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Epidemiological characteristics of hypertension, impaired fasting capillary glucose and their comorbidity: a retrospective cross-sectional population-based study of rural adolescents in Southeast Nigeria

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ABSTRACT

Objective To assess the prevalence of hypertension, impaired fasting capillary glucose (IFCG) and coexistence of both as well as determinants of these conditions among rural adolescents.

Design A retrospective cross-sectional population-based study.

Setting Three rural communities in southeast Nigeria.

Participants A total of 401 adolescents (10 – 19 years) selected through a five-stage sampling technique completed the study. Sick adolescents, pregnant and nursing adolescent mothers were excluded.

Primary outcome measures Prevalence and determinants of hypertension, IFCG and comorbidity of both were assessed through weight, height, blood pressure, fasting capillary glucose measurements and statistical analysis.

Results Prehypertension (10.7%), hypertension alone (12.7%), IFCG alone (11.0%), diabetes (0.2%) and hypertension with IFCG (6.2%) were prevalent among the adolescents. The adolescents aged 15 – 19 years were less likely to be affected by hypertension alone (adjusted OR (AOR)=0.36, 95% CI 0.18 to 0.74, p<0.01). The likelihood of having hypertension alone was three times higher among those who smoked any substance (AOR=3.43, 95% CI 1.34 to 8.78, p<0.05) and 2.85 times higher among those who consumed alcohol (AOR=2.85, 95% CI 1.33 to 6.10, p<0.01). Meal skipping (AOR=2.69, 95% CI 1.16 to 6.25, p<0.05), consumption of fried/baked snacks (AOR=15.46, 95% CI 1.62 to 147.37, p<0.05) and vegetables (AOR=2.27, 95% CI 1.11 to 4.66, p<0.05) were also significant risk factors of hypertension alone. Skipping meals (AOR=2.15, 95% CI 0. 93 to 4.99, p>0.05) and longer than 7 hours of night sleep (AOR=1.88, 95% CI 0.94 TO 3.73, p>0.05) increased the risk of IFCG alone by twofold. Female adolescents (AOR=0.29, 95% CI 0.10 to 0.78, p<0.05) and those who consumed fried/baked snacks (AOR=0.09, 95% CI 0.02 to 0.37, p<0.01) were less likely to have hypertension with IFPG than males and those who consumed non-fried/baked snacks, respectively.

Conclusion This study reported relatively low prevalence of hypertension alone, IFCG alone, hypertension with IFCG and epidemiological characteristics that can become focus of interventions to curtail the emergence of cardiovascular events at an early age. Awareness creation through health and nutrition education is emphasised.

Strengths and limitations of this study

- ► This study examined retrospectively the prevalence of hypertension and impaired fasting capillary glucose (IFCG) and their comorbidity among adolescents in rural communities of Enugu North senatorial zone of Enugu State, Southeast Nigeria.
- ► The study design and multistage sampling technique allowed the assessment of the epidemiological characteristics of hypertension, IFCG and comorbidity of both to be studied extensively in comparison with either a school-based or hospital-based study.
- ► Cross-sectional studies do not showcase cause–effect relationships; however, the associations they reveal may help intervention studies and programmes.
- ► The sample size was relatively small and so the research outcome may not be generalised to the entire adolescents in Enugu State, Southeast Nigeria, despite its relevance.
- ► The possibility of information bias may not be ruled out absolutely since some characteristics examined were self-reported.

INTRODUCTION

Hypertension and impaired fasting capillary glucose (IFCG)/diabetes may become severe public health problems with grave consequences among children and adolescents the world over if not identified early and controlled as these two are often associated with metabolic syndrome and cardiovascular diseases. Increase in traditional cardiovascular risk factors such as obesity and diabetes mellitus early in life has heightened concerns that premature cardiovascular disease and its associated sequelae may develop in a growing number of children and adolescents.[1] These conditions are often neglected and proceed unnoticed partly because adolescents are difficult to reach and often their caregivers see them as healthy and unlikely subjects for these 'adult' problems. The implication is that they carry these problems into adulthood with consequences of target-organ damage, poor prognosis and high disability-adjusted life years. Inclination to develop these conditions in adulthood have been traced to childhood and adolescence when their foundations are laid through exposure to many risk factors. Hypertension in children and adolescents has become a major concern because of its rising prevalence and because available evidence suggests that hypertension tracks from childhood into adulthood.[2] The same is also true of diabetes. Types 1 and 2 diabetes have become prevalent in children and adolescents with the prevalence of complications and comorbidities in later life (teenage and early adulthood) being higher among those with type 2 diabetes compared with type 1 diabetes.[3]

In a systematic review and meta-analysis of the prevalence of elevated blood pressure (BP) in African children and adolescents, the authors[2] reported a range of 0.2%–24.8% with a pooled prevalence of 5.5% for systolic or diastolic BP ≥95th percentile and 12.7% for systolic or diastolic BP ≥90th percentile but <95th percentile. Prevalence of hypertension has also been reported among Nigerian children and adolescents. Hypertension prevalence of 3.5% was reported among children and adolescents in a semiurban area of Uyo Metropolis, Nigeria.[4] Prevalence of hypertension and prehypertension were 6.3% and 5.0%, respectively, among adolescents attending secondary schools in urban area of Southeast Nigeria.[5] Hypertension prevalence of 25.1% among Nigerian university adolescent freshmen has also been documented.[6] In a study on fasting blood glucose profile of secondary school adolescents in Ado-Ekiti Nigeria, prediabetes (28.7%) and diabetes (0.6%) prevalence were reported.[7] In a school-based study on prevalence and risk factors of fasting blood glucose among Nigerian adolescents, pre-diabetes prevalence of 4.0% was reported.[8] Increasing prevalence of these conditions among adolescents may be attributed to urbanisation and lifestyle changes associated with increasing negative nutrition transition as earlier documented.[9 10] There is concern that those in rural communities may also be affected due to inadequate diet and changes in lifestyle.

Hypertension and diabetes share common risk factors suggesting a coexistence. The synergistic relationship of hypertension and diabetes has been reported with many defined mechanisms and consequences on vital organs like the kidneys,[11] heart and coronary artery,[12] brain[3] and the eyes.[13] While diabetes damages arteries and makes them targets for atherosclerosis, hypertension may lead to insulin resistance[14] and is often seen in diabetes suggesting substantial overlap in their aetiology and disease mechanisms.[15] It has also been shown that people with hypertension are at increased risk of developing diabetes.[16] This implies that coexistence of both conditions in adolescence puts the individual at higher risk of morbidity and mortality as well as target-organ damage in early life with reduced life expectancy.

The emergence of diabetes and hypertension as major medical and public health problems and as important risk factors for coronary artery disease, heart failure and stroke with evidence of early target-organ damage in children and adolescents calls for routine examination of free living adolescents for early identification. Understanding the epidemiological dynamics of hypertension and IFCG/diabetes among them as primary tools for planning effective preventive and control interventions is an urgent need whose importance cannot be overemphasised as aversion of long-term hypertension and diabetes related cardiovascular complications and reduction in disability-adjusted life years are guaranteed outcomes. In this study, we conducted a population-based cross-sectional survey to determine the prevalence of hypertension alone, IFCG alone and comorbidity of the two and evaluated factors associated with them among adolescents in Enugu North senatorial zone of Enugu State, Southeast Nigeria.

METHODS

Study setting

The study was conducted in three communities (Ukehe, Ikolo and Idoha) in Igbo-Etiti local government area (LGA), Enugu North senatorial zone of Enugu State, Southeast Nigeria. The inhabitants are mostly farmers, traders with few civil servants and crafts workers (artisans). The commonly consumed foods include bambara groundnut (*okpa*), cassava, rice, yam, maize, cocoyam, pigeon pea and various species of cowpea.

Study design

This study made use of retrospective cross-sectional study design.

Study population

This consisted of 401 adolescents aged 10 – 19 years (males and females inclusive) who resided in the three communities; have never been diagnosed with hypertension and diabetes by any health worker prior to the survey; and therefore not on any BP/blood glucose lowering drugs. Sick adolescents, pregnant and nursing adolescent mothers were excluded.

Sample size and sampling technique

A sample size of 403 was derived from a single population formula using a design effect of 1.5 and a precision level of 95% with the assumption that the proportion of adolescents affected by hypertension was 20%. The sample size was distributed among the three communities proportionately: Ukehe: 40.7% (164; Uwelle-Amakofia: 84 and Amadim: 80), Ikolo: 24.8% (100; Ikoloani: 45 and

Amaedem: 55) and Idoha: 34.5% (139; Amaudara: 82 and Umuefoke: 57). Multistage sampling technique was used to select the participants for the study.

Stage 1 involved the selection of three communities from the LGA using simple random sampling.

In stage 2, two villages were selected from each community by balloting through simple random selection giving a total of six villages.

Stage 3 comprised the identification and selection of clans by simple random sampling technique. Number of clans was also proportionately determined.

Stage 4 consisted of systematic selection of every third house and simple random selection of one household from each house where there are more than one household in a house. In cases where there is no adolescent in a selected household, the household next to it was selected in its place.

In stage 5, only one adolescent was selected from each household by simple random sampling.

Informed consent

The parents and the adolescents gave informed consent in writing indicating approval to participate in the study after detailed explanation of what the study was all about and what their roles were. Sick adolescents, pregnant and nursing adolescent mothers were excluded from the study.

Data collection methods

Questionnaire

A list of relevant questions generated from literature and experiences were pooled together in simple understandable English Language for easy understanding by the rural adolescents. These involved demographic, socioeconomic and lifestyle characteristics. For those who had difficulty with reading and writing, the interviewer method of questionnaire administration was used.

Anthropometry

Weight and height measurements were carried out by methods described elsewhere.[17] Height was measured with the adolescent standing on a flat surface and without shoes while they were allowed light clothing for weight measurement using Hanson's 120 kg capacity weighing scale. Both readings were recorded to the nearest 0.1 cm and 0.1 kg, respectively. The values were used in body mass index (BMI) calculations for assessment of BMI-for-age of the adolescents. Z scores ≤−2 SD were interpreted as thinness and those ≥+2 were taken as overweight/obesity.

BP determination

Electronic sphygmomanometer (Andon KD-595, China) was used to measure the BP of the adolescents. Each respondent was made to sit comfortably upright with feet on the floor and arm positioned in such a way that the elbow while resting on a stable surface is parallel to the heart. Two readings were taken at 3 min interval and the mean of the two used in analysis. A third reading was taken if a wide difference of about 5 mm Hg was observed between the first two readings in either systolic or diastolic BP. Adolescents with high BP on two different occasions were referred to a physician. Prehypertension was defined as raised systolic or diastolic BP for sex, age and height ≥90th–<95th percentile or 120/80 mm Hg (whichever is lower) for children less than 13 years. For those who were 13 years and older, prehypertension was taken as values of 120/<80–129/<80 mm Hg. For children <13 years, stage 1 hypertension was defined as raised systolic or diastolic BP ≥95th–<95th percentile plus 12 mm Hg or 130/80–139/89 mm Hg (whichever is lower), but for ≥13 years, it was 130/80–139/89 mm Hg. Stage 2 hypertension was ≥140/90 for <13 years and ≥95th percentile plus 12 mm Hg or ≥140/90 mm Hg (whichever is lower) for those ≥13 years.[18] Hypertension alone describes hypertension uncomplicated with IFCG.

Fasting capillary glucose

Accu-Chek glucometer was used in the determination of fasting capillary glucose of the adolescents after an overnight fast of 8–10 hours. Participant's finger was pricked after being cleaned with cotton wool soaked in methylated spirit. Test strip was used to collect one or two drops of blood and placed in the glucometer. Reading was classified as high if ≥100 mg/dL: 100–125 mg/dL for IFCG and ≥126 mg/dL for diabetes.[19] The choice of capillary blood in glucose analysis has been supported by literature.[20] IFCG alone describes IFCG uncomplicated with hypertension.

Covariates

Demographic variables taken into consideration were age, sex and marital status. Socioeconomic variables of interest were occupation and monthly income. Lifestyle characteristics were smoking, alcohol consumption, sleep duration and exercise. Meal skipping, consumption of snacks, fruits, vegetables and sugar-containing drinks were dietary habits examined. Adequate consumption of fruits and vegetables were taken as weekly consumption of four to seven times a week. These covariates were assessed at both the bivariate and multivariate levels.

Quality control

This was maintained throughout the data collection period through a pretest of the questionnaire and training of research assistants (especially those who could translate the questionnaire into Igbo language correctly). Supervision and provision of technical support was carried out during the survey to ensure adherence to study protocols. Regular intermittent on the spot random verification of data was also carried out, and identified inconsistencies/missing data and problems were resolved.

Statistical analyses

Validated data were entered into Microsoft Excel, cleaned and sorted. Statistical Product and Service Solution (IBM, V.21) was used in data analysis. Results

Table 1 Sex-wise and age-wise distribution of respondents' general characteristics

	Sex			Age (years)			
Variables	**Male**	**Female**	**P value**	**10–14**	**15–19**	**P value**	**Total**
Marital status							
Single	179 (95.2)	200 (93.9)		176 (94.1)	203 (94.9)		379 (94.5)
Married	9 (4.8)	13 (6.1)	0.663	11 (5.9)	11 (5.1)	0.745	22 (5.5)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Main occupation							
Studying	173 (92.0)	189 (88.7)		166 (88.8)	196 (91.6)		362 (90.3)
Other occupations	15 (8.0)	24 (11.3)	0.267	21 (11.2)	18 (8.4)	0.342	39 (9.7)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Monthly income (Naira)							
0–40 000	147 (78.2))	171 (80.3)		144 (77.0)	174 (81.3)		318 (79.3)
>40 000	41 (21.8)	42 (19.7)	0.606	43 (23.0)	40 (18.7)	0.289	83 (20.7)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Household size (persons)							
1–6	91 (48.4)	84 (39.4)		86 (46.0)	89 (41.6)		175 (43.6)
>6	97 (51.6)	129 (60.6)	0.071	101 (54.0)	125 (58.4)	0.375	226 (56.4)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Ever smoked any substance†							
No	170 (90.4)	190 (89.2)		174 (93.0)	186 (86.9)		360 (89.8)
Yes	18 (9.6)	23 (10.8)	0.687	13 (7.0)	28 (13.1)	0.045*	41 (10.2)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Ever consumed alcohol							
No	90 (47.9)	99 (46.5)		77 (41.2)	112 (52.3)		189 (47.1)
Yes	98 (52.1)	114 (53.5)	0.780	110 (58.8)	102 (47.7)	0.026*	212 (52.9)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Hours of sleep							
≤7 hours	121 (64.4)	133 (62.4)		124 (66.3)	130 (60.7)		254 (63.3)
>7 hours	67 (35.6)	80 (37.6)	0.690	63 (33.7)	84 (39.3)	0.249	147 (36.7)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Duration of weekly exercise‡							
<30 min	53 (28.2)	53 (24.9)		47 (25.1)	59 (27.6)		106 (26.4)
≥30 min	135 (71.8)	160 (75.1)	0.453	140 (74.9)	155 (72.4)	0.581	295 (73.6)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Skipping meals at least once/day							
No	75 (39.9)	87 (40.8)		75 (40.1)	87 (40.3)		162 (40.4)
Yes	113 (60.1)	126 (59.2)	0.846	112 (59.9)	127 (59.3)	0.911	239 (59.6)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Skipping breakfast at least once/week							
No	109 (58.0)	123 (57.7)		111 (59.4)	121 (56.5)		232 (57.9)
Yes	79 (42.0)	90 (42.3)	0.963	76 (40.6)	93 (43.5)	0.569	169 (42.1)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Types of snacks consumed							
None	15 (8.0)	16 (7.5)		12 (6.4)	19 (8.9)		24 (6.0)
Non-fried/baked products	10 (5.3)	14 (6.6)		7 (3.8)	17 (7.9)		346 (86.3)
Fried/baked products	163 (86.7)	183 (85.9)	0.862	168 (89.8)	178 (83.2)	0.120	31 (7.7)

Continued

Table 1 Continued

Variables	Sex: Male	Female	P value	Age (years): 10–14	15–19	P value	Total
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Weekly consumption of fruits							
<4	122 (64.9)	147 (69.0)	0.381	118 (63.1)	151 (70.6)	0.113	269 (67.1)
4–7 times	66 (35.1)	66 (31.0)		69 (36.9)	63 (29.4)		132 (32.9)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Weekly consumption of vegetable							
<4 times	128 (68.1)	146 (68.5)	0.921	125 (66.8)	149 (69.6)	0.055	274 (68.3)
4–7 times	60 (31.9)	67 (31.5)		62 (33.2)	65 (30.4)		127 (31.7)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Weekly consumption of sugar containing drinks							
<4 times	161 (85.6)	191 (89.7)	0.218	158 (84.5)	194 (90.7)	0.060	352 (87.8)
4–7 times	27 (14.4)	22 (10.3)		29 (15.5)	20 (9.3)		49 (12.2)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)

*P<0.05.
†Tobacco, cigarette, cocaine and Indian hemp.
‡Exercises such as stretching, walking, running, weight training and sprinting.

were presented in frequencies and percentages for categorical variables and stratified according to age and sex. χ^2, bivariate and multivariate logistic regression analysis were used to evaluate relationship among variables with precision level set at 95%. Statistical significance was established at p<0.05.

Patient and public involvement

The study did not involve any patient nor member of the public in the conception, design and development of the study protocol. They were not also involved in data acquisition, analysis, interpretation and development of this manuscript.

RESULTS

Response rate for this study was 99.5%.

General characteristics of the respondents by sex and age are shown in table 1. The study consisted of 46.9% males and 53.1% females; 46.6% and 53.4% were within 10 – 14 and 15 – 19 years, respectively. More males (95.2%) and 93.9% females as well as 94.1% of 10–14 and 94.9% of 15 – 19 year-olds were single. More males slept for ≤7 hours (64.4%), had exercise duration of <30 min weekly (28.2%), skipped meals at least once a day (60.1%) and consumed fried/baked snacks (86.7%), whereas more females smoked any substance (10.8%), consumed alcohol (53.5%), skipped breakfast (42.3%) and had less than 4 times weekly consumption of fruit (69.0%), vegetable (68.5%) and sugar-containing drinks (89.7%). Ever consumed alcohol (58.8%), hours of sleep ≤7 hours (66.3%), skipping meals (59.9%) and consumption of fried/baked snacks (89.8%) had higher prevalence among adolescents within 10 – 14 years while among 15 – 19 years, ever smoked any substance (13.1%), duration of exercise <30 min (27.6%), skipping breakfast (43.5%) and less frequent (<4 times weekly) consumption of fruits (70.6%), vegetables (69.6%) and sugar-containing drinks (90.7%) were more prevalent. These differences were not sex dependent (p>0.05). Age differences were significant (p<0.05) for ever smoked any substance and ever consumed alcohol.

Table 2 displays the BMI-for-age, BP and fasting capillary glucose status of the adolescents. Overall prevalence of overweight was 3.2% with higher prevalence among males (3.7%) and those aged 15–19 years (4.7%) than among females (2.8%) and the 10 – 14 year-olds (1.6%). Overall prehypertension and hypertension prevalence were 10.7% and 19.0%, respectively. Prehypertension (13.3%) and hypertension (22.3%) affected more males than females (8.4% and 16.0%, respectively). Adolescents aged 10 – 14 years had higher prevalence of prehypertension (12.3% vs 9.3%) and hypertension (26.2% vs 12.7%) than the 15 – 19 year-olds. IFCG and diabetes overall prevalence were 17.0% and 0.2%, respectively. IFCG (21.3%) affected more males, while diabetes (0.5%) was found more among the females. IFCG (18.2% vs 15.9%) and diabetes (0.5% vs 0.0%) were more prevalent among adolescents aged 10 – 14 years than adolescents aged 15–19 years. Out of 19.0% with hypertension, 12.7% had hypertension alone. IFCG alone was found among 11.0% out of 17.0% with IFCG. Those with both hypertension and IFCG were 6.2%. Having both conditions affected the males (10.1%) and the 10–14 year-olds (8.0%) more than the females (2.9%) and the 15 – 19 year-olds (4.7%). Gender differences were significant for hypertension and

Table 2 Body mass index-for-age, blood pressure and fasting capillary glucose status of the adolescents

Variables	Sex			Age (years)			Total
	Male	Female	P value	10–14	15–19	P value	
Body mass index-for-age							
Normal	146 (77.7)	184 (86.4)		139 (74.3)	191 (89.2)		330 (82.3)
Overweight	7 (3.7)	6 (2.8)	0.067	3 (1.6)	10 (4.7)	0.000‡	13 (3.2)
Thinness	35 (18.6)	23 (10.8)		45 (24.1)	13 (6.1)		58 (14.5)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Blood pressure classification by degree							
Normotension	121 (64.4)	161 (75.6)	0.047*	115 (61.5)	167 (78.0)	0.001†	282 (70.3)
Prehypertension	25 (13.3)	18 (8.4)		23 (12.3)	20 (9.3)		43 (10.7)
Hypertension	42 (22.3)	34 (16.0)		49 (26.2)	27 (12.7)		76 (19.0)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Fasting capillary glucose status							
Normal	148 (78.7)	184 (86.4)	0.064	152 (81.3)	180 (84.1)	0.461	332 (82.8)
IFCG	40 (21.3)	28 (13.1)		34 (18.2)	34 (15.9)		68 (17.0)
Diabetes	0 (0.0)	1 (0.5)		1 (0.5)	0 (0.0)		1 (0.2)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)
Comorbidity of hypertension with IFCG							
Normal	125 (66.5)	156 (73.2)	0.026*	118 (63.1)	163 (76.2)	0.006†	281 (70.1)
Hypertension alone	23 (12.2)	28 (13.1)		34 (18.2)	17 (7.9)		51 (12.7)
IFPG alone	21 (11.2)	23 (10.8)		20 (10.7)	24 (11.2)		44 (11.0)
Both	19 (10.1)	6 (2.9)		15 (8.0)	10 (4.7)		25 (6.2)
Total	188 (100.0)	213 (100.0)		187 (100.0)	214 (100.0)		401 (100.0)

*P<0.05.
†P<0.01.
‡P<0.001.
IFCG, impaired fasting capillary glucose.

comorbidity of hypertension with IFCG (p<0.05). Age differences were significant for BMI-for-age (p<0.001), hypertension (p<0.01) and comorbidity of hypertension with IFCG (p<0.01).

Bivariate and multivariate logistic regression analysis of factors associated with hypertension alone are shown in table 3. Age 15 – 19 years was less likely to be affected by hypertension alone (AOR=0.36, 95% CI 0.18 to 0.74, p<0.01). Adolescents who smoked any substance (AOR=3.43, 95% CI 1.34 to 8.78, p<0.05), consumed alcohol (AOR=2.85, 95% CI 1.33 to 6.10, p<0.01) and fried/baked snacks (AOR=15.46, 95% CI 1.62 to 147.37, p<0.05) were significantly at higher risk of having hypertension alone than others who did not smoke any substance nor consumed alcohol and fried/baked snacks. The risk of hypertension alone was about three times higher among those who skipped meals daily (AOR=2.69, 95% CI1.16 to 6.25, p<0.05) and two times higher among adolescents who consumed vegetables four to seven times a week (AOR=2.27, 95% CI 1.11 to 4.66, p<0.05).

Table 4 shows the bivariate and multivariate logistic regression analysis of factors associated with IFCG alone. Adolescents who skipped meals daily were more likely to have IFCG alone (AOR=2.15, 95% CI 0.93 to 4.99, p>0.05) than those who did not skip meals. Those who skipped breakfast were less likely to have IFCG (AOR=0.48, 95% CI 0.20 to 1.11, p>0.05), while longer than 7 hours of night sleep increased the risk of IFCG by 2 (AOR=1.88, 95% CI 0.94 to 3.73, p>0.05).

Bivariate and multivariate logistic regression analysis of factors associated with comorbidity of hypertension with IFCG are displayed in table 5. Being a female (AOR=0.29, 95% CI 0.10 to 0.78, p<0.05) and consumption of fried/baked snacks (AOR=0.09, 95% CI 0.02 to 0.37, p<0.01) were associated with less likelihood of having hypertension with IFCG. Those who skipped meals had almost twofold higher risk of hypertension with IFCG (AOR=1.98, 95% CI 0.54 to 7.34, p>0.05).

DISCUSSION

Prevalence of hypertension

This study reported prevalence of prehypertension as 10.7%, hypertension as 19.0% and hypertension alone (uncomplicated with IFCG) as 12.7% (table 2). These figures are lower than 19.8% and 25.1%, respectively,[6]

Table 3 Bivariate and multivariate logistic regression analysis of factors associated with hypertension alone

Variables	Hypertension alone					
	Absent	Present	COR (95% CI)	P value	AOR (95% CI)	P value
Sex						
Male	165 (47.1)	23 (45.1)				
Female	185 (52.9)	28 (54.9)	1.09 (0.60 to 1.96)	0.785	1.18 (0.61 to 2.28)	0.616
Age (years)						
10–14	153 (43.7)	34 (66.7)				
15–19	197 (56.7)	17 (33.3)	0.39 (0.21 to 0.72)	0.003†	0.36 (0.18 to 0.74)	0.005†
Marital status						
Single	332 (94.9)	47 (92.2)				
Married	18 (5.1)	4 (7.8)	1.57 (0.51 to 4.84)	0.432	3.71 (0.68 to 20.20)	0.129
Main occupation						
Studying	318 (90.9)	44 (86.3)				
Other occupations	32 (9.1)	7 (13.7)	1.58 (0.67 to 3.80)	0.306	0.75 (0.22 to 2.58)	0.647
Monthly income						
0–40 000	277 (79.1)	41 (80.4)				
>40 000	73 (20.9)	10 (19.6)	0.93 (0.44 to 1.94)	0.837	0.70 (0.30 to 1.62)	0.405
Ever smoked any substance						
No	320 (91.4)	40 (78.4)				
Yes	30 (8.6)	11 (21.6)	2.93 (1.37 to 6.30)	0.006†	3.43 (1.34 to 8.78)	0.010*
Ever consumed alcohol						
No	176 (50.3)	13 (25.5)				
Yes	174 (49.7)	38 (74.5)	2.96 (1.52 to 5.74)	0.001†	2.85 (1.33 to 6.10)	0.007†
Hours of sleep						
≤7 hours	216 (61.7)	38 (74.5)				
>7 hours	134 (38.3)	13 (25.5)	0.55 (0.28 to 1.07)	0.080	0.78 (0.38 to 1.63)	0.511
Duration of weekly exercise						
<30 min	92 (26.3)	14 (27.5)				
≥30 min	258 (73.7)	37 (72.5)	0.94 (0.49 to 1.82)	0.860	0.080 (0.39 to 1.65)	0.549
Type of snacks consumed						
None	30 (8.6)	1 (2.0)		0.135		0.041*
Non-fried/baked products	23 (6.6)	1 (2.0)	1.30 (0.08 to 21.98)	0.854	4.85 (0.24 to 96.38)	0.300
Fried/baked products	297 (84.8)	49 (96.0)	4.95 (0.66 to 37.13)	0.120	15.46 (1.62 to 147.37)	0.017*
Skipping meals						
No	115 (41.4)	17 (33.3)				
Yes	205 (58.6)	34 (66.7)	1.42 (0.76 to 2.63)	0.273	2.69 (1.16 to 6.25)	0.022*
Skipping breakfast						
No	200 (57.1)	32 (62.7)				
Yes	150 (42.9)	19 (37.3)	0.79 (0.43 to 1.45)	0.450	0.35 (0.15 to 0.81)	0.015*
Weekly fruit consumption						
<4 times	234 (66.9)	35 (68.6)				
4–7 times	116 (33.1)	16 (31.4)	0.92 (0.49 to 1.74)	0.802	0.53 (0.24 to 1.17)	0.117
Weekly vegetable consumption						
<4 times	246 (70.3)	28 (54.9)				
4–7 times	104 (29.7)	23 (45.1)	1.94 (1.07 to 3.53)	0.029*	2.27 (1.11 to 4.66)	0.025*
Weekly consumption of sugar-containing drinks						

Continued

Table 3 Continued

Variables	Hypertension alone		COR (95% CI)	P value	AOR (95% CI)	P value
	Absent	Present				
<4 times	311 (88.9)	41 (80.4)				
4–7 times	39 (11.1)	10 (19.6)	1.95 (0.90 to 4.19)	0.089	1.57 (0.62 to 3.93)	0.341
Body mass index-for-age						
Normal	289 (82.6)	41 (80.4)		0.698		0.890
Overweight	12 (3.4)	1 (2.0)	0.59 (0.07 to 4.64)	0.614	1.14 (0.13 to 0.988)	0.907
Thinness	49 (14.0)	9 (17.6)	1.30 (0.59 to 2.83)	0.518	0.81 (0.34 to 1.96)	0.645

*P<0.05.
†P<0.01.
AOR, adjusted OR; COR, crude OR.

but higher than 2.5% and 3.5%[4] documented earlier and similar to hypertension prevalence of 10.6% reported by another researcher.[21] Males being significantly affected more than females disagrees with the report of yet another author[22] who reported higher prevalence of prehypertension (20.1%) and hypertension (6.9%) among females than males (14.3% and 3.8%). This may probably be due to a slightly higher prevalence of overweight among the males in support of earlier findings[2 6 22] that overweight and obesity were associated with higher BP. That more 10 – 14year-olds were significantly affected was a surprise because hypertension has been associated with increase in age,[23] and the older group had a higher prevalence of overweight. Lifestyle characteristics though not significant (p>0.05) may have led to this situation as both males and the adolescents aged 10 – 14years had higher prevalence of meal skipping, hours of sleep ≤7and consumption of fried/baked snacks. Besides, a higher percentage of adolescents who consumed alcohol was found among those within 10 – 14 years. These lifestyle characteristics have been associated with raised BP. The fact that this was not significant with IFCG alone suggests hypertension dominance and that controlling hypertension may effectively control IFCG by reducing insulin resistance. Hypertension prevalence is on the increase when compared with studies conducted earlier.[4 18 22] As a major cardiovascular risk factor, its occurrence in adolescents should be taken seriously to prevent early target-organ damage and reduce the potential burden of CVDs on adulthood and healthcare delivery systems especially of low-income and middle-income countries with limited resources.

Prevalence of IFCG and diabetes

The overall prevalence of IFCG and diabetes observed in this study were 17.0% and 0.2%, respectively, with male and 10 – 14year-old preponderance. Other researchers[7] have documented higher prevalence of IFCG (28.7%) and diabetes (0.6%) and a lower IFCG prevalence of 4.0%.[8] The preponderance observed in this study may be consequent on the adolescent lifestyle as earlier stated. IFCG and diabetes in adolescence is a major health problem that requires urgent attention because of the potential of associated comorbidities like hypertension developing in later life.

Prevalence of comorbidity of hypertension with IFCG

Adolescents with both hypertension and IFCG were 25 (6.2%) with significantly higher prevalence in males and the 10 – 14year-olds. Higher prevalence of 9.7% was reported in a review article on the rising burden of diabetes and hypertension in Southeast Asian and African regions.[24] According to Long *et al*,[14] 75% of people with diabetes also had hypertension and patients with hypertension alone often show evidence of insulin resistance. The lower prevalence reported here may be attributed to the fact that most of the affected adolescents were at the impaired capillary glucose stage and have not developed diabetes. That males and the 10 – 14year-olds were significantly affected more follows the pattern of their being affected more by hypertension and IFCG independently. We attributed this finding to their lifestyle, which included consumption of alcohol, skipping meals and consumption of fried/baked snacks. Some studies[15 25] have corroborated the comorbidity of hypertension and diabetes with hypertension complicating diabetes in most cases. Hypertension and diabetes are common, intertwined conditions with significant overlap in underlying risk factors and complications.[15] Wu and Wang[26] reported a significant relationship between hypertension and diabetes and supports the assertion that these are comorbidities.

Factors associated with hypertension, IFCG and a combination of both

Sex affected having hypertension with IFCG with affinity for males as females were significantly less likely to be affected. This is contrary to an existing documentation[22] in which females were affected more. Females were also less likely to be affected by IFCG alone but more likely to have hypertension alone though these associations did not reach significant proportions. Male disposition to IFCG alone and hypertension with IFCG was attributed to their lifestyle characteristics as they had higher prevalence of overweight, ≤7hours of sleep, skipped meals and fried/baked snacks consumption than females though

Table 4 Bivariate and multivariate logistic regression analysis of factors associated with IFCG alone

Variables	IFCG alone		COR (95% CI)	P value	AOR (95% CI)	P value
	Absent	Present				
Sex						
Male	167 (46.8)	21 (47.7)				
Female	190 (53.2)	23 (52.3)	0.96 (0.51 to 1.80)	0.905	0.87 (0.45 to 1.67)	0.670
Age (years)						
10–14	167 (46.8)	20 (45.5)				
15–19	190 (53.2)	24 (54.5)	1.06 (0.56 to 1.98)	0.868	0.97 (0.48 to 1.95)	0.929
Marital status						
Single	340 (95.2)	39 (88.6)				
Married	17 (4.8)	5 (11.4)	2.56 (0.90 to 7.33)	0.079	1.91 (0.48 to 7.70)	0.361
Main occupation						
Studying	325 (91.0)	37 (84.1)				
Other occupations	32 (9.0)	7 (15.9)	1.92 (0.79 to 4.66)	0.148	1.07 (0.32 to 3.55)	0.912
Monthly income						
0–40 000	283 (79.3)	35 (79.5)				
>40 000	74 (20.7)	9 (20.5)	0.98 (0.45 to 2.14)	0.966	0.92 (0.41 to 2.08)	0.838
Ever smoked any substance						
No	322 (90.2)	38 (86.4)				
Yes	35 (9.8)	6 (13.6)	1.45 (0.57 to 3.68)	0.431	1.18 (0.38 to 3.60)	0.777
Ever consumed alcohol						
No	171 (47.9)	18 (40.9)				
Yes	186 (52.1)	26 (59.1)	1.33 (0.70 to 2.51)	0.382	1.50 (0.74 to 3.04)	0.264
Hours of sleep						
≤7 hours	230 (64.4)	24 (54.5)				
>7 hours	127 (35.6)	20 (45.5)	1.51 (0.80 to 2.84)	0.202	1.88 (0.94 to 3.73)	0.073
Duration of weekly exercise						
<30 min	93 (26.1)	13 (29.5)				
≥30 min	264 (73.9)	31 (70.5)	0.84 (0.42 to 1.67)	0.620	0.86 (0.42 to 1.77)	0.675
Type of snacks consumed						
None	25 (7.0)	6 (13.6)		0.023		0.066
Non-fried/baked products	18 (5.0)	6 (13.6)	1.39 (0.39 to 5.01)	0.616	2.64 (0.61 to 11.42)	0.195
Fried/baked products	314 (88.0)	32 (72.8)	0.43 (0.16 to 1.11)	0.081	0.72 (0.22 to 0.230)	0.576
Skipping meals						
No	147 (41.2)	15 (34.1)				
Yes	210 (58.8)	29 (65.9)	1.35 (0.70 to 2.61)	0.367	2.15 (0.93 to 4.99)	0.074
Skipping breakfast						
No	204 (51.4)	28 (63.6)				
Yes	153 (42.9)	16 (36.4)	0.76 (0.40 to 1.46)	0.762	0.48 (0.20 to 1.11)	0.086
Weekly fruit consumption						
<4 times	238 (66.7)	31 (70.5)				
4–7 times	119 (33.3)	13 (29.5)	0.84 (0.42 to 1.66)	0.614	0.68 (0.31 to 1.49)	0.335
Weekly vegetable consumption						
<4 times	246 (68.4)	28 (63.6)				
4–7 times	111 (31.1)	16 (36.4)	1.27 (0.66 to 2.44)	0.479	1.45 (0.69 to 3.07)	0.330
Weekly consumption of sugar containing drinks						

Continued

Table 4 Continued

Variables	IFCG alone Absent	Present	COR (95% CI)	P value	AOR (95% CI)	P value
<4 times	311 (87.1)	41 (93.2)				
4–7 times	46 (12.9)	3 (6.8)	0.50 (0.15 to 1.66)	0.255	0.59 (0.17 to 2.13)	0.424
Body mass index-for-age						
Normal	293 (82.0)	37 (84.1)		0.912		0.970
Overweight	12 (3.4)	1 (2.3)	0.66 (0.08 to 5.22)	0.694	0.78 (0.09 to 6.47)	0.814
Thinness	52 (14.6)	6 (13.6)	0.91 (0.37 to 2.27)	0.846	0.96 (0.36 to 2.52)	0.932

AOR, adjusted OR; COR, crude OR; IFCG, impaired fasting capillary glucose.

gender differences were not significant. Overweight/obesity,[2 6 22] sleep duration/pattern and meal skipping have been associated with hypertension and diabetes probably by fostering weight gain.

Age 15 – 19 years was associated with low risk for hypertension alone, IFCG alone and hypertension with IFCG. Significance was observed with hypertension alone. This is contrary to previous studies[4 6] that reported higher risks with increasing age. Our finding may be attributed to the low prevalence of meal skipping, alcohol and fried/baked snacks consumption among 15 – 19 year-olds suggesting that adoption of appropriate strategies such as lifestyle modification may decrease risk for hypertension despite age.

Smoking any substance was significantly associated with three times greater risk for hypertension alone. Though it was also associated with higher risk of IFPG alone, significance was not attained. According to Keto *et al*,[27] cigarette (and such substances) smoke is a major risk factor for CVDs and the second leading cause for CVD mortality after high BP. This implies that adolescents who smoke any substance were at double risk of CVD as smoking is a known independent risk factor for CVDs and has also been associated with hypertension and diabetes.[27] Adolescents should therefore be discouraged from smoking and those already involved encouraged to quit as it has serious acute and chronic consequences of morbidity and mortality.

Adolescents who consumed alcohol were at higher risk of hypertension alone, IFCG alone and hypertension coexisting with IFCG; the association with hypertension alone achieved statistical significance. Alcohol is a toxic and psychoactive substance with dependence-producing properties; adolescents who consumed alcohol run the risk of early morbidity of alcohol-related health challenges as a recent research report[28] showed that no amount of alcohol intake is healthy and the level of consumption that minimises health loss is zero standard drinks per week.

Adolescents who consumed fried/baked snacks were significantly at higher risk of hypertension alone but surprisingly at lower risk of hypertension coexisting with IFPG. These findings may be attributed to quantity and consumption frequency, type of oil, frying procedure (deep and pan frying), temperature, duration, how often oils were reused and whether the snacks were homemade or not.[29] Fried/baked snacks contain saturated fats, added sugars and salt; these contents have been associated with hypertension. WHO[30] asserted that excessive intake of saturated fatty acids and trans fatty acids, along with consumption of high quantities of salt and sugar, are risk factors for cardiovascular diseases including hypertension. These products contain high calories that, if unused, would invariably lead to overweight and obesity, very important risk factors for diabetes, hypertension and therefore CVDs. Frequent and prolonged consumption of fried/baked snacks should therefore be discouraged.

We also observed an association of higher income with coexistence of hypertension with IFPG which, though not significant, supports earlier report.[31] That some of the adolescents who go to school were engaged in income generating activities both after school and during holidays may have given them income and empowered them to buy what they liked. Increased income paves way for proper nutrition only if accompanied with good nutrition knowledge; otherwise, one would expect the misuse as seen in this study where those affected more (males) consumed fried/baked products as snacks. Introduction of nutrition education programmes at school and community levels would help to create awareness and modify lifestyle for healthy living.

Hypertension alone was positively influenced by skipping meals as those who skipped meals were almost three times at higher risk of being affected. Though not significant, skipping meals was also associated with IFCG alone and coexistence of hypertension with IFCG. This was expected because skipping meals has been associated with weight gain. We also observed that those who skipped breakfast were more likely to have hypertension with IFPG. This association, though not significant, may suggest that skipping breakfast does not necessary mean not eating anything at all but may denote not eating cooked food. For adolescents and most people, snacks are not meals hence they may resort to snack (eg, biscuits and sugar-containing beverages) consumption rather than cooked foods and still assert that they have not

Table 5 Bivariate and multivariate logistic regression analysis of factors associated with comorbidity of hypertension with IFCG

Variables	Hypertension with IFCG		COR (95% CI)	P value	AOR (95% CI)	P value
	Absent	Present				
Sex						
Male	169 (44.9)	19 (76.0)				
Female	207 (55.1)	6 (24.0)	0.26 (0.10 to 0.66)	0.005†	0.29 (0.10 to 0.78)	0.014*
Age (years)						
10–14	172 (45.7)	15 (60.0)				
15–19	204 (54.3)	10 (40.0)	0.56 (0.25 to 1.28)	0.171	0.66 (0.24 to 1.77)	0.546
Marital status						
Single	357 (94.9)	22 (88.0)				
Married	19 (5.1)	3 (12.0)	2.56 (0.70 to 9.32)	0.153	0.81 (0.11 to 5.83)	0.836
Main occupation						
Studying	342 (91.0)	20 (80.0)				
Other occupations	34 (9.0)	5 (20.0)	2.52 (0.89 to 7.13)	0.021*	1.67 (0.32 to 8.87)	0.544
Monthly income (Naira)						
0–40 000	299 (79.5)	19 (76.0)				
>40 000	77 (20.5)	6 (24.0)	1.23 (0.47 to 3.18)	0.462	1.44 (0.50 to 4.17)	0.504
Ever smoked any substance						
No	336 (89.4)	24 (96.0)				
Yes	40 (10.6)	1 (4.0)	0.35 (0.05 to 2.66)	0.310	0.13 (0.01 to 1.32)	0.085
Ever consumed alcohol						
No	180 (47.9)	9 (36.0)				
Yes	196 (52.1)	16 (64.0)	1.63 (0.70 to 3.79)	0.253	1.74 (0.66 to 4.59)	0.262
Hours of sleep						
≤7 hours	239 (63.6)	15 (60.0)				
>7 hours	137 (36.4)	10 (40.0)	1.16 (0.51 to 2.66)	0.720	1.41 (0.53 to 3.72)	0.488
Duration of weekly exercise						
<30 min	99 (26.3)	7 (28.0)				
≥30 min	277 (73.7)	18 (72.0)	0.92 (0.37 to 2.27)	0.855	1.10 (0.40 to 3.04)	0.850
Snacks commonly consumed						
None	24 (6.4)	7 (28.0)		0.002†		0.003†
Non-fried/baked products	23 (6.1)	1 (4.0)	0.15 (0.02 to 1.31)	0.086	0.12 (0.01 to 1.27)	0.078
Fried/baked products	329 (87.5)	17 (68.0)	0.18 (0.07 to 0.47)	0.000‡	0.09 (0.02 to 0.37)	0.001†
Skipping meals						
No	155 (41.2)	7 (28.0)				
Yes	221 (58.8)	18 (72.0)	1.80 (0.74 to 4.42)	0.197	1.98 (0.54 to 7.34)	0.304
Skipping breakfast						
No	220 (58.5)	12 (48.0)				
Yes	156 (41.5)	13 (52.0)	1.53 (0.68 to 3.44)	0.306	1.54 (0.47 to 5.11)	0.479
Weekly fruit consumption						
<4 times	255 (67.8)	14 (56.0)				
4–7 times	121 (32.2)	11 (44.0)	1.66 (0.73 to 3.76	0.227	1.43 (0.50 to 4.12)	0.509
Weekly vegetable consumption						
<4 times	261 (69.4)	13 (52.0				
4–7 times	115 (30.6)	12 (48.0)	2.10 (0.93 to 4.73)	0.075	1.61 (0.59 to 4.43)	0.357

Continued

Table 5 Continued

Variables	Hypertension with IFCG		COR (95% CI)	P value	AOR (95% CI)	P value
	Absent	Present				
Weekly consumption of sugar containing drinks						
<4 times	330 (87.8)	22 (88.0)				
4–7 times	46 (12.2)	3 (12.0)	0.98 (0.28 to 3.40)	0.972	0.93 (0.22 to 3.94)	0.919
Body mass index-for-age						
Normal	312 (83.0)	18 (72.0)		0.368		0.388
Overweight	12 (3.2)	1 (4.0)	1.44 (0.18 to 11.73)	0.731	2.91 (0.30 to 28.16)	0.356
Thinness	52 (13.8)	6 (24.0)	2.00 (0.76 to 5.27)	0.161	1.87 (0.62 to 5.69)	0.270

*P<0.05.
†P<0.01.
‡P<0.001
AOR, adjusted OR; COR, crude OR; IFCG, impaired fasting capillary glucose.

eaten. This may account for this finding and the documented evidence that adolescents who skipped breakfast had higher values of trunk fatness and systolic BP.[32] When meals are skipped, it is more likely for adolescents who have money at their disposal to spend it on foods especially unhealthy snacks. Fried food preference observed among Nigerian youths aged 15 - 18 years had a significant relationship with prehypertension.[33] Frequent fried food consumption was also reported as being significantly associated with risk of incident type 2 diabetes and moderately with incident coronary artery disease, with the associations largely mediated by body weight and comorbid hypertension and hypercholesterolemia.[34]

Vegetable consumption of four to seven times a week was associated with higher likelihood of having hypertension alone, IFCG alone and hypertension with IFCG. This association was significant for hypertension alone and, though a surprise, was supported by Kim and Kim,[35] who reported a higher intake of fruit and not vegetable with lower risk of incident hypertension regardless of sex. This may be attributed to consumption of low quantity at each sitting. Frequent consumption does not necessary imply adequate intake as the type, quantity and duration of regular intake vary greatly. Studies showed that greater long-term intake and increased consumption may reduce the risk of developing hypertension[36] and diabetes.[37] A meta-analysis on fruit and vegetable consumption and risk of hypertension indicated that fruit and vegetable consumption might be inversely associated with hypertension risk[38] and by implication diabetes. Our finding may also be attributed to sugar-containing drinks as sugary drinks can influence daily intake of fruits and vegetables in resource-limited communities.[39] Increasing fruit, juice and vegetable consumption also increased circulating level of beneficial nutrients in healthy subjects[40] and therefore should be encouraged.

Though not significant, we noted that consumption of sugar-containing beverages four to seven times weekly was inversely associated with IFCG alone. This is contrary to an earlier documentation that frequent consumption of carbonated drinks increases the risks of IFCG.[8] The seeming protective effect observed in this study may be attributed to quantity consumed each time and weekly exercise of ≥30 min engaged in by majority of the adolescents, which was less likely to lead to IFCG and known to prevent build-up of adiposity. Frequent consumption of these drinks should be discouraged despite our finding as it reduces the chances of dietary diversification and promotes poor nutrition with danger of increasing CVD risk factors.

Contrary to an earlier finding,[41] longer than 7 hours of night sleep was associated with IFCG alone and hypertension with IFCG (p>0.05) but not with hypertension alone. This association may be attributed to poor sleep quality. Various forms of sleep disturbances have been linked to hypertension and diabetes[42] and therefore CVDs. Besides duration, emphasis should also be on sleep quality as these two are necessary for healthful living.

Though not significant, being married was a likely predictor of hypertension alone and IFCG alone but not hypertension with IFCG as suggested by the findings of this study in contrast with earlier reports.[43 44] Being married increased the risk for hypertension by almost four times though not significant. Being married may provide intimate companionship for sharing feelings and worries as well as provide better opportunities for improvement in income, education and stress-coping strategies. However, where marital life is associated with poverty and lack of social freedom or in cases where the adolescent was forced into marriage, a reasonable amount of physical and mental stress may be placed on the adolescent and this may cause psychosomatic illnesses such as hypertension and diabetes. In support, Dhindsa *et al*[45] asserted that dissatisfaction in a marriage and marriage quality have significant impact on cardiovascular risk and that psychosocial and socioeconomic factors, as well as other acute stressors, may contribute to the association between marital status and CVD outcomes. This may account for married adolescents being at risk of hypertension, IFPG and their comorbidity.

Our study is not without limitations. Since the study was cross-sectional, the associations reported were probabilistic and not causal though identified correlates may be beneficial in planning and implementing intervention studies and programmes. The results of the study may not be generalised to the entire adolescents in Enugu State, Southeast Nigeria, due to the relatively small sample size used. Also, the possibility of information bias may not be ruled out absolutely as some characteristics were self-reported.

CONCLUSION

The epidemiological characteristics of hypertension alone, IFPG alone and comorbidity of hypertension with IFCG among Nigerian adolescents were exposed with preponderance among males and those aged 10 – 14 years. An intensive nutrition and health education youth friendly programmes at school and community levels are recommended for control and reversal to halt progression that may lead to cardiovascular tragedy in adulthood.

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REFERENCES

1 Redwine KM, Acosta AA, Poffenbarger T, *et al*. Development of hypertension in adolescents with pre-hypertension. *J Pediatr* 2012;160:98–103.
2 Noubiap JJ, Essouma M, Bigna JJ, *et al*. Prevalence of elevated blood pressure in children and adolescents in Africa: a systematic review and meta-analysis. *Lancet Public Health* 2017;2:e375–86.
3 Dabelea D, Stafford JM, Mayer-Davis EJ, *et al*. Association of type 1 diabetes vs type 2 diabetes diagnosed during childhood and adolescence with complications during teenage years and young adulthood. *JAMA* 2017;317:825–35.
4 Okpokowuruk FS, Akpan Enobong MU, Ikpeme E. Prevalence of hypertension and prehypertension among children and adolescents in a semi-urban area of Uyo Metropolis, Nigeria. *Pan Afr Med J* 2017;28:303.
5 Ezeudu CE, Chukwuka JO, Ebenebe JC, *et al*. Hypertension and prehypertension among adolescents attending secondary schools in urban area of south-east, Nigeria. *Pan Afr Med J* 2018;31:145.
6 Abiodun O, Ladele A, Olu-Abiodun O, *et al*. Hypertension among adolescents in Nigeria: a retrospective study of adolescent university freshmen. *Int J Adolesc Med Health* 2019;16. doi:10.1515/ijamh-2018-0287. [Epub ahead of print: 16 Mar 2019].
7 Oluwayemi IO, Brink SJ, Oyenusi EE, *et al*. Fasting blood glucose profile among secondary school adolescents in Ado-Ekiti, Nigeria. *J Nutr Metab* 2015;2015:1–4.
8 Arigbede O, Adeoye I, Jarrett O, *et al*. Prediabetes among Nigerian adolescents: a school-based study of the prevalence, risk factors and pattern of fasting blood glucose in Ibadan, Nigeria. *Int J Diabetes Dev Ctries* 2017;37:437–45.
9 Aounallah-Skhiri H, Traissac P, El Ati J, *et al*. Nutrition transition among adolescents of a south-Mediterranean country: dietary patterns, association with socio-economic factors, overweight and blood pressure. A cross-sectional study in Tunisia. *Nutr J* 2011;10:38.
10 Popkin BM. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. *Am J Clin Nutr* 2006;84:289–98.
11 Shi W, Wang H, Zhou Y, *et al*. Synergistic interaction of hypertension and diabetes on chronic kidney disease: insights from the National health and nutrition examination survey 1999-2006. *J Diabetes Complications* 2020;34:107447.
12 Masoudkabir F, Poorhosseini H, Vasheghani-Farahani A, *et al*. Synergistic effect of hypertension with diabetes mellitus and gender on severity of coronary atherosclerosis: findings from Tehran heart center registry. *ARYA Atheroscler* 2015;11:317–22.
13 Sanspree M, Daum KM, Arthur S. Synergistic effects of diabetes mellitus, hypertension and obesity as risk factors for glaucoma and diabetic retinopathy. *Invest Ophthalmol Vis Sci* 2005;46:3658.
14 Long AN, Dagogo-Jack S. Comorbidities of diabetes and hypertension: mechanisms and approach to target organ protection. *J Clin Hypertens* 2011;13:244–51.
15 Cheung BMY, Li C. Diabetes and hypertension: is there a common metabolic pathway? *Curr Atheroscler Rep* 2012;14:160–6.
16 Emdin CA, Anderson SG, Woodward M, *et al*. Usual blood pressure and risk of new-onset diabetes: evidence from 4.1 million adults and a meta-analysis of prospective studies. *J Am Coll Cardiol* 2015;66:1552–62.
17 Ayogu RNB, Afiaenyi IC, Madukwe EU, *et al*. Prevalence and predictors of under-nutrition among school children in a rural south-eastern Nigerian community: a cross sectional study. *BMC Public Health* 2018;18:587.
18 Flynn JT, Kaelber DC, Baker-Smith CM. Subcommittee on screening and management of high blood pressure in children. clinical practice guideline for screening and management of high blood pressure in children and adolescents. *Pediatrics* 2017;140:e20171904.
19 American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2011;34 Suppl 1:S62–9.
20 Muktabhant B, Sanchaisuriya P, Sarakarn P, *et al*. Use of glucometer and fasting blood glucose as screening tools for diabetes mellitus type 2 and glycated haemoglobin as clinical reference in rural community primary care settings of a middle income country. *BMC Public Health* 2012;12:349.
21 Eyitayo EE, Oluwole AB, Olusola OO. Behavioural and socio-demographic predictors of cardiovascular risk among adolescents in Nigeria. *J Health Sci* 2017;7:25–32.
22 Ujunwa FA, Ikefuna AN, Nwokocha ARC, *et al*. Hypertension and prehypertension among adolescents in secondary schools in Enugu, South East Nigeria. *Ital J Pediatr* 2013;39:70.
23 Cuschieri S, Vassallo J, Calleja N, *et al*. The effects of socioeconomic determinants on hypertension in a cardiometabolic at-risk European country. *Int J Hypertens* 2017;2017:1–7.
24 Mohan V, Seedat YK, Pradeepa R. The rising burden of diabetes and hypertension in Southeast Asian and African regions: need for effective strategies for prevention and control in primary health care settings. *Int J Hypertens* 2013;2013:1–14.
25 Chen G, McAlister FA, Walker RL, *et al*. Cardiovascular outcomes in Framingham participants with diabetes: the importance of blood pressure. *Hypertension* 2011;57:891–7.

26 Wu X, Wang Z. Role of socioeconomic status in hypertension among Chinese middle-aged and elderly individuals. *Int J Hypertens* 2019;2019:1–6.
27 Keto J, Ventola H, Jokelainen J, *et al*. Cardiovascular disease risk factors in relation to smoking behaviour and history: a population-based cohort study. *Open Heart* 2016;3:e000358.
28 Griswold MG, Fullman N, Hawley C, *et al*. Alcohol use and burden for 195 countries and territories, 1990–2016: a systematic analysis for the global burden of disease study 2016. *The Lancet* 2018;392:1015–35.
29 Gadiraju TV, Patel Y, Gaziano JM, *et al*. Fried food consumption and cardiovascular health: a review of current evidence. *Nutrients* 2015;7:8424–30.
30 WHO. World health day 2013: diet, nutrition and hypertension. WHO, 2020. Available: http://www.emro.who.int/world-health-days/2013/nutrition-hypertension-factsheet-whd-2013.html
31 Leng B, Jin Y, Li G, *et al*. Socioeconomic status and hypertension: a meta-analysis. *J Hypertens* 2015;33:221–9.
32 Cayres SU, Júnior IFF, Barbosa MF, *et al*. Breakfast frequency, adiposity, and cardiovascular risk factors as markers in adolescents. *Cardiol Young* 2016;26:244–9.
33 Odunaiya NA, Louw QA, Grimmer KA. Are lifestyle cardiovascular disease risk factors associated with pre-hypertension in 15-18 years rural Nigerian youth? A cross sectional study. *BMC Cardiovasc Disord* 2015;15:144.
34 Cahill LE, Pan A, Chiuve SE, *et al*. Fried-food consumption and risk of type 2 diabetes and coronary artery disease: a prospective study in 2 cohorts of US women and men. *Am J Clin Nutr* 2014;100:667–75.
35 Kim J, Kim J. Association between fruit and vegetable consumption and risk of hypertension in middle-aged and older Korean adults. *J Acad Nutr Diet* 2018;118:1438–49.
36 Borgi L, Muraki I, Satija A, *et al*. Fruit and vegetable consumption and the incidence of hypertension in three prospective cohort studies. *Hypertension* 2016;67:288–93.
37 Li M, Fan Y, Zhang X, *et al*. Fruit and vegetable intake and risk of type 2 diabetes mellitus: meta-analysis of prospective cohort studies. *BMJ Open* 2014;4:e005497.
38 Li B, Li F, Wang L, *et al*. Fruit and vegetables consumption and risk of hypertension: a meta-analysis. *J Clin Hypertens* 2016;18:468–76.
39 Okop KJ, Ndayi K, Tsolekile L, *et al*. Low intake of commonly available fruits and vegetables in socio-economically disadvantaged communities of South Africa: influence of affordability and sugary drinks intake. *BMC Public Health* 2019;19:940.
40 Duthie SJ, Duthie GG, Russell WR, *et al*. Effect of increasing fruit and vegetable intake by dietary intervention on nutritional biomarkers and attitudes to dietary change: a randomised trial. *Eur J Nutr* 2018;57:1855–72.
41 Gangwisch JE, Heymsfield SB, Boden-Albala B, *et al*. Sleep duration as a risk factor for diabetes incidence in a large U.S. sample. *Sleep* 2007;30:1667–73.
42 Quan SF. Sleep disturbances and their relationship to cardiovascular disease. *Am J Lifestyle Med* 2009;3:55S–9.
43 Ramezankhani A, Azizi F, Hadaegh F. Associations of marital status with diabetes, hypertension, cardiovascular disease and all-cause mortality: a long term follow-up study. *PLoS One* 2019;14:e0215593.
44 Lipowicz A, Lopuszanska M. Marital differences in blood pressure and the risk of hypertension among Polish men. *Eur J Epidemiol* 2005;20:421–7.
45 Dhindsa DS, Khambhati J, Schultz WM, *et al*. Marital status and outcomes in patients with cardiovascular disease. *Trends Cardiovasc Med* 2020;30:215–20.