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Screening for obesity and dyslipidaemia in children and young adults residing in rural and urban communities in Kassena Nankana District, Ghana

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Abstract

Obesity and dyslipidaemia have been found among the major risk factors of cardiovascular diseases. Although they are considered problems associated with adults, there have been a sudden rise in the prevalence of the risk factors in children and also in developing countries. It is therefore imperative for early detection of these factors to prevent their accompanying co morbidities. In studying 305 children and young adults of 5 to 20 years, 147 (47.2%) were males and females were 158 (51.8%). Overweight and obesity was found to be 7.8% and 2.0% respectively in the study subjects, where more females were overweight and obese combined than the males. Children and young adults from urban communities were more overweight and obese combined than their rural counterparts. Hypercholesterolaemia was 9.8% of the study subjects and a gradual rise of cholesterol was found among the age groups in the female whiles observing the reverse in the males. Low HDL-C was higher (29.8%) in the subjects where it was rather rampant in the rural subjects than their urban colleagues and 10.8% of subjects had high levels of LDL-C, it was commoner in the urban dweller especially the females. There is an indication of the presence of obesity and dyslipidaemia in children and young adults, which occurs more in urban than rural populations as well as in females than in males. It therefore calls for enhancement of favourable lifestyles to reduce their occurrence in adulthood.

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Introduction

The prevalence of obesity in both children and adults is increasing dramatically in both the developed and developing countries (Booth *et al.,* 2007; Li *et al.,* 2008). This sudden and surprising rise in obesity in children in developing countries resulted because their physical activity levels and diet have become similar to those of the developed nations where obesity is epidemic. Countries of sub-Saharan Africa are experiencing a burden of both obesity and diabetes, otherwise known as diabesity and this is expected to be higher than that of the industrialized nations (Danquah *et al.,* 2010). Global estimates indicate that in 2010, 92 Million children were at risk for being overweight while an estimated 43 Million children were overweight and obese, and out of this number 35 million of them were from developing countries (De Onis *et al.,* 2010). The prevalence of childhood obesity in sub-Saharan Africa is scarce, especially in northern Ghana.

Inappropriate lifestyle factors are considered as a cause of elevation of body mass index (BMI) levels in the general population, which indirectly results in risk factors of coronary heart disease (CHD). In adolescents, eating unhealthy foods combined with low physical activity may be among the lifestyle factors leading to overweight and obesity, and having a BMI above a certain value for a very long period of time can bring about some diseases which lead to infirmities, reduced quality of life and lower life expectancy (Mason, 1995; Foutaine *et al.,* 2003).

Additionally, there is an association between overweight and obesity in childhood and an increased cardiovascular mortality in adults regardless of the adult weight. Dyslipidaemia is a very common factor associated with overweight and obese children and adolescents (Ghergerehchi, 2009). Not only is obesity associated with dyslipidaemia, it is significantly connected to morbid conditions such as type 2 diabetes mellitus and hypertension. Generally, the onset of cardiovascular disease and the atherosclerotic process occurs at a tender age and relates strongly with abnormal lipid levels (Freedman *et al.,* 2001).

Clustering of risk factors of coronary heart disease such as low high density lipoprotein cholesterol (HDL-c), high low density lipoprotein cholesterol (LDL-c) and elevated triglycerides in the young eventually result in increased risk of complications such as myocardial infarction later in life (Grundy *et al.,* 2000). The onset of dyslipidaemia in children and adolescent usually start early thereby leading to atherosclerosis and then extending to early premature cardio vascular disease (CVD). It is therefore imperative to detect dyslipidaemia in children at an early age so as to institute prevention strategies to improve the lipid profile successfully. It will go a long way to slow the process of atherosclerosis and prevent or delay the onset of CVDs in adulthood. Screening for abnormal lipids in children gives an opportunity for early identification and control of paediatric dyslipidaemia to reduce the risk and severity of cardiovascular disease in adulthood.

This study was therefore to determine the proportion of individuals who are overweight, obese and with abnormal lipid levels namely; total cholesterol, low density lipoprotein, high density lipoprotein, and triglycerides among the apparently healthy children and young adults in rural and urban set-ups.

Materials and methods

Study area and design

This study was carried out at the Kassena Nankana district (presently made up of Kassena Nankana Municipal and Kassena Nankana West districts) of the Upper East region of Ghana as a cross sectional survey for a five-month period from January to May 2012. The district is partitioned into zones by the Navrongo Health and Demographic Surveillance System (NHDSS) of the Navrongo Health Research Centre (NHRC) and the zones are further divided into clusters or communities (Oduro *et al.,* 2012).

Using stratified sampling, six (6) clusters were randomly chosen, followed by a random selection of individuals from each of the chosen clusters. Out of the six clusters chosen, three (3) of them are from the rural communities whiles the remaining are from urban communities.

Study subjects and their recruitment

Children and young adults of 5-20 years of age living in the study area were investigated. A total of three hundred and five (305) healthy volunteers were recruited into the study. A list of the chosen participants was obtained from the NHDSS and the subjects were invited to the community clinic to participate in the study. The study was clearly explained to the subjects, and when an individual agrees to be part of the study, a written consent was obtained from the participants or their caregivers before their participation. The inclusion criteria were that an individual should be selected randomly by NHDSS, apparently healthy, willing to participate in the study and should have had an overnight fast of 10-12 hours. Individuals below 5 years, above 20 years or severely-ill were not eligible to take part in the study. A structured questionnaire which was pretested for appropriateness was administered to the participants to obtain their demographic characteristics.

Anthropometry and Biochemical variables

Anthropometric measurements of the participants were taken by measuring the body weight in kilogram using a physician scale, the height in centimeters using a stadiometer and waist circumference in centimeters around the navel level of the umbilicus using a flexible tape measure. The BMI (kg/m^2) was calculated as weight (kg)/height^2 (m^2) for each participant.

Two (2.0) milliliters of venous blood was taken from each participant and put in a vacutainer tube. The blood samples in the tubes were centrifuged at 3000 revolutions per minute (rpm) for 10 minutes at room temperature, and the blood sera were separated into plain separator tubes and stored in a freezer at -20^{o}C. These samples were transported to Clinical Analysis Laboratory, KNUST, Kumasi where the lipid parameters including total cholesterol (TC), high-density lipoprotein cholesterol (HDL-c) and triglycerides (TG) were determined using a semi-automated analyser, Humalyser Junior (HUMAN, GmbH, Germany). The low-density lipoprotein cholesterol (LDL-c) levels were calculated using the Friedewald's formula, where LDL-c = TC-HDL-c - TG/2.2 (Freidewald *et al.,* 1972).

Operational definitions

A BMI exceeding the 85th percentile and less than the 95th percentile for age and gender was considered overweight; whiles a BMI exceeding the 95th percentile for age and gender was considered obese (Cole *et al.,* 2000). Dyslipideamia was considered in the participants if the blood totals cholesterol, triglyceride, LDL-c levels were greater than the 95th percentile for age and gender and when the HDL-c levels were less than the 5th percentile for both age and gender (Klingeman *et al.,* 2007). The study protocol and consenting procedures were reviewed by the Committee on Human Research, Publication and Ethics of Kwame Nkrumah University of Science and Technology/Komfo Anokye Teaching Hospital and the Institutional Review Board of the Navrongo Health Research Center.

Data analysis

The SPSS software package, version 18.0 was used to analyse the data of the study. The means and standard deviation were computed for the continuous variables, whiles for the categorical variables the percentages and proportions were calculated. Pearson's Chi square (χ^2) was used to determine the differences in proportions. Odds ratio for each parameter was computed using the logistic regression model. There was statistical significance present when the p-value was less the 0.05.

Results

A male and female populations of 147 and 158 children and young adults respectively took part in the study and their ages ranged from 5-20 years. Table 1 indicates the distribution of age, gender, educational status, BMI, the waist circumference and the lipid profile of the participants.

The comparisons of the means and proportions of the Body Mass Index and waist circumference, in addition to the different components of lipid variables in the rural and urban participants are shown in table 2. Total cholesterol, HDL-cholesterol, triglycerides and LDL-cholesterol were statistically different between the rural and urban participants ($p<0.05$). The male and female characteristics of the study participants are shown in table 3.

Table 1. Baseline characteristics and lipid profile of the study participants.

Parameter	Study subjects n (%)
Age(yrs)	
Mean ± SD	12.04 ± 4.15
5-9	105 (34.4%)
10-14	105 (34.4%)
15-20	95 (31.2%)
Gender	
Male	147 (48.2%)
Female	158 (51.8%)
Educational status	
No education	57(18.7%)
Pre-primary	33(10.8%)
Primary	114(37.4%)
High School (JHS & SHS)	101(33.1%)
Body Mass Index (kg/m2)	
Mean ± SD	18.13 ± 3.6
<85th percentile	275 (90.1%)
85th-95th percentile	24 (7.9%)
≥95th percentile	6 (2.0%)
Waist circumference(cm)	
Mean ± SD	63.3 ± 8.0
<60	110 (36.1%)
60–80	191 (62.6%)
>80	4 (1.3%)
Total cholesterol (mmol/L)	
Mean ± SD	3.76 ± 1.14
Abnormal	30(9.8%)
Borderline	46(15.1%)
Normal	229(75.1%)
Triglycerides (mmol/L)	
Mean ± SD	0.81 ± 0.5
Abnormal	29 (9.5%)
Borderline	65(21.3%)
Normal	211(69.2%)
HDL cholesterol (mmol/L)	
Mean± SD	1.11 ± 0.36
Abnormal	91(29.8%)
Borderline	98(32.1%)
Normal	116(38.0%)
LDL cholesterol (mmol/L)	
Mean ± SD	2.29 ± 0.9
Abnormal	33(10.8%)
Borderline	20(6.6%)
Normal	252(82.6%)

HDL=High Density Lipoprotein, LDL=Low Density Lipoprotein.

Table 2. Anthropometric and biochemical characteristics of the rural and urban communities.

Characteristics	Urban subjects (n =155)	Rural subjects (n =150)
BMI (Kg/m²)		
Mean ± SD	18.1±3.8	18.1±3.3
≥85th percentile	17(11.0%)	13(8.7%)
<85th percentile	138(89.0%)	137(91.3%)
WC (cm)		
Mean ± SD	64.0±8.4	62.6±7.5
>88	1(0.6%)	0(0.0%)
≤88	151(99.4%)	155(100.0%)
TC(mmol/L)		
Mean± SD	4.26±1.15	3.24±0.87*
Abnormal	28(18.1%)	2(1.3%)
Borderline	31(20.0%)	15(10%)
Normal	96(61.9%)	133(88.7%)
HDL-C(mmol/L)		
Mean ± SD	1.28±0.26	0.93±0.36*
Abnormal	19(12.3%)	72(48.0%)
Borderline	52(33.5%)	46(30.7%)
Normal	84(54.2%)	32(21.3%)
TG (mmol/L)		
Mean ± SD	0.64±0.29	0.98±0.62*
Abnormal	2(1.3%)	27(18.0%)
Borderline	28(18.1%)	37(24.7%)
Normal	125(80.6%)	86(57.3%)
LDL-C (mmol/L)		
Mean ± SD	2.70±0.94	1.86±0.72*
Abnormal	30(19.4%)	3(2.0%)
Borderline	14(9.0%)	6(4.0%)
Normal	111(71.6%)	141(94.0%)

*p<0.05 between urban and rural, BMI = Body Mass Index, WC = Waist Circumference, TC = Total Cholesterol, LDL-C = Low Density Lipoprotein cholesterol, HDL-C = High Density Lipoprotein cholesterol, TG = Triglycerides.

Table 3. Some Anthropometric and biochemical characteristics of male and female study participants.

Parameters	Males (n=147)		Females (n=158)		P- value
	Mean (SD)	C.I.	Mean (SD)	C.I	
Age (years)	11.94 (4.3)	5.0 - 20.0	12.13 (4.0)	6.0 - 20.0	0.693
W.C (cm)	62.1 (7.2)	48.0 - 78.0	64.4 (8.5)	44.0 - 89.5	0.100
BMI (kg/m²)	17.9 (3.4)	11.5 - 37.8	18.3 (3.7)	9.7 - 30.1	0.322
TC (mmol/L)	3.69 (1.00)	1.59 - 6.74	3.82 (1.27)	1.11 - 8.60	0.307
HDL-C (mmol/L)	1.10 (0.34)	0.31 - 2.4	1.11 (0.37)	0.26 - 2.20	0.862
TG (mmol/L)	0.82 (0.54)	0.18 - 3.65	0.79 (0.48)	0.19 - 3.02	0.568
LDL-C (mmol/L)	2.21 (0.80)	0.23 - 4.99	2.35 (1.04)	0.16 - 6.86	0.186

WC=Waist circumference, TC=Total cholesterol, BMI= Body Mass Index, HDL-C= High Density Lipoprotein Cholesterol, TG=Triglycerides, LDL-C=Low Density Lipoprotein Cholesterol, CI=Confidence Interval, SD=Standard Deviation.

Discussion

Cardiovascular risk among children and young adults is becoming increasingly common as a result of the progression of childhood obesity and dyslipidemia. This study obtained an overall prevalence of overweight and obesity to be 9.8%, it however obtained a 7.8% overweight and 2.0% obese children and young adults. The prevalence of overweight in the study population is similar to the estimated prevalence of 9.8% of overweight in school children in the Tamale metropolis in Ghana (Amidu *et al.,* 2013). There were more females than males who were overweight and obese (73.3% versus 26.7%), several researchers have documented higher obesity in females than males (Armstrong *et al.,* 2006; Acquah *et al.,* 2011). The urban communities recorded a high prevalence (56.7%) of overweight and obese individuals than the rural communities.

In this study, the proportion of individuals with high cholesterol levels was 9.8%, with about two-thirds of them being females. This is similar to an observation made by Yip and colleagues that the prevalence of hypercholesterolaemia is more in females, compared to males and recording a prevalence of 5-11% hypercholesterolaemia in different age groups in a paediatric population (Yip *et al.*, 2006). It was also observed that there was gradual rise in cholesterol levels across the age groups in the females but the reverse was rather found for the male counterparts. According to one report, sexual maturation reduces levels of serum lipids, which often occur more in boys than girls (Wennlof *et al.*, 2005). During the ages of adolescence and puberty, there is a gradual accumulation of fats, mainly through an increase in the number of fat cells, with a little or no change in the fat cell volume (Wabitsch, 2002). The female and male subjects had similar mean cholesterol levels ($p>0.05$), and it is similar to the results of a study in South Africa which documented no significant difference in the cholesterol levels between males and females (Smith, 2010). Subjects residing in the rural communities had mean total cholesterol levels significantly lower ($p<0.05$) than the mean cholesterol level of participants from the urban communities (Table 2). This shows that place of residence (rural/urban) has an effect on cholesterol or other lipid levels. This goes to emphasise that lifestyle factors associated with urbanisation and westernization such as a higher consumption of refined sugars and saturated fat in addition to a reduction in fibre intake coupled with physical inactivity (Mennen *et al.*, 2000) result in abnormal lipid levels.

There was no significant difference ($p>0.05$) between the mean cholesterol levels in the normal weight, overweight and obese subjects in this study and this was inconsistent with a study in Iran which reported high levels of total cholesterol in overweight and obese children and adolescents. (Ghergerehchi, 2009). The accumulation of fat in the adipose tissue, results in the secretion of free fatty acids from the fat cells, which may stimulate hepatic triglyceride and very low density lipoprotein cholesterol production in the youth and adults (Kahn and Flier, 2000; Bacha *et al.,* 2004). From Table 2, there was lower level of mean triglycerides in the urban population than their rural counterparts (0.64 versus 0.98 mmol/L) [$p<0.05$] and hypertriglyceridaemia was higher among the rural dwellers (8.8%) than their urban counterparts. This, however, contrasts results from a study in Nigeria which showed hypertriglyceridaemia was commoner in the urban settlers than their rural counterparts (Adediran *et al.*, 2012).

High levels of triglycerides in the rural subjects may be as a result of the consumption of energy-dense diets high in fats, especially saturated fats and low in unrefined carbohydrates, which among other factors, is the cause of hypertriglyceridaemia in children. There is a reported increase in the occurrence of obesity epidemic in children and adolescents (Fagot-Campagna *et al.*, 2000; Daniels *et al.,* 2005), and childhood obesity is commonly associated with dyslipidaemia (Goran *et al.*, 1998). Nonetheless, in this study, the triglyceride levels in the underweight and normal subjects were similar to those of the overweight and obese ($p>0.05$). This could be attributable to the lower number of the overweight and obese individuals.

HDL cholesterol was generally low in the subjects in this study (Table 2), it further showed that low HDL-C was commoner among the rural dwellers than the urban dwellers, (72 versus 19). A similar finding was made in the study by Adediran and colleagues (2012), where 25.8% of rural dwellers and 3.8% of the urban dwellers had low HDL-C values. It is also worrying that a high percentage of participants were with low HDL-C levels. HDL-C is a cardioprotective lipoprotein, which exhibit its effect through different mechanisms such as reverse cholesterol transport, anti-inflammatory activity and scavenging toxic by-products of LDL-C oxidation (Mooradian *et al.*, 2006). Low HDL-C and elevated triglyceride were more common in the rural dwellers, who are supposed to have less exposure to modern dietary pattern and lifestyle, as compared to their urban counterparts. This could be attributed to prenatal and childhood nutritional deficiency, which has a link to metabolic dysfunction and disease in later life (Prentices and Moore, 2005). Decreased HDL-C levels are most often as a result of the catabolism of the triglycerides, which result in a higher rate of clearing HDL-C and the subsequent reduction in the size of the HDL-C particles (Boyd *et al.,* 2005).

Nutrition transition in the rural areas, characterized by a shift from undernutrition to overnutrition problems could be the cause of low HDL-C and elevated triglycerides in these environments.

The number of individuals with high LDL-C levels was 33 (10.8%) of the study subjects. High levels of LDL-C was significantly ($p<0.05$) commoner in the urban dwellers, especially the females than their rural counterparts, similar to the report by Adediran *et al.* (2012) that dyslipidaemia is associated with urbanization. LDL cholesterol typically makes up 60-70% of the total serum cholesterol and it is the major atherogenic lipoprotein and has long been identified by NCEP as the primary target of cholesterol-lowering therapy (Expert Panel on Detection, Evaluation and Treatment, 2001). Excess fat has often been associated with elevated LDL-C and triglycerides levels, and reduced HDL-C values (Eisenmann *et al.,* 2001).

The values of LDL-C are elevated when foods high in trans-fatty acids or hydrogenated fat are consumed, but HDL-C levels may reduce or such effect may not be seen (Judd *et al.,* 2002).

Conclusion

This study has shown the occurrence of overweight combined with obesity and abnormal levels of lipids in children and young adults in the study area. These were more in the urban subjects than the rural subjects except for low HDL-C levels. Overweight, obesity and dyslipidaemia were found to occur more in females than in the males. There is therefore the need for adoption of favourable lifestyles by the young in the study area so as to reduce the occurrence of obesity, dyslipidaemia and the associated complications later in adulthood.

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