p > 0.999$). Six hundred and forty-one (54%) pupils were of the higher social classes (class I-III) and 546 (46%) of the lower classes (IV and V), giving a higher: lower social class ratio of 1.2:1.

**Prevalence of Over Nutrition (ON) and Elevated Blood Pressure (EBP):** Overall, 1088 (91.7%) pupils had a normal BMI status and 99 (8.3%) an abnormal BMI status. Among the latter, 41 (3.4%) were overweight, 17 (1.4%) obese, 38 (3.2%) thin and 3 (0.3%) severely thin. Forty-four (3.7%) pupils had pre-hypertension and 35 (2.9%) hypertension. The prevalence of systolic pre-hypertension was significantly higher than the prevalence of diastolic pre-hypertension (38/1187, 3.2% versus 7/1187, 0.6%; Odds Ratio (95% Confidence Interval), OR (95% CI) = 5.57 (2.48, 12.53), $p < 0.001$). The prevalence of systolic hypertension was also significantly higher than that of diastolic hypertension (28/1187, 2.4% versus 14/1187, 1.2%; OR (95% CI) = 2.02 (1.06, 3.87), $p = 0.031$). The pre-hypertension was systolic in 37 (3.0%) pupils, diastolic in 6 (0.5%) and both in 1 (0.1%) while hypertension was systolic in 21 (1.8%), diastolic in 7 (0.6%) and both in 1 (0.6%). Two of the pupils with systolic HTN also had diastolic PHTN while two with diastolic HTN also had systolic PHTN. Analysis of the difference in distribution of pre-hypertension and hypertension did not meet the criteria for $\chi^2$ test.

The trends in the mean (standard deviation) of BMI and BP with age is shown in Table 1 while the correlations between BMI and BPs are shown in Figures 1a & 1b. Mean BMI and mean systolic and diastolic BPs increased significantly with age ($p < 0.001$ for all three features) (Table 1). Both systolic and diastolic BPs correlated positively with BMI (beta coefficient = 1.534, standard error = 0.164, $p < 0.001$ for correlation with SBP and beta coefficient = 0.760, standard error = 0.125, $p < 0.001$ for correlation with DBP) (Figures 1a & 1b) but the correlations were weak ($r = 0.32$ and $r^2 = 0.102$ for SBP and $r = 0.25$, $r^2 = 0.063$ for DBP).

The variation in prevalence of ON and EBP with age (early versus late school age) is shown in Table 2. The prevalence of ON was higher in late school age but the difference was not statistically significant (OR (95% CI) = 1.60 (0.93, 2.77), $p = 0.117$). The overall prevalence of EBP was significantly higher in late school age pupils (64/628, 10.2% versus 27/559, 4.8%; OR (95% CI) = 2.24 (1.40, 3.56), $p < 0.001$). The prevalence of both systolic and diastolic pre-hypertension and hypertension was also higher in late school age pupils ($p = 0.008$ for $\chi^2$ test with 4 degrees of freedom) (Table 2).

**Association between Elevated Blood Pressure and Nutritional Status**

The relationship between BP profile and nutritional status as defined by the BMI is shown in Table 3. The numbers were too small in many of the sub-groups to enable analysis of the overall relationship using group $\chi^2$ test. Obese pupils had a higher overall prevalence of EBP, systolic or diastolic (7/17, 41.2%) than pupils with a normal BMI (68/1088, 6.3%; OR (95% CI) = 10.5 (3.88, 28.44), $p < 0.001$), pupils with severely thin/thin pupils (1/41, 2.4%; OR (95% CI) = 28 (3.08, 254.4), $p < 0.001$), and overweight pupils (3/41, 7.3%; OR (95% CI) = 8.87 (1.94, 40.59), $p = 0.009$). The OR (95% CI) of hypertension in obese versus normal pupils was 28.59 (10.09, 80.99), $p < 0.001$. The OR (95% CI) of EBP in overweight or obese pupils (10/58, 17.2%) versus normal, thin or severely thin pupils (69/1129, 6.1%) was 3.2 (1.55, 6.60), $p = 0.007$. The other differences were not statistically significant.

The prevalence of systolic pre-hypertension was significantly higher than the prevalence of diastolic pre-hypertension (38/1187, 3.2% versus 7/1187, 0.6%; OR (95% CI) = 5.57 (2.48, 12.53), $p < 0.001$). The prevalence of systolic hypertension was also significantly higher than that of diastolic hypertension (28/1187, 2.4% versus 14/1187, 1.2%; OR (95% CI) = 2.02 (1.06, 3.87), $p = 0.031$). Pre-hypertension was systolic in 37 (3.0%) pupils, diastolic in 6 (0.5%) and both in 1 (0.1%) while hypertension was systolic in 21 (1.8%), diastolic in 7 (0.6%) and both in 1 (0.6%). Two of the pupils with systolic HTN also had diastolic PHTN while two with diastolic HTN also had systolic PHTN. Analysis of the difference in distribution of pre-hypertension and hypertension did not meet the criteria for $\chi^2$ test.
Table 1: Variation of BMI with mean SBP and DBP

<table>
<thead>
<tr>
<th>Age (in years)</th>
<th>No.</th>
<th>Mean BMI (SD) Kg/m²</th>
<th>Mean SBP (SD) mmHg</th>
<th>Mean DBP (SD) mmHg</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>142</td>
<td>14.94 (1.29)</td>
<td>91.61 (9.88)</td>
<td>52.06 (7.22)</td>
</tr>
<tr>
<td>7</td>
<td>197</td>
<td>15.07 (1.58)</td>
<td>93.12 (10.44)</td>
<td>54.98 (8.19)</td>
</tr>
<tr>
<td>8</td>
<td>220</td>
<td>15.22 (1.09)</td>
<td>95.31 (9.55)</td>
<td>55.75 (7.26)</td>
</tr>
<tr>
<td>9</td>
<td>226</td>
<td>15.46 (1.78)</td>
<td>99.01 (9.82)</td>
<td>58.69 (7.04)</td>
</tr>
<tr>
<td>10</td>
<td>232</td>
<td>15.84 (1.97)</td>
<td>99.96 (10.23)</td>
<td>59.44 (7.48)</td>
</tr>
<tr>
<td>11</td>
<td>170</td>
<td>16.31 (2.23)</td>
<td>102.76 (9.50)</td>
<td>59.61 (7.18)</td>
</tr>
<tr>
<td>Total</td>
<td>1187</td>
<td>15.48 (1.76)</td>
<td>97.19 (10.57)</td>
<td>57.02 (7.83)</td>
</tr>
</tbody>
</table>

*F statistic and p-value for ANOVA with 5 degrees of freedom. BMI = body mass index; SD = standard deviation; SBP = systolic blood pressure; DBP = diastolic blood pressure.

Table 2: Age and the prevalence of over nutrition and elevated blood pressure

<table>
<thead>
<tr>
<th>Age</th>
<th>Over nutrition</th>
<th>Systolic</th>
<th>Diastolic</th>
<th>Systolic</th>
<th>Diastolic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PHTN</td>
<td>HTN</td>
<td>PHTN</td>
<td>HTN</td>
</tr>
<tr>
<td>Early school age (N = 559)</td>
<td>21 (3.8)</td>
<td>13 (2.3)</td>
<td>6 (1.1)</td>
<td>4 (0.7)</td>
<td>4 (0.7)</td>
</tr>
<tr>
<td>Late school age (N = 628)</td>
<td>37 (5.9)</td>
<td>27 (4.3)</td>
<td>22 (3.5)</td>
<td>5 (0.8)</td>
<td>10 (1.6)</td>
</tr>
</tbody>
</table>

PHTN = Pre-hypertension, HTN = hypertension

Table 3: Relationship between nutritional status and blood pressure profile

<table>
<thead>
<tr>
<th>Nutritional status</th>
<th>Blood pressure profile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Systolic or diastolic hypertension* No. (%)</td>
</tr>
<tr>
<td>Normal</td>
<td>26 (2.4)</td>
</tr>
<tr>
<td>Thin/severely thin</td>
<td>0</td>
</tr>
<tr>
<td>Over-weight</td>
<td>2 (4.9)</td>
</tr>
<tr>
<td>Obese</td>
<td>7 (41.2)</td>
</tr>
<tr>
<td>Total</td>
<td>35 (2.9)</td>
</tr>
</tbody>
</table>

Percentages add across.

*Fisher exact p <<0.001 for the prevalence of hypertension and **p = 0.709 for the prevalence of pre-hypertension, normal plus thin/severely thin versus overweight plus obese in both analysis.

DISCUSSION

This study examined the prevalence of ON and EBP, and the association between them, among apparently healthy primary school children in a non-urban area of Mid-Western, Nigeria. This is important because EBP is one of the most common consequences of over nutrition.36

The prevalence of overweight was 3.4% and that of obesity 1.4%. These rates are comparable with the 3.0-3.7% prevalence of overweight and 0.0-2.1% prevalence of obesity reported previously from both urban,36,37 semi urban38 and rural9 areas of Nigeria. On the other hand, the rates are higher than the 0.0% of both overweight and obesity reported by Ayoola et al10 in 2008 from among children and adolescents in rural areas of western Nigeria and considerably lower than the rates of 4.9-10.4% and 5.4-23.4% in other reports from Nigeria,8 Tanzania,7 Ghana,11 Iran39 and the USA.5

Some of the differences between the results of this and other studies, and even between previous studies, could be explained by differences in methodology. The diagnosis of over nutrition in this study was made using the WHO 2007 criteria34 which is more sensitive than the CDC criteria used by Senbanjo and Oshikoya24 and Ayoola et al.10 Owa and Adejuyigbe8 used bioelectrical impedance and included adolescents in their study, which was carried out among pupils in a University staff school, a privileged community. A recent study38 in the same city of Ile-Ife, from which Owa and Adejuyigbe8 had earlier reported 18% prevalence of obesity, reported a prevalence of 2.8% and 0.3% for overweight and obesity, respectively, which are comparable to those in this study. The location of the study population is also a factor. Thus, the Iranian39 and Ghanaian11,12 studies were conducted in the capital cities and the Tanzanian study7 in fast growing metropolitan areas, Dodoma and Kinondoni. The lower prevalence of ON in rural areas may be related to the expectedly greater physical activity and increased energy expenditure in predominantly rural agricultural settings coupled with a diet of...
The findings from this study suggests that while overweight and obesity may have become emerging nutritional problems even in rural and semi-urban areas in Nigeria, they are so far not of the same magnitude as in developed countries such as the USA, nor are they also of the same magnitude as in some metropolitan cities Africa. There could therefore still be a great opportunity for intervention through the institution of preventive methods. Policy advocacy and community education and treatment could greatly limit the further emergence of ON and reduce the associated burden and consequences.

The prevalence of hypertension. An upward trend in the prevalence of hypertension has been described among children in the USA, with a rise in prevalence from 2.7% in 1988-1994 to 3.7% in 1999-2002 in one of the reports. More recently Sorof et al in 2004, reported prevalence of hypertension of 19.4%, 9.5% and 4.5% at first, second and third screening respectively, while Urrutia-Rojas et al in 2006 reported a higher prevalence of 20.6% among school aged children. Therefore, an attempt to temporally classify previous studies from Nigeria and Africa may not be out of place for the purpose of determining the occurrence or otherwise of a similar trend in African children. In this regard, only a few reports are available from Nigeria pre-1980 with prevalence rates of hypertension of 1.7% and 3.5% whereas there are many fairly recent reports. Among the latter, a few from urban areas report high prevalence rates of 5.5-9.8% while many, mostly from urban areas but also from semi-urban areas, report lower rates of 2.5-4.7% that are comparable to the rates reported earlier and the rate of 2.9% found in this study. It may therefore, be difficult to state that there is or has been an upward trend in the prevalence of hypertension in Nigerian children. Overall, however, the 2.9% prevalence of hypertension in this study is within the ranges of 1.7-12% reported previously over decades form Nigeria, which rates are comparable to the 7.4% reported from the Republic of Seychelles in 2004-2006 and the 3.5% reported from South Africa in 2010.

Only a few studies have reported on the prevalence of pre-hypertension. The prevalence of 3.7% in this study is lower than the rates of 10% - 22% reported from Lagos and Kogi State but higher than the 0.4% - 1.6% reported from Sagamu, another non-urban area in 2012. Investigation of the prevalence of pre-hypertension is important because pre-hypertension could be predictive of the progression to hypertension in later life. It is also an important predictor of cardiovascular morbidity and mortality later in life. Therefore, pupils with pre-hypertension need preventive measures, especially lifestyle changes of diet and physical exercise.

This study has (supported the conclusion) confirmed, like others, that over nutrition is an important risk factor for pre-hypertension and hypertension. Unlike in some of the previous reports, however, the association was with obesity rather than obesity and overweight. This is similar to the findings of Sorof et al who investigated adolescents. The association of pre-hypertension and hypertension with obesity rather than with overweight could mean that proper intervention even at overweight levels might be capable of preventing the development of hypertension. The correlation of BP with BMI was weak, although it was statistically highly significant and positive. Earlier studies also report a significant positive correlation of blood pressure with BMI. The weak correlation of BP with BMI could mean that factors other than nutritional status may be equal or even greater determinants of the increase in BP with age. In spite of this however, the relationship could mean that the emergence of childhood obesity may increase the risk of childhood hypertension with attendant cardiovascular diseases.

CONCLUSIONS

In conclusion, the problems of pre-hypertension and hypertension, and to a lesser extent, the associated problem of obesity have become emergent in non-urban areas. Therefore, determination of BMI and BPs, and the institution of preventive measures for ON should be part of the School Health Programmes in rural and non-urban areas of developing countries.

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