African Journal of Biotechnology Vol. 6 (4), pp. 459-464, 19 February 2007
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2007 Academic Journals

Full Length Research Paper

Energy intake and anthropometry: a case study of families in Zaria, Nigeria

Oranusi S[1*], Galadima M[2], Umoh VJ[2] and Nwanze PI[1]

[1]Department of Biological Sciences, College of Natural and Applied Sciences, Igbinedion University, Okada, P.M.B. 0006,Edo State, Nigeria.
[2]Department of Microbiology, Ahmadu Bello University, Zaria, Kaduna State, Nigeria.

Accepted 10 November, 2006

Energy intake and nutritional status of 44 members of 5 families in Zaria Local Government Area of Kaduna State were evaluated for 6 consecutive days. The socioeconomic activities and health condition of the participants was determined by the administration of questionnaire interviews. Food samples were analyzed by the standard AOAC methods to determine their energy and proximate composition while nutritional status was determined by anthropometric measurements. The mean energy intake (EI) of the subjects from the families were 2435-4558 kj/d for age groups 1-5 years; 4446-4996 kj/d for age groups 6-15 years; 5632-6493 kj/d for age groups 16-35 years and; 5547-10,883 kj/d for age groups 36 years and above. Fifteen (42.9%) of the subjects from the families had a normal body mass index (BMI) of 20-25 kg/m^2, 10 (28.6%) were underweight with BMI of 18.4 kg/m^2 and below while 5 (14.3%) were of thin weight with BMI of 18.5-19.49 kg/m^2. Energy intake contributed approximately 22% (r = 0.22) to the BMI.

Key words: Anthropometry, BMI, BF, EI, socioeconomic and nutritional status and energy intake.

INTRODUCTION

According to Stephenson (1999), Eckhardt et al. (2005) and Laraia et al. (2006) diet is the most influential determinant of linear growth because it is through diet that the influences of other determinants of linear growth such as socioeconomic status (SES) and infection are largely reflected. In Africa, the situation is acute considering the ravaging effects of inadequate food supply and poverty (Boafo-Arthur, 2000; Adam, 2003; Jyoti et al., 2005; Ingbian and Akpapunam, 2005). This is of relevance in the education sector since improving childhood nutrition may have long-lasting educational benefits such as increased rates of secondary school completion in developing countries (Mendez, 2000; Pierce et al., 2005).

Provision of adequate energy intake and prevention of infection can be achieved through sustainable preventive strategies such as improving food production and water supply as well as promoting food and personal hygiene (Molls et al., 2005; Oranusi et al., 2006). Nutritional anthropometry has an important advantage over other nutritional indicators because it is sensitive over a full spectrum while biochemical and clinical indicators are useful only at the extremes of malnutrition. In addition and more importantly, however, anthropometric measurements are inexpensive, practical, easy to use in large population-based field studies, non-invasive and age- and sex-specific reference data are available (de Onis, 2000; Eckhardt et al., 2003; Saksvig et al., 2005).

Some researchers view body mass index (BMI) as the most common anthropometric indicator of body fat (BF). The World Health Organization (WHO, 1995) and the Center for Disease Control and Prevention both support this view (Seidell, 2000; Cole et al., 2000). However, recent work suggests that BMI may have a different meaning among the different ethnic groups (WHO, 2000). This has lead to the need for research, especially in the developing countries, to help clarify ethnic differences in body composition (Durenberg et al., 1998, 2000).

With the above facts in mind the present study aimed at the measurement of the food intake by members of 5 families in Zaria Local Government Area of Kaduna

*Corresponding author. E-mail: orasol2002@yahoo.com.au.

State, the determination of the energy and proximate composition of the foods consumed by the families, the determination of the nutritional status of the above subjects using anthropometry and the determination of the contribution of energy intake to nutritional status.

MATERIALS AND METHODS

Subjects

Subjects were recruited from Zaria Local Government Area (ZLGA) of Kaduna State, Nigeria. The families were selected based on the clustering sample technique and on interest and willingness to participate in the exercise as suggested by Eckhardt et al. (2003). The population consisted of 44 participants made up of 6 subjects from family 1; 11 from family 2; 6 from family 3; 8 from family 4; and 13 from family 5. Thirty-five other families were selected from the 4 clusters of ZLGA to serve as control. Selection of the control group was also based on interest and willingness to participate in the exercise, and on perceived health and socioeconomic status in the society.

Questionnaire interview

Questionnaires were administered to consenting individuals in order to evaluate their socioeconomic activities and health conditions. The participants were asked to study the survey form and supply necessary information regarding their personal data: names, sex, age, occupation, number of persons in the family, parent's occupation, disease conditions and infection in the families such as diarrhea or abdominal pain, date of onset, and whether drugs had been administered. Presence of other forms of infection such as cough, dysentery, and common cold were also sought. For children who could not supply the information, parents/guardians provided the necessary information for evaluation.

Food intake measurement

At meal times, 10:45-11:20 h (breakfast); 14:25-15:00 h (lunch) and 19:00-19:35 h (supper), quantities of foods to be consumed by individual participants were weighed using a Selter scale calibrated up to 5 kg. Plate waste was weighed and deducted from the original weights of food. Weights of foods consumed between meals were also recorded where possible and the resultant values were added to the values of the specified meal. By this weighed inventory method described by Reh (1976), the total food intake of each subject was calculated for six consecutive days. Samples of foods consumed by participants were collected in labeled specimen containers for proximate analysis. For snacks, butter, sugar and beverages, standard values for chemical contents were obtained from food composition tables (McCance and Widdowson, 1993).

Chemical analysis of food samples

The chemical analysis was carried out in the laboratories of the National Animal Product Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria. The food samples were analyzed for protein, lipid, carbohydrate, ash, moisture content, energy content, sodium, potassium, calcium, magnesium and iron as recommended by the Association of Official Analytical Chemists (AOAC, 1980). The protein value was derived from the nitrogen content by multiplying by a factor of 6.25 while carbohydrate content was assayed by difference (Nwanze et al., 2006).

Energy values were determined by calculation from the individual nutrient content and employing the conversion factors of 4, 9, and 4 for carbohydrate, lipid and protein respectively, as stipulated by FAO/WHO/UNU (1985) and McCance and Widdowson (1993).

Anthropometry

The study was conducted as described by Cole et al. (1997) and Eckhardt et al. (2005). The ages of the subjects were supplied by consenting parents or guardians. Weights were measured using a portable platform floor Salter scale, height was measured with a vertical wall mounted meter rule while triceps skin fold measurements were obtained at the sub-scapular region using the Lange pinch caliper. Mid-arm and head circumferences were both measured using a flexible cloth tape. All measurements were performed by trained personnel using standard techniques. Body mass index (BMI) in kg/m^2 was calculated from the weight and height measurements using the formula BMI = weight (kg)/height (m^2). Results were cross checked against a standard WHO nomogram (WHO, 1995).

Statistics

Total energy intake was analyzed by analysis of variance while the percentage distribution of energy and anthropometric values were expressed as means ± SD (Snedecor and Cochran, 1987; Nwanze et al., 2006b).

RESULTS

The mean daily energy intake and the percentage contribution of carbohydrate, protein and fat to the total energy intake of different age groups in five families are shown in Table 1. The energy intake in age groups 1-5 and 6-15 were statistically less than the standard required by WHO while the converse was the case for age group > 50. The highest contribution to energy intake was 80.75, 15.83 and 19.56% by carbohydrates, proteins and fats, respectively.Table 2 depicts the energy intake and anthropometric characteristics of the five families. The results show that apart from age, family 1 had the highest mean value of all the parameters examined. In addition, the energy intake of family 1 was comparable to that of families 2, 3 and 4 but significantly higher than that of family 5. Table 3 shows the anthropometric characteristics of the different subject age groups. The results reveal that the mean weight, height, triceps skin fold and mid arm circumference of the subjects in this study were slightly lower than the mean standard values. Table 4 depicts the BMI distribution for the various families. It reveals that 42.9% of the subjects have normal BMI of 20-25 kg/m^2 while 28.6% were under weight with BMI of 18.4 kg/m^2 and below. Table 5 represents the energy intake and anthropometric characteristics of two family sizes. The results reveal that the small sized family recorded relatively higher energy intake and anthropometric values. Table 6 represents the mean energy intake and anthropometry of the subjects based on socio-econo-

Table 1. Mean daily energy intake and percentage contribution of carbohydrate, protein and fat to the total energy intake of different age groups in five families (mean values, range and standard*).

Age group	Mean, range standard	Total energy intake (Kj/d)	Percentage distribution of energy		
			Carbohydrate	Protein	Fat
1-5	Mean	3391±802[b]	73.84 ± 4.21	12.72 ± 1.48	13.44 ± 4.64
Male and Female	Range	2435-4558	63.31-76.23	11.13-15.78	9.90-20.92
combined n =9	Standard	6620-7336[a]			
6-15	Mean	4996 ± 480[b]	75.05 ± 9.40	11.45±5.74	13.51 ± 3.66
Male	Range	4656 - 5335	68.40- 81.69	7.39 -15.51	10.92 -- 16.09
n=2	standard	9633.7a			
6-15	Mean	4446 ± 413[b]	76.41 ± 11.24	11.28 ± 2.80	12.31 ± 3.49
Female	Range	3928 - 4673	66.55 – 79.55	7.32 – 16.20	8.66 – 17.25
n = 8	Standard	8315.7[a]			
16-35	Mean	6493 ± 971`	80.75 ± 2.62	8.75 ± 3.00	10.99 ± 1.94
Male	Range	530 – 7680	78.50 – 84.10	3.83 – 12.86	8.89- 13.37
n=4	Standard	7196.5			
16-35	Mean	5632 ± 2140	71.47 ± 6.51	13.25 ± 1.74	15.29 ± 489
Female	range	3566 – 10386	62.27 – 79.60	10.82 –6.06	6.64 – 24.05
n=11	standard	5714			
36 – 55	Mean	7374 ± 1545[ab]	71.93 ± 2.15	13.42 ± 1.57	15.55 ± 1.92
Male	Range	6220 – 9130	69.74 – 73.52	12.51- 15.13	13.87- 17.65
n= 3	standard	6980.3[b]			
36- 55	Mean	4349 ± 517[b]	74.03 ± 5.19	13.63 ± 1.32	12.35 ± 3.95
Female	Range	3914 - 5040	66.38 - 77.97	11.69- 15.41	10.07 - 18.22
n=4	Standard	5447.6[b]			
>55	Mean	10883 ±3548[a]	64.61± 4.34	15.83 ±1 4.03	19.56 ± 0.41
Female/Male	Range	7335 - 6602	61.51 – 69.57	11.19- 18.47	19.24 – 20.02
n = 8	Standard	4870- 5878.0[b]			

* = WHO 1995 standards
abc = Mean within column with the same letter are not significantly different (P=0.05).

Table 2. Energy intake and anthropometric characteristic of the five families.

	Family				
Characteristic	**1**	**2**	**3**	**4**	**5**
Age (yrs)	25.3	19.5	28.0	23.5	21.0
Weight (kg)	72.3	56.5	57.0	50.0	53.0
Height (m)	1.7	1.6	1.6	1.6	1.6
Tsf (mm)	13.3	9.0	10.0	9.5	10.3
M.A.C. (cm)	27.3	26.3	25.0	22.0	22.8
E.I. (Kj/d)	8098[a]	5367[ab]	5157[ab]	4812[ab]	4049[b]
B.M.I. (Kg/m^2)	25.6	21.4	21.3	20.0	19.8
B.M.R. (Kj/d)	6404	5817	5581	5537	5463

Ab = Means within row with the same letter are not significantly different ($p<0.05$)
Tsf = Triceps skin fold
M.A.C = Mid arm circumference
E.I.= Energy intake
B.M.I = Body mass index
B.M.R = Basal metabolic rate

mic status. The results reveal that families were parents are traders, recorded relatively higher EI and anthropometric characteristics than families of civil servants and farmers.

DISCUSSION

The energy intake values reported for families in the present study were lower than those reported in similar studies in Nigeria as well as Burkino Faso, India and the Philippines (Bleiberg et al., 1981; Oguntona et al., 1987; Durnin, 1990; Cole et al., 1997; Eckhardt et al., 2005). The low EI values presently recorded could be due to the fact that the Nigerian diet contains little fat as well as the lack of reference standards for developing countries (Inua-Mero et al., 1983; Durenberg et al., 2000). However, the results concurred with those reported by Karadjati et al. (1983), Jansen et al. (1984) and Evers and Hopper (1996) but were higher than the values obt-

Table 3. Means and standard anthropometric characteristic for different age groups.

Age Group	Age (yrs)	Weight (Kg)	Height (m)	TSF (cm)	MAC (cm)	BMI (Kg/m^2)	EI (Kj/d)
6-15							
Male	10.5 ± 1.2	28.5 ± 4.95	1.3 ±0.09	7.0 ± 0.02	18.0 ±.0.03	16.4± 0.78	4996 ± 480
Standard	-	29.4 (24.4 - 65.1)	1.53s (1.2 - 1.85)	8.1 (6.3 - 9.1)	21.4 (17.3 - 26.8)	20 - 25	9633.7
Female	11.5 ± 3.46	23.9 ± 8.72	1.2 ± 0.2	6.6 ± 0.92	17.6 ± 2.84	17.0 ± 5.63	4446 ± 4.3
Standard	-	27.3 (22.3 - 62.2)	1.5 (1.2 - 1.80)	10.3 (17.3 - 24.9)	21.2 (17.3 - 24.9)	20 - 25	8315.7
16 - 35							
Male	18.0 ± 1.63	55.5 ± 9.68	1.7 ± 0.05	9.3 ± 0.96	24.9 ±1.7	19.4±2.01	6493± 971
Standard	-	63.5 (58 - 73)	1.58 (1.45 - 1.92)	12.5	29.3	20-25	7196.5
Female	23.0 ± 5.53	58.8± 2.92	1.6 ± 0.08	10.7 ± 4.78	24.7 ± 4.1	21.9 ±3.61	5632± 2104
Standard	-	52.6 (48 - 61)	1.55 (1.4 - 1.69)	16.5	28.5	20 - 25	5714
36 - 55							
Male	44.3 ± 5.03	61.0 ± 6.0	1.7 ± 0.07	13.3 ± 6.26	27.8 ± 1.89	22.1 ± 1.82	7374 ± 545
Standard	-	63.5 (58 - 73)	1.55 (1.45 - 1.92)	12.5	29.3	20 - 25	6890.3
Female	41.3 ± 4.35	54.5 ± 8.3	1.6 ± 0.06	10.0 ± 4.08	26.0 ± 4.55	22.3 ± 3.08	4349 ± 517
Standard	-	52.6 (48 - 61)	1.55 (1.4 - 1.69)	16.5	28.5	20-25	5447.6
>55	58.0 ± 2.00	68.7 ± 11.93	1.6 ± 0.09	12.7 ± 3.06	28.2 ± 0.76	25.4 ± 4.62	10883 ± 3547
Standard	-	63.5 (58 - 73)	1.6 (1.45 - 1.92)	12.5 - 16.5	28.5 - 29.3	20 - 25	4870 - 5879

MAC = Mid Arm Circumference
BMI = Body Mass Index
EI = Energy Intake

Table 4. Body mass index (Kg/m^2) for age group 6 and above from the five families.

	Families n (%)					
BMI Range	**1 (n = 5)**	**2 (n = 10)**	**3 (n = 3)**	**4 (n = 6)**	**5 (n = 11)**	**total (n = 35)**
18.4 and below (Underweight)	-	2(20.0)	1 (33.3)	2 (33.3)	5 (45.5)	10 (28.6)
18.5 –19.49 (thin)	-	3 (30.0)	-	1 (16.7)	1 (9.1)	5 (14.3)
20 – 25 (Normal)	2 (40.0)	3 (30.0)	2(66.7)	3 (50.0)	5 (45.5)	15 (42.9)
26 – 29 (over weight)	2 (40.0)	1 (10.0)	-	-	-	3 (8.6)
30 and above (Obese)	1 (20.0)	1 (10.0)	-	-	-	2 (5.7)

- = No subject in family within range.

Table 5. Mean energy intake and anthropometry of subjects from small and large family sizes.

Characteristics	Family Size	
	Small (below 10 persons)n=8	**Large (above 10 persons) n = 14**
Age (years)	24.6 ± 5.68	20.4 ± 5.13
Weight (Kg)	63.6 ± 16.29	54.40 ± 9.91
Height (m)	1.60 ± 0.08	1.60 ± 0.08
Triceps skin fold (mm)	11.80 ± 3.56	9.80 ± 4.29
Mid arm circumference (cm)	25.20 ± 3.31	24.20 ± 5.53
Body mass index (Kg/m^2)	24.20 ± 3.13	20.10 ± 3.87
Energy intake (Kj/d)	7746 ± 2644	540±983

Table 6. Mean energy intake and anthropometry of subjects from families of different socioeconomic status.

Characteristics	Socio-economic status		
	Business trader(n = 10)	Civil servants (n =8)	Farmers (n = 4)
Age (years)	25.3 ± 2.52	25.74 ± 10.61	21.0 ± 6.17
Weight (Kg)	72.3 ± 14.64	53.8 ± 7.78	53.0±11.50
Height (m)	1.7 ± 0.07	1.6 ± 0.05	1.6 ± 0.11
Triceps skin fold (mm)	13.3 ± 3.79	10.0 ± 2.12	10.3 ± 5.77
Mid arm circumference (cm)	27.3 ± 1.94	23.0 ± 1.41	22.8 ± 7.25
Body mass index (Kg/m^2)	23.9 ± 5.07	19.9 ± 3.04	19.1 ± 4.99
Energy intake (Kj/d)	7539 ± 2636	5376 ± 783	5001 ± 889

Table 7. Mean proximate composition per 100 g of foods prepared at home.

Food	Moisture (g)	Protein (g)	Carbohydrate (g)	Lipids (g)	Ash (g)	Na (mg)	K (mg)	Ca (mg)	Ma (mg)	Fe(mg)
Bean Cake/miomoi	72.97	7.81	13.80	3.12	2.26	986.8	530.5	197.3	114.6	1.49
Maize gruel (Akamu)	87.12	2.62	9.27	0.55	0.43	753.0	112.9	20.8	45.1	3.24
Tuwo (Corn meal)	73.33	3.63	21.39	0.79	0.86	619.0	259.9	14.2	43.3	1.05
Eba	76.40	0.56	21.73	0.86	0.45	123.7	218.8	2.7	63.9	1.57
Rice Jollof	70.68	3.46	22.85	1.90	1.12	558.7	262.9	8.5	194.0	1.04
Beans Jollof	67.82	8.19	15.64	5.17	1.23	812.3	978.7	181.1	124.9	1.73
Yam porridge	75.00	2.13	20.40	1.22	1.25	542.3	203.5	17.3	116.2	0.87
Been/plantain porridge	62.53	8.55	25.79	3.12	1.40	673.6	1 015	263.0	106.9	1.91
Soy/G.nut Soup	78.76	8.26	1.38	8.49	3.49	269.4	1075	326.4	139.1	1.71
Egg	73.40	11.90	-	12.3	1.21	135.0	138.0	56.0	12.3	2.53
Fried Fish	65.60	20.00	-	11.3	1.82	153.0	418.0	28.4	34.8	1.20
Orange	86.10	0.80	8.50	-	2.13	2.9	197.0	41.3	12.9	0.33
Egg plant	93.40	0.70	3.10	-	1.04	2.5	238.0	10.4	9.5	0.39
Sweet potatoes	72.00	1.10	20.10	-	1.83	17.8	296.0	20.5	12.3	0.62
Tomatoes	93.40	0.90	2.80	-	0.52	2.8	288.0	13.3	11.0	0.43
Bournvita	6.00	11.40	67.60	7.50	0.48	360.0	660.0	679.0	170.0	3.30
Doughnuts	26.40	6.00	48.80	15.80	2.10	60.0	113.0	67.0	16.4	1.92
Sugar	-	-	105.00	0.00	1.93	0.4	2.0	1.5	0.2	0.04
Biscuit	5.20	7.40	75.30	13.20	1.11	244.0	170.0	126.0	14.3	1.78
Spaghetti	12.40	9.90	84.00	1.00	0.74	4.8	161.0	22.6	34.9	1.21
Bread	53.80	7.80	52.70	1.40	2.21	515.0	161.0	92.0	22.6	1.80
Macaroni	72.20	3.40	25.20	0.60	0.62	7.9	67.0	8.1	17.6	0.45
Cornflakes	70.00	6.60	20.20	0.80	0.64	10.5	114.0	7.4	16.5	2.80
Custard	12.50	0.50	92.00	0.70	1.22	15.6	61.0	15.3	7.2	1.43
Butter	13.40	0.40	-	85.10	0.30	223.0	15.0	15.0	2.4	0.16
salt	-	0.00	0.00	0.00	0.02	38900	-	2.0	160.0	0.15

- Trace amount or not detectable.

ained by Malcom (1970) and McNaughton and Cahn (1970a; 1970b).

The assessment of specific nutrient intake and individual meals showed that carbohydrate, fat and protein contributed 73%, 14% and 13% of energy intake respectively while breakfast, lunch and supper contributed 25%, 31% and 40% energy to the total EI. The results concur with the findings of Cole et al. (1997) and further highlight the importance of dinner in the feeding habit of the average Nigerian citizen. The mean weight and height, mid-arm circumference and triceps skin fold values currently reported were lower than those obtained from similar studies in Canada and the United Kingdom (Tanner and Whitehouse, 1962; Jenicek and Demirjian, 1972). This could be explained by an underlying mild malnutrition in the subjects of study. The relatively higher EI and anthropometric values of participants from business/trading socio-economic backgrounds supports the theory that socioeconomic status is a major determinant of energy intake (Pierce et al., 2005; Eckhardt et al., 2005; Laraia et al., 2006). There is thus an urgent need for research in diverse populations in developing countries over a long time frame in order to clarify ethnic differences in body composition and produce functional reference standards.

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