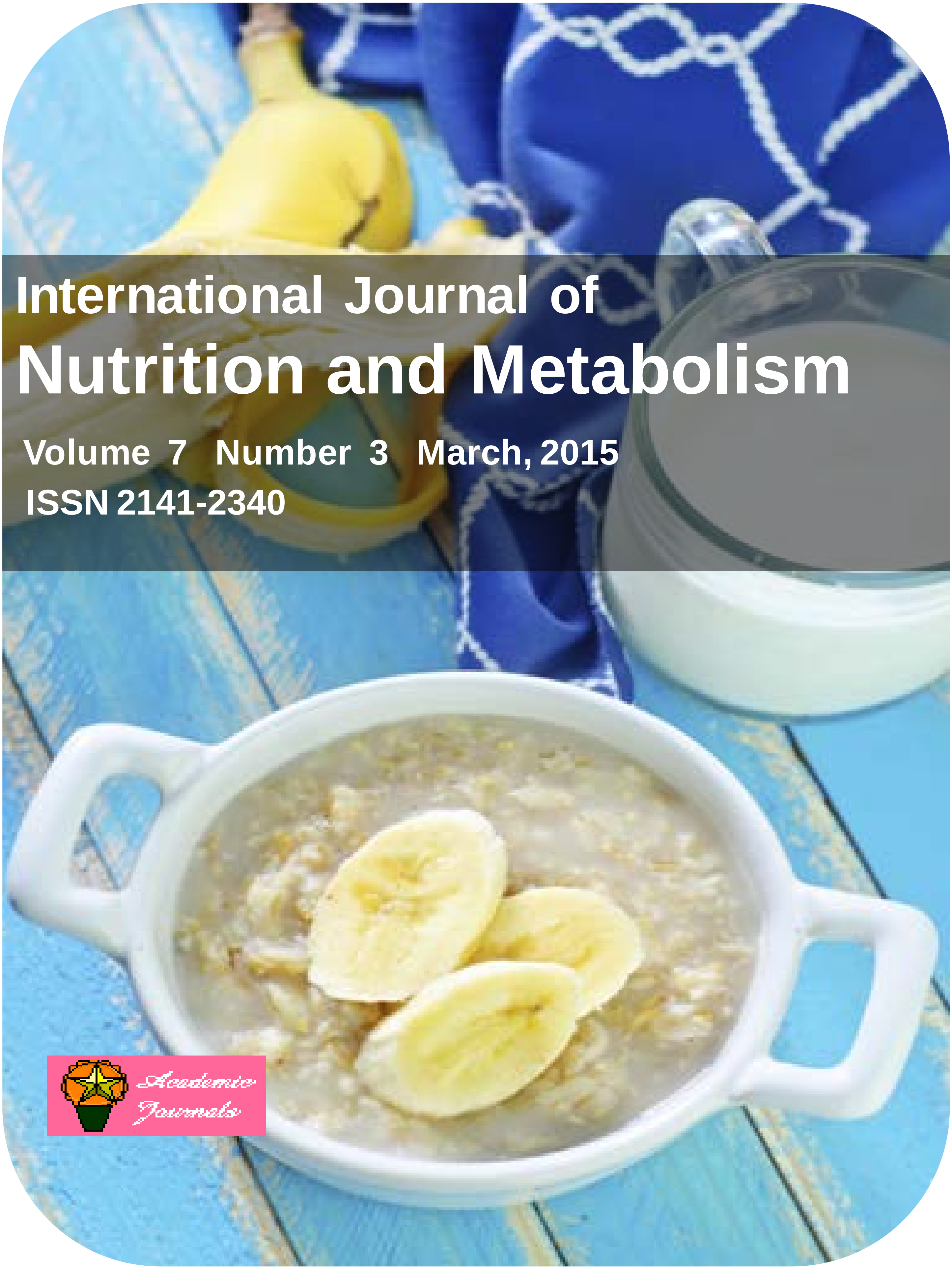
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Full Length Research Paper

Counting carbohydrates as an educational tool to reduce fat consumption in obese children exposed to videogames: A pilot study

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This study aimed to use carbohydrate counting as an educational tool to improve the diet habits and reduce fat mass in obese children exposed to videogames. It involved analytical and comparative pilot study in 10 children, 5 to 10 years of age with obesity and who were exposed to video games for more than five hours a day. It formed two study groups (five in each). One used carbohydrates count tool plus a diet plan and food orientation and the other group, although similar but was without the counting carbohydrates tool. To both groups, anthropometric (fat mass), biochemical, dietetics and clinical indicators were measured. The reduction of body fat in the 10 children was 4%, with a reduction in the consumption of simple sugars. In making the comparison, at the end of the intervention there was decreased consumption of sugar-sweetened beverages and food and an increase in the consumption of vegetables. No significant correlation was found between carbohydrate consumption and exposure to video games and also there was no difference (p < 0.05). The carbohydrate count tool improved the consumption of vegetables and decreased consumption of sugar-sweetened beverages and food, but was not clearly so for the fat mass reduction. These early findings showed a first approximation to apply this experience in a large sample.

Key words: Sugar-sweetened beverages, body fat, obesity, video games, children.

INTRODUCTION

The prevalence of childhood obesity has been increasing since the 90s. In 2010 it was estimated that 43 million children worldwide were overweight and obese; 35 million of them lived in developing countries (Méndez et al., 2007; Martinez et al., 2011). In Mexico, according to the 2012 Health and Nutrition Survey (ENSAUT, 2012), the overall prevalence of overweight and obesity combined is 34.4% (19.8 and 14.6%, respectively), with 5,664,870 school-aged children making up this number (Trejo et al., 2012).

Overweight and obese children are at a higher risk of suffering from metabolic diseases such as diabetes

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mellitus (DM), hypertension, arteriosclerosis, and other orthopedic, respiratory, digestive, dermatological, neurological and endocrine conditions, as well as certain types of cancer at an early age (Martinez et al., 2011; Trejo et al., 2012; Chiesa et al., 2005). An estimated 55% of metabolic diseases, such as child resistance to insulin have been linked to the amount of body adipose tissue, which is also the main risk factor for metabolic syndrome (Chiesa et al., 2005; Scavone et al., 2010). Lifestyle factors have a direct impact on the development of obesity and its consequences. A personalized healthy diet with a food intake suited to the individual's socio-cultural context promotes weight loss, reduces adipose tissue, improves insulin resistance and prevents the development of chronic degenerative diseases (Rodríguez, 2006).

Children in both urban and rural areas have adopted watching television and playing video games as recreational activities (Poletti and Barrios, 2007). According to the World Health Organization (WHO), the rise in time spent watching television or playing video games is directly responsible for 60% of children worldwide failing to fulfill the minimum 30-min-a-day recommendation for physical activity (Denot et al., 1998). It is estimated that 50% of children aged four to six have been exposed to video games, mostly girls (56%) (Poletti and Barrios, 2007). A study in the US found that children spend an average of 5.5 h a day engaged in these activities, which amounts to a full working day for an adult (Poletti and Barrios, 2007).

Another US study defines 7 h and 57 min as the period of time that determines an increased risk of developing obesity due to sedentarism in children and teenagers (González and Atalah, 2011). The risk of obesity increases 1.7 times after being exposed for ≥ 4 h to television or video games. Other studies have found that children aged 9 ± 1.5, after being exposed to video games for five hours, start developing a number of physiological obesity and obesity-related symptoms such as increased cardiovascular activity, breathing responses and cortisol release due to the stress produced by the constant noise and music (Denot et al., 1998; National Institute of Public Health México, Ministry of Health, 2012; Yeste and Carrascosa, 2011).

Eventhough obesity is a multifactorial disease, as described earlier, an important correlation has been found between obesity and television and video game use. Obesity is also linked to the development of diabetes mellitus type 2 and to inflammatory responses (Rodríguez, 2006). The combination of a low-glycemic diet and regular aerobic exercise has positive effects on postprandial glucose levels, thus reducing hyperglycemia and the inflammatory response (Kelly et al., 2011). The high prevalence of childhood obesity in Mexico, linked to bad eating habits, and the sedentary lifestyle associated with video games could lead to a future of diabetes mellitus, hypertension and hypertriglyceridemia for these children. Helping to prevent this is the main motivation for our study. Our goal was to develop and test an educational carbohydrate-counting tool to help promote healthy eating and improve the eating habits (that is, decrease the intake of sugary foods and sugar-sweetened beverages) of obese children habitually exposed to video games. Its impact should be measurable as a decrease of adipose tissue over a short period of time.

MATERIALS AND METHODS

An analytical, comparative and longitudinal study was conducted for four months in a total of 10 children aged 5 to 10 years. The study was approved by the Ethical and Research Committees of the General Regional Hospital of the Ministry of Health, in Guanajuato, Mexico. The children were recruited between January and May, 2013 from the outpatient clinic at the Uriangato General Hospital, in Uriangato, Guanajuato. A total of 50 children were invited to participate through a series of informational meetings conducted in primary and secondary state health care facilities. Of an original 24 participating children, 10 were able to complete the process due to the limitations of the study. Inclusion criteria were a body mass index (BMI) above the 85th percentile and exposure to video games for more than five hours a day. Patients with an existing healthy eating plan were not considered. Informed consent was obtained from the parents and two groups of five children each were formed. Consultation appointments were scheduled for each child according to their, respective group. Each child was seen once every 15 days (four appointments in total), with an average appointment duration of 1.5 h.

Lifestyle was assessed using the *IPAQ* (International Physical Activity Questionnaire) (IPAQ, 2012). Each patient's nutritional state was evaluated using anthropometric, biochemical, clinical and nutritional parameters. As to anthropometric indicators, weight was measured with a SECA® scale (1 g accuracy). Four subcutaneous folds (bicipital, tricipital, subscapular and suprailiac) were also measured using a Lange® plicometer (1 mm accuracy). These measurements were used to determine initial and final percentages of fat using the Durnin equation (Secretaría de Salud, Guanajuato México (in spanish), 2010).

For the biochemical indicators, 8 h fasting samples were obtained from the children to measure glucose, glycated hemoglobin and lipid profile (triglycerides and cholesterol). These biochemical indicators were analyzed and processed by hospital laboratory technicians (American Diabetes Association, 2010). The measurements were analyzed at the beginning and at the end of the study. To assess dietary indicators, each consultation included a 24-h recall using food replicas. Interviews were conducted to investigate eating habits at the first and last interventions (Rodríguez et al., 2008). Each group of participants received a different intervention. Group A was prescribed a hypocaloric plan, 500 kcal lower than the estimated maintenance energy intake, based on the Guanajuato Ministry of Health's Guidelines, which recommend a calorie intake between 1000 and 1500 kcal for children. The caloric distribution among the three macronutrients (proteins, fats and carbohydrates) was 60% for carbohydrates, 15% for protein and 25% for lipids, in keeping with official guidelines (Secretaría de Salud, Guanajuato México (in spanish), 2010). Group B (hypocaloric plan plus carbohydrate-counting tool) was prescribed a hypocaloric plan 500 kcal under maintenance energy intake, with 55% carbohydrates, 15% protein, and 30% lipids. Caloric requirements were calculated using the Harris-Benedict equation, adapted for a population aged 1 to 18 (Secretaría de Salud, Guanajuato México (in spanish), 2010). No patient was prescribed an intake below 1000 kcal (Table 1).

Three to four (45 to 50 g) servings of carbohydrates per meal were prescribed. Servings of fruit, cereal, pulses and milk were also recommended (Pérez et al., 2008). Dietary guidance was provided as to basic carbohydrate-counting, where 15 g of carbohydrates equals one serving. Patients were able to identify various food groups as established by the Mexican food system equivalents: vegetables, fruit, sugar, cereal, pulses, animal products, milk, oil and fat (Pérez et al., 2008; Karmeen, 2005). From these they learned to identify the ones with high carbohydrate contents, examples of foods belonging to each food group and the recommended servings for some types of foods (Karmeen, 2005).

The learning strategies used included presenting interactive materials and connecting elements. The materials used were flashcards, posters and food replicas. A 2.5 to 2.7% fat loss was considered positive in terms of reducing long-term risk of obesity-related diseases, in keeping with recent studies (Hlavatý et al., 2010).

Statistical analysis

Results are described as median and range. A Wilcoxon rank test was used to compare baseline medians with the final measurements (after the four-month intervention period). These values were later compared using a Z-test. Spearman's rank correlation was considered between the different parameters analyzed: fat, carbohydrates, lipids, cholesterol and triglycerides, exposure to video games, age, glucose and glycated hemoglobin. A value of $p < 0.05$ was defined as the level of significance. The data were processed using Minitab 16 statistical software and Microsoft Office Excel 2013®.

RESULTS

Patients were aged 5 to 10; 5 of them were male and 5 female. Four months after the dieting intervention, the change in body fat was 4% in both groups: 5% for group A (from an initial 28% to a final 23%) and 4% for group B (from 28% to 24%). Consumption of carbohydrates assessed in both groups by counting changed towards a reduced final intake (Table 2). After comparing changes between initial and final carbohydrate consumption, a 4% decrease in body fat was observed, with intakes of 210 g of fruit, cereal, pulses and milk. As to correlations between biochemical indicators and total carbohydrate intake, a positive, significant correlation was observed with fasting glucose levels ($p = 0.0004$, $r = 0.94$) and glycated hemoglobin ($p = 0.01$, $r = 0.95$) (Table 3). Fat mass and biochemical indicators showed strong correlations in total cholesterol ($p = 0.05$, $r = 0.99$) and fasting glucose ($p = 0.0008$, $r = 0.98$). No correlation was found between video game use and carbohydrate intake ($p = 0,93$, $r = 0.97$) (Table 4).

DISCUSSION

The aim was to determine whether this sort of intervention was more efficient in reducing body fat than simply prescribing a hypocaloric diet. A 4% fat reduction was found when 17 servings of carbohydrates (210 g) a day were distributed among 5 meals.

The resulting reduction in fat mass coincides with previous studies by Foster et al. (2003), who focused on reducing fat with a low-carbohydrate diet. Their results showed that there was a decrease in the risk of early complications caused by childhood obesity when fat decreased by 4% (Foster et al., 2003). Even though our results on reduction coincide with those of Foster et al. (2003) the dietary changes we introduced based on difference in counting carbohydrates. Our counts recommended a 50 to 55% carbohydrate intake and no less (Karmeen, 2005; Tomoyuki, 2007). By contrast, Foster et al. (2003) recommended a 20 to 30% carbohydrate intake (Foster et al., 2003). In turn, Mullan et al. (2004) studied the effects on growth and development of reducing carbohydrates to very low levels (20 to 30%) (Mullan et al., 2004). A moderate reduction in carbohydrate intake was shown to be effective by Bourges et al. (2004) whose recommended 55 to 63% carbohydrate percentages had fewer collateral effects on metabolism when compared to lower levels (Carvalhal et al., 2007; Bourges, 2004; Demol et al., 2009).

The educational carbohydrate-counting tool helps keep the carbohydrate percentage at 55% and focuses on avoiding sugars while maintaining a balance between reducing simple carbohydrates and increasing complex carbohydrates. In the long term there is a sustained reduction of fat that does not compromise the metabolism in ways that may affect the child's development (Carvalhal et al., 2007; Demol et al., 2009). Children following this plan have an appropriate diet, with a balanced distribution of food types that does not interfere with their development (Bourges, 2004; Demol et al., 2009; Foster et al., 2010).

The carbohydrate-counting tool contributed to finding significant differences between initial and final glucose levels ($r = 0.32$; $p = 0.0004$) and glycated hemoglobin ($r = 0.2892$; $p = 0.01$) when simple carbohydrate intake was reduced. (Demol et al. (2009) and Carmel et at. (2011) argued that the main food group related to postprandial glucose control is carbohydrates; reducing them improves glucose metabolism (Demol et al., 2009; Carmel et al., 2011). Evidence shows that decreasing total carbohydrate intake can reduce the risk of obesity-related complications, especially in children, whose sugar intake may be excessive because of their preference for sweets (Poletti and Barrios, 2007; Perrot et al., 2006; Carmel et al., 2011). Carbohydrate counting does not involve any recommendations regarding sugar intake. [35] It makes up for the daily requirements for children by incorporating carbohydrates from other sources such as pulses, milk and cereal (Karmeen, 2005; Kulkarni, 2005; Zipp et al., 2011).

Regarding the unchanged cholesterol levels, Perrot et al. (2006) in earlier studies clearly described reductions in blood pressure and circulating triglycerides achieved by

Table 1. Comparison between macronutrient intakes before and after intervention (n=10).

Group	Initial				Final			
	Energy Kcal	P* (g)	L** (g)	C*** (g)	Energy Kcal	P* (g)	L** (g)	C*** (g)
A	2540 (3680-1600)	12.4 (15-10); 78.7 (138-40 g)	24.8 (31-18); 70 (127-32 g)	54 (69-31); 349 (635-124 g) -	1960 (3350-760) ¶*p*=0.37	13.4 (15-10); 65 (125-19) ¶*p*=0.50	26.4 (31-21); 57(115-18) ¶*p*=0.44	58.7 (66-50); 286(553-95) ¶*p*=0.49
B	1905 (2183-1225)	15.5 (20-11); 74 (109-33)	26.3 (30-20); 56 (73-27)	55.6 (62-51); 265 (338-156) -	1732 (2183-1225) ¶*p*=0.18	16.2 (19-12); 70 (103- 37) ¶*p*=0.18	26.2 (30-22); 50 (73-30) ¶*p*=0.89	55.2 (62-51); 239 (338-156) ¶*p*=0.44

A= Hypocaloric diet plan, B= Hypocaloric diet plan plus carbohydrate counting, P*= Protein; L** = Lipids (fat intake); C*** = Carbohydrates, ***Data are shown as median (range**). ¶p= Comparison with Wilcoxon rank test

decreasing carbohydrate intake (Perrot et al., 2006). Unfortunately, the sample size in this study was limited because patient attendance dropped after the third consultation. This was due to a combination of factors: parents' lack of interest, difficulty acknowledging their child's habits, work-related time constraints, and children's rejection of the diet plan and reluctance to undergo laboratory testing. The acceptance of the educational tool was low, in line with other studies on perseverance in dieting and its impact on body composition. It is reported that up to 68% of patients fail to adhere to a prescribed eating plan, which suggests that sticking to the diet is key to modifying body composition in a positive way (González et al., 2007).

A comparison of the data on frequency of food intake before and after the intervention with the carbohydrate-counting tool reveals that the daily intake of vegetables increased. This is significant, given the difficulties commonly encountered in the search for strategies to encourage eating more vegetables (Johnston et al., 2011).

The tendency to drink sugar-sweetened beverages like juice and soda decreased significantly; sugar as a group was avoided because it was not included for calculating servings in the eating plan. Mexico is considered the leading consumer of soft drinks worldwide (16 million liters of soda were consumed nationally in 2005) (Barquera et al., 2008). Counting carbohydrates could help revert the habit of drinking excessive amounts of soda, juice, flavored water and other sugar-sweetened drinks.

Dietary guidance based on counting carbohydrates played a significant role in the changes revealed by the results of our study. The focus on an educational approach based on concepts patients can understand increases patients' nutritional knowledge (Friedman et al., 2007), which in turn stimulates a preference for non-sugary foods. Observing healthy eating habits is traditionally considered expensive. The carbohydrate-counting tool made it possible to diversify choice by including fruit and vegetables. The decrease of fried foods and foods rich in simple carbohydrates reflects an increase in the number of informed decisions made. Counting carbohydrates was considered by most parents as a cheap option because it did not involve additional shopping expenses, as the recommended foods can be found in the regular weekly shopping basket. The key lies in keeping a record of what is eaten and of the servings eaten.

Despite its limitations, the study showed an improvement in some metabolic and habit indicators, which can have an immediate clinical application and contribute to collecting more data with further interventions.

Conclusion

This study found beneficial effects of a dietary intervention based on a carbohydrate-counting tool: a significant increase in the consumption of fruit and vegetables and a decrease in the consumption of fried foods and sugar-sweetened beverages (juice and soft drinks). Even though the reduction in body fat using the carbohydrate-counting tool was not significant, improvements were made in terms of the food choices made. This finding alone suggests that this tool could be useful in the counseling and treatment of obese children, for improving their eating habits, decreasing exposure to video games and preventing weight gain. Finally, this carbohydrate-counting tool could help parents decide which foods to eliminate from their children's diet and which to offer according to age and diet requirements.

Table 2. Average consumption of carbohydrates (g), (n=10).

Group	Before	After	p
A	419.1(277-638)	237(130-323)	0.06
B	308(169-375)	242(180-278)	0.02

*Data are shown as median (range)

Table 3. Correlations among biochemical indicators, fat mass and carbohydrates (n=10), before and after intervention.

Parameter	Before	After	p
Biochemical indicators and fat mass			
Triglycerides (mg/dl)	126 (62-226)	90 (51-147)	p =0.10, r=0.99
Total cholesterol (mg/dl)	164 (114-218)	146 (110-218)	p =0.05, r=0.99
Fasting glucose (mg/dl)	88 (82-98)	100 (84-110)	p =0.0008, r=0.98
Glycated hemoglobin (%)	5.35 (5-5.7)	5.39 (5-5.7)	p=3.59, r=0.9848
Biochemical indicators and carbohydrates			
Triglycerides (mg/dl)	126 (62-226)	90 (51-147)	p =0.11, r=0.98
Total Cholesterol (mg/dl)	164 (114-218)	146 (110-218)	p =0.16, r=0.98
Fasting glucose (mg/dl)	88 (82-98)	100 (84-110)	p=0.0004, r=0.94
Glycated hemoglobin (%)	5.35 (5-5.7)	5.39 (5-5.7)	p = 0.01, r=0.95

Spearman's rank correlation coefficient r*. *Data are shown as median (range).

Table 4. Carbohydrate intake (g) correlation with duration of exposure to video games (n=10).

Group	Before		After		Spearman's correlation
	Exposure/week/h	C***g	Exposure/week/h	C*** g	
A	12	420	4.5	260	r=0.97; p =0.93
B	6	300	0.6	220	

C***= Carbohydrates; A = hypocaloric diet plan, B = hypocaloric diet plan plus carbohydrate counting.

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Conflict of interests

The author(s) have not declared any conflict of interests.

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Maternal anthropometry in rural and urban areas of Ogun-East senatorial district, Nigeria: A comparative study

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Maternal nutrition is a well documented determinant of pregnancy outcome. Maternal anthropometry has been shown to be a predictor of the occurrence or otherwise of low birth weight, foetal macrosomia, increased maternal and newborn morbidity and mortality. Rural-urban differences in nutritional status have been documented in literature. A cross-sectional comparative study of the anthropometric indices of 720 pregnant women accessing antenatal care at selected rural and urban primary health centres in Ogun State, Nigeria was carried out, using semi-structured, interviewer-administered questionnaires, adult weighing scales, a stadiometre and measuring tapes. The mean height, weight, and body mass index of rural participants were higher than those of urban participants, although the difference was not significant ($p > 0.05$) for these parameters. The mean mid-upper arm circumference value for urban participants was significantly higher ($p = 0.014$) than that of the rural participants. Community-level nutritional interventions, including adequate feeding of the girl child, will help to improve maternal nutrition in developing countries.

Key words: Maternal, anthropometry, pregnant, rural, urban.

INTRODUCTION

Malnutrition is a major public health concern in many developing countries, particularly for women and children, being responsible for a significant proportion of morbidity and mortality in the affected countries (Farugue et al., 2008). Studies have shown that women from low socio-economic status households are most affected by malnutrition, and their children are also not spared (Edilberto, 1997;TellerandYimmer,2000;Getanehetal.,1998; Genebo

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et al., 1998). Increased perinatal and neonatal mortality, a higher risk of low birth weight babies, still births and miscarriage, are some of the well documented consequences of maternal under-nutrition (Hernandez-Julian et al., 2011; Henriksen, 2006; Scott and Duncan, 2000).

Studies from low income countries corroborate the association between maternal under-nutrition prior to and during pregnancy as well as high rates of low birth weight and stillbirths (Scott et al., 1997; Lartey, 2008). Women in developing countries have been shown to gain the least weight during pregnancy and have the lowest birth weight infants, when compared with counterparts from developed countries (Scott et al., 1997; Durnin, 1987).

Poor nutrition in pregnancy, in combination with infections, aggravates maternal and infant morbidity and mortality, particularly among the poor and underserved in rural areas and urban slums (Pena and Becalao, 2002). Many sub-Saharan African countries, like others in Latin America and south Asia, have a high prevalence of malnourished children and women of reproductive age. In some of these countries, particularly in Africa and Latin America, childhood under-nutrition, as evidenced by stunting, coexists with both maternal overweight and under-nutrition (Garrett and Ruel, 2005).

A study in rural India showed that 23.3% of all pregnant women studied had a body mass index (BMI) less than 18.5 kg m^{-2}. An average weight gain of 6.6 kg was recorded for all the pregnant women studied. Inadequate dietary intake was found in 29.5% of the women studied (Saxena et al., 2000). A cohort of 5,564 pregnant women attending a public antenatal clinic was assessed for malnutrition, using height and body mass index. The prevalence of underweight was 5.7%, overweight 19.2% and obesity 5.5%. Overweight nutritional status (obesity and pre-obesity) was seen in 25% of adult pregnant women and was associated with increased risk for gestational diabetes, macrosomia, hypertensive disorders and renal problems (Nucci et al., 2001). The prevalence of underweight among pregnant women was assessed in Western Kenya, using BMI, in addition to mid-upper arm circumference. Different cut off points were used for the first (BMI >18.5 kg/m^2) and second trimesters (BMI > 20.2 kg/m^2) of pregnancy (van Ejik et al., 2008).

A study of the predisposing factors of protein – energy malnutrition (PEM) among pregnant women in a Nigerian Igbo community measured the weight, height and body mass index of the 1,387 study participants. The weight and height of the 477 rural women were significantly lower ($p < 0.0001$) than those of the 910 urban women. The mean BMI of rural subjects (25.28 ± 4.60 kg/m^2) was significantly lower ($p < 0.0027$) than that (26.41 ± 3.36) of the urban subjects. Pregnant women aged 24 years and below had significantly lower ($p < 0.0001$) mean BMI and a higher prevalence of PEM (Okwu et al., 2007). Ugwa (2014) in a prospective study of maternal anthropometry as a determinant of birth weight in Northwest Nigeria reported a significant association between birth weight and maternal body mass index and weight. The mean maternal weight was 72.05 ± 11 kg; maternal height was 1.64 ± 0.55 m; while the mean maternal BMI was 27.9 ± 4.3 kg/m^2. In Lagos, Southwest Nigeria, Oluwafemi et al. (2013) found mothers of small-for-gestational age babies to have significantly lower anthropometric characteristics than mothers of normal and large-for-gestational age babies, including weight, height and BMI. A mean maternal height of 1.61 ± 0.08 m; mean weight of 72.55 ± 11.01 kg and mean maternal BMI of 27.90 kg/m^2 at delivery was reported by Ukegbu et al. (2012) in Umuahia, Abia, southeast Nigeria.

The American College of Obstetricians and Gyneacologists (ACOG) recommended that BMI be recorded for all women at the initial prenatal visit. Information concerning the maternal and foetal risks of an elevated BMI in pregnancy should also be provided (ACOG, 2005). Maternal morbid obesity, particularly in early pregnancy, is strongly associated with a number of pregnancy complications and peri-natal conditions (Satpathy et al., 2008). Morbidly obese mothers as compared with normal-weight mothers had an increased risk of the following outcomes: pre-eclampsia, ante-partum stillbirth, instrumental delivery, shoulder dystocia, meconium aspiration, foetal distress and early neonatal death in studies conducted in Europe (Cedergren, 2004; Grossetti et al., 2004).

Maternal mid-upper arm circumference (MUAC) has been used as a potential indicator of maternal nutritional status. Ricaldo et al. (1998) studied 92 pregnant women who were followed through at the prenatal service of a hospital in Sao Paulo, Brazil, showing significant association between gestational age and newborn variables. Maternal MUAC and pre-pregnancy weight were found to be positively correlated to birth weight. The authors concluded that MUAC could be used in association with other anthropometric measurements, instead of pre-pregnancy weight, as an alternative indicator to assess women at risk of poor pregnancy outcome.

The effect of maternal nutritional status on pregnancy outcome was studied in Sudan. This descriptive study involved 1000 Sudanese mothers and their singleton babies. The birth weight of newborns was measured in addition to maternal anthropometric indices, including weight, height and MUAC. Maternal age and all maternal anthropometric measurements were positively correlated ($p < 0.01$) with birth weight. A maternal height of less than 156 cm; a weight of less than 66 kg; a maternal MUAC of less than 27 cm and years of education of less than or equal to 8 years, were found to increase the relative risk of low birth weight (Elshibly and Schmalisch, 2008). A similar study carried out in Sudan, investigated the relationship between maternal and newborn anthropometry, utilizing multiple regression and multivariate analysis. Maternal anthropometry was found to be significantly associated with newborn anthropometry. The strongest associations were found for maternal MUAC, supine length and birth weight (Elshibly and Schmalisch, 2009).

No study has been carried out on maternal anthropometric indices in Ogun State, Nigeria. This study therefore assessed and compared anthropometric indices of pregnant women accessing antenatal care at rural and urban primary health centres in Ogun State, Nigeria, as a means of determining their nutritional status.

METHODOLOGY

A cross-sectional comparative study was carried out among 720 pregnant women at selected Primary Health Centres in rural and urban areas of Ogun state, between 4th December, 2012 and 6th May, 2013. Only women aged between 18 and 49 years, in the first and second trimesters of pregnancy and fully resident in the study locations were allowed to participate. Using a formula for the comparison of two independent proportions, the calculated sample size (N) was rounded up to 360 per group. A total of 720 pregnant women were studied in all. The sampling technique used in this study was multi-stage sampling. The first stage involved the selection of a senatorial district/zone, from the three zones present in the state, by simple random sampling. Ogun - East senatorial district was selected. The second stage involved the selection of one rural and one urban LGA, by simple random sampling. Sagamu LGA was selected as the urban study location, while Remo-North LGA was selected as the rural study location, by simple random sampling. The third stage of sampling involved the selection of two wards, from each of the selected LGAs, by simple random sampling. In Remo-North LGA, wards 7 and 9 were selected from the 15 existing wards, by simple random sampling (balloting).

In Sagamu LGA, wards 5 and 8 were also selected. The Primary health cares (PHCs) located within the selected wards, constituted the study sites, making a total of four primary health facilities. All consenting pregnant women, who met the inclusion criteria, were recruited into the study consecutively till the required sample size was reached. A semi-structured, interviewer-administered questionnaire was used to collect information on respondents' socio-demographic profile. The semi-structured, interviewer-administered questionnaire was translated into the local language (Yoruba) and back into English, to ensure clarity, standard and uniformity. It was pretested in Ikenne and Ijebu-Ode LGAs, which are similar to the study locations in Ogun-East senatorial district.

Five research assistants were trained over a period of two days prior to commencement of the study. They were undergraduate students of Olabisi Onabanjo University and neighbouring tertiary institutions. An adult weighing scale was used to measure participants' body weight, to the nearest 0.1 kg. Study participants had only light clothing on, with no shoes, keys, phones or anything that added to the weight being recorded. After each recording, the weighing scale was checked and reset at the zero point, in order to ensure accuracy of the measurements taken (James et al., 1998). A stadiometer was used to measure participant's height to the nearest 0.01 m. Participants were required to remove their shoes, head ties and any other thing that may distort the measurement of their height. With the two feet placed together and the women standing fully erect, with both hands placed by the side and the head at 90 degrees to the rest of the body, the participants' heights were measured using the stadiometer in the Frankfurt plane (Zerihun et al., 1997). Respondents' body mass index was classified according to World Health Organization (WHO) criteria, similar to previously published research works (Nucci et al., 2001; Crane et al., 2009).

Mid – upper arm circumference (MUAC) was measured using a measuring tape. The mid-point between the acromion process and the olecranon was taken as the site for measurement of the mid-upper arm circumference. This was recorded in centimeters (cm) (Ricaldo et al., 1998; UNICEF, 2009). The adult tape has three colour codes namely: red; yellow and green. MUAC readings below 21 cm are in the red region, signifying severe malnutrition; those between 21 and 23 cm are in the yellow region, showing mild malnutrition or borderline nutritional status. Only measurements from 23 cm and beyond fall into the green – coloured region, signifying a healthy nutritional status.

Data analysis was done using the IBM Statistical Package for the Social Sciences (SPSS) version 14.00. Proportions, means and frequencies were calculated, presented as tables and charts, and compared between the two groups using the appropriate statistical tests. Chi square test was used to test for association between categorical variables, while t test was used for comparison of means. Level of significance was placed at $p = 0.05$.

Ethical approval was obtained from the Ogun State Primary Health Care Board, Ogun State Ministry of Health, as well as the Health Research and Ethics Committee of Olabisi Onabanjo University Teaching Hospital, Sagamu. Written approval was also sought from the Local Government Health Authorities in Sagamu LGA and Remo-North LGA, through the Medical Officer for Health/Director, Primary Health Care Department. Participants' informed consent was obtained verbally and by thumb printing, prior to the commencement of the study. Strict confidentiality was ensured throughout the course of the research.

RESULTS

Age of respondents

Women aged 18 to 25 years were 27.2 and 26.4% among rural and urban respondents, respectively. About 52% of rural and 54% of urban respondents were aged between 26 and 33 years; 19.4 and 17.8% of rural and urban respondents were aged between 34 and 41 years, respectively; while 1.7% of rural respondents and 1.9% of urban respondents were aged between 42 and 49 years. There was no significant difference ($p = 0.905$) between the ages of rural and urban respondents.

Occupation of respondents

Traders constituted 49.2% of rural respondents and 53.3% of urban respondents. Only 10.3% of rural and 9.2% of urban respondents were either housewives or unemployed; 29.0% of rural women were unskilled workers compared with 29.2 of the urban respondents. An equal number (11.3% rural and 10.8% urban) of respondents were Civil servants in both rural and urban study locations. There was no significant difference ($p = 0.572$) between both groups of respondents.

Table 1. Weight and height distribution of respondents.

Weight (kg)	Location		Test Statistic
	Rural	Urban	
	Frequency (%)	Frequency (%)	
Less than 60	110 (30.6)	117 (32.5)	X^2=0.903; df=3; p=0.825
61 - 80	201 (55.8)	190 (52.8)	
81 - 100	44 (12.2)	46 (12.8)	
Greater than 100	5 (1.4)	7 (1.9)	
Mean (kg)	68.01 ± 12.36	67.80 ± 12.55	t=0.226; p=0.822
Height (m)			
Less than 1.50	14 (3.9)	25 (6.9)	X^2 =4.909; df= 3; p=0.179
1.51 - 1.60	154 (42.8)	164 (45.6)	
1.61 - 1.70	166 (46.1)	151 (41.9)	
1.71 - 1.80	26 (7.2)	20 (5.6)	
Mean (m)	1.61 ± 0.07	1.60 ± 0.06	t=1.279; p=0.201

Source of drinking water

A nearby well was the source of drinking water for 3.0% of rural respondents and 5.3% of urban respondents; 48.0% of rural respondents and 50.0% of urban respondents drank pipe-borne water flowing within their homes. Nearby streams served as a source of drinking water for 3.0% of rural and 1.9% of urban respondents. Public taps and neighbourhood water points served as a source of drinking water for 46.0% of rural respondents and 42.8% of urban respondents. There was no significant difference (p = 0.316) in the source of drinking water between rural and urban respondents.

Weight and height distribution of respondents

Most rural participants (55.8%) and their urban counterparts (52.8%) weighed between 61 and 80 kg; 1.4% of rural and 1.9% of urban participants weighed more than 100 kg. The mean weight of rural respondents was 68.01 ± 12.36 kg and that of urban respondents was 67.80 ± 12.55 kg. There was no statistically significant difference (p = 0.822) between both means. A height of less than 1.50 m was found in 3.9% of rural participants, compared with 6.9% of urban participants; 42.8% of rural participants compared with 45.6% of urban respondents had a height measurement between 1.51 and 1.60 m. There was no significant difference (p = 0.179) between the height distributions of rural and urban participants. The mean height of rural respondents was 1.61 ± 0.07 m, while that of urban respondents was 1.60 ± 0.06 m. There was no significant difference (p = 0.201) between both means (Table 1).

Respondents' body mass index

Women with BMI values less than 18.5 kg/m^2 were 1.3% in the rural and 2.8% in the urban areas; 43.9% of rural respondents and 40.0% of urban respondents had a BMI value between 18.5 and 24.9 kg/m^2. BMI values between 25.0 and 29.9 kg/m^2 were found in 35.6 and 37.8% of rural and urban respondents, respectively. Only 5.6% of rural participants and 6.1% of urban participants had a BMI greater than 35 kg/m^2. There was no significant difference (p = 0.616) in BMI, between the rural and urban women studied (Table 2).

Mid-upper arm circumference of respondents

Most rural participants (78.4%) and their urban counterparts (86.4%) had normal MUAC readings. 17.2% of rural participants and 9.2% of urban participants had MUAC readings indicative of mild to moderate malnutrition. An equal proportion (4.4%) of respondents was severely malnourished in both rural and urban groups of women. There was a significant difference (p = 0.006) in MUAC readings between rural and urban women. The mean MUAC reading among rural respondents was 26.46 ± 3.54 cm, while that of urban respondents was 27.17 ±

Table 2. Respondents' body mass index and mid-upper arm circumference.

Body mass index (kg/m^2)	Location Rural (n = 360) Frequency (%)	Urban (n = 360) Frequency (%)	Test statistic
Less than 18.5	5 (1.3)	10 (2.8)	
18.5 - 24.9	158 (43.9)	144 (40.0)	
25.0 - 29.9	128 (35.6)	136 (37.8)	X^2 = 2.664; df=4; p=0.616.
30.0 - 34.9	49 (13.6)	48 (13.3)	
35.0 and above	20 (5.6)	22 (6.1)	
Mean (kg/m^2)	26.27 ± 5.59	26.19 ± 4.94	t=0.195; p=0.846
Mid – upper arm circumference (cm)			
Severe malnutrition (less than 21.0)	16 (4.4)	16 (4.4)	
Mild to moderate malnutrition (21.0 - 23.0)	62 (17.2)	33 (9.2)	X^2=10.271; df=2; p=0.006
Normal (greater than 23.0)	282 (78.4)	311 (86.4)	
Mean (cm)	26.46 ± 3.54	27.17 ± 4.09	t=2.473; p=0.014

4.09 cm. There was a statistically significant difference (p = 0.014) between both means (Table 2).

DISCUSSION

Over the years, maternal anthropometry has been used as a measure of the nutritional status of pregnant women (Watkins et al., 2003; Mantakas and Farell, 2010; Saxena et al., 2000; Nucci et al., 2001; Crane et al., 2009). It has been considered a predictor of pregnancy outcome over several years (Scott et al., 1997; Lartey, 2008; ACOG, 2005; Nucci et al., 2001; Crane et al., 2009; Cedergren, 2006; Addo, 2010). The mean height of rural respondents was 1.61 ± 0.07 m, while that of urban respondents was 1.60 ± 0.06 m. There was no statistically significant difference between both means (p = 0.201). This is different from findings in a small scale study in Oromiya, where the mean height was 155.5 cm (Zerihun et al., 1997). In this study, only 3.9% of rural and 6.9% of urban women showed evidence of chronic childhood under nutrition, with heights less than 150 cm, which is very much lower than 20% reported in the Oromiya study (Zerihun et al., 1997). The difference could be as a result of a disparity in the nutritional status of the underlying populations of both countries. The mean weight of rural respondents was 68.01 ± 12.36 kg, while that of urban respondents was 67.80 ± 12.55 kg. However, there was no statistically significant difference between both mean values (p = 0.822). This is different from the findings of a previous research in a Nigerian Igbo community in which the weight of rural respondents was significantly lower (p < 0.001) than that of their urban counterparts (Okwu et al., 2007). The weight measurements were mainly used to calculate body mass index values. This is because a single weight measurement in the first or second trimester, without knowledge of the pre-pregnancy weight and serial measurement of same, does not offer adequate information about the magnitude of weight gained in pregnancy by the woman concerned. Therefore, serial weight measurements have been documented in literature, with the aim of determining the adequacy or otherwise of the weight gained in pregnancy (Crane et al., 2009; Cedergren, 2006; Addo, 2010).

The mean BMI values were 26.27 ± 5.59 kg/m^2 for rural women and 26.19 ± 4.94 kg/m^2 for the urban women. There was no significant difference between both means (p = 0.846). These findings are different from those documented in a study from southeastern Nigeria, in which the mean BMI of rural women was significantly lower (p < 0.003) than that of the urban pregnant women. Also the mean BMI value recorded in that study for the rural women (25.28 ± 4.60 kg/m^2) was much lower than the value obtained in our study (Okwu et al., 2007). Only 1.3% of rural women and 2.8% of urban respondents had BMI values less than 18.5 kg/m^{2,} indicative of a sub-optimal nutritional status. Such women have been described as being in a state of chronic energy deficiency (James et al., 1998). These findings are different from those reported from a study of pregnant women in their second trimester, where 5.7% had BMI values less than

18.5 kg/m^2 (Nucci et al., 2001).

BMI values between 30 and 34.9 kg/m^2 were found in 13.6% of rural and 13.3% of urban study participants. This is higher than the value (5.5%) reported in a previous study (Nucci et al., 2001). BMI values greater than 30 kg/m^2 as well as excessive weight in pregnancy are well documented to be associated with negative pregnancy outcomes (Watkins et al., 2003; Crane et al., 2009; Cedergren, 2006; Addo, 2010). Only 5.6% of rural respondents and 6.1% of urban respondents had BMI values greater than or equal to 35 kg/m^2, a finding associated with some obstetric risks including gestational diabetes, foetal macrosomia, gestational hypertension, pre-eclampsia, stillbirth, increased likelihood of instrumental delivery and caesarean sections, as well as neonatal metabolic abnormalities (Nucci et al., 2001; Crane et al., 2009; Cedergren, 2004; Satpathy et al., 2008; Grossetti et al., 2004).

According to MUAC readings, severe malnutrition was found in 4.4% of rural and urban respondents. A higher proportion of respondents had MUAC readings indicative of mild malnutrition, with 17.2% of rural respondents and 9.2% of urban respondents falling into this category. However, most rural respondents (78.4%) and their urban counterparts (86.4%) had MUAC readings indicative of a normal nutritional status. The prevalence of malnutrition found in this study using MUAC (21.6% rural; 13.6% urban), is far lower than the 60 and 37% reported by United Nations International Children Education Fund (UNICEF) in Samburu and Marsabit districts of Kenya, respectively (Carter, 2006). It is also lower than the prevalence of 65% reported for malnutrition among pregnant women in Ghana (Kwapong et al., 2008). There was a significant association ($p = 0.006$) between location and MUAC readings. There was also a significant difference ($p = 0.014$) between the mean MUAC values of rural and urban respondents.

Some studies have used maternal MUAC values as indicators of poor pregnancy outcomes; maternal MUAC was also found to be positively correlated with birth weight and other newborn anthropometry (Ricaldo et al., 1998; Elshibly and Schmalisch, 2008; Elshibly and Schmalisch, 2009). Although the mid - upper arm circumference tape has been widely acknowledged as a tool for determining the nutritional status of children several years ago, not many studies have documented MUAC as an indicator of nutritional status in adults. UNICEF developed guidelines for the use of MUAC tapes; published the relevant cut off points and supervised the distribution of such in 2009, for the assessment of nutritional status of pregnant women and children. The essential medicines and nutrition unit of UNICEF has been in the forefront of enlightenment and advocacy for its use as a rapid assessment tool in resource-constrained settings as well as in emergency situations (UNICEF, 2009). Although this study did not investigate participants' pregnancy outcomes due to its cross-sectional design, the MUAC values recorded are representative of the pregnant women's nutritional status and provide baseline information for more detailed longitudinal studies in the nearest future.

The high burden of malnutrition in Nigeria is well documented in literature, due to a multiplicity of factors, requiring a multi-sectoral response (Ubesie and Ibeziakor, 2012). Many women in sub-Saharan Africa are in a state of chronic energy deficiency. It has been defined as a steady state at which a person is in energy balance at a cost to his or her health (James et al., 1998). Nutrition affects the health economics outcomes at both the individual and the societal levels. An individual's nutritional choices affect his or health condition, thereby influencing productivity and economic contributions to the household and society at large (Gyles et al., 2012).

Conclusion

The mean weight, height and body mass index of rural study participants was higher than those of their urban counterparts, with the exception of the MUAC, which was significantly higher among urban participants. Community level nutritional interventions, including behavior change communication on adequate nutrition from infancy to reproductive age, will have considerable impact on the anthropometric indices of pregnant women in developing countries like Nigeria.

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Conflict of interests

The authors have not declared any conflict of interests.

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