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Total Energy Intake and Frequency of Food Consumption in Relation to Body Mass Index of Adult Population in Nigeria

[1]C.I. OJO, [1]A.S. ADEKOYA , [1]O.B. IJAYA, [1]O.A. OPELAMI
[1.] Department of Home and Rural Economics, Federal Cooperative College, Ibadan, Nigeria

Abstract:- Animals compare their diets from a wide range of potential foods. They exhibit some levels of orosensory biases such as attraction to sweet (sugars), flavours (fat). They tend to avoid bitter. This study aimed at assessing the total energy intake and frequency of food consumption, as it influenced the Body Mass Index of adults (aged 20-64 yrs) population in Abeokuta, Nigeria.

The study was a cross-sectional one that focused on information on total energy intake via 24h dietary recall of the respondents, to determine the caloric intake (kcal/d) using the cut-off mark of Recommended Daily Allowance (RDA). The food frequency was obtained on daily and weekly based on choices of the food groups consumption; and Body Mass Index (BMI) kg/m^2 using cut-off ≥ 30 kg/m$^{2.}$. The results were compared with the RDA for energy, which showed an association between the frequency of consumption of high caloric food groups and the changes in the BMI of the respondents both males and females. The incident of obesity based on frequency of consumption of the high caloric foods is a reflection of the type of staple foods being consumed in this region of the world, in comparison with what applies in the western world or developed world. The underlying food preferences and choices were due to taste and cost of the food groups, but improvement in incomes and wages can also increase obesity pandemic in the direction of nutrition transition been observed in all developed countries. Thus, calling for more nutrition education and awareness in this regard.

I. INTRODUCTION

Obesity prevalence and its associated metabolic diseases is still increasing globally, despite the increases in awareness and research efforts to curb the menace. (1,2). Energy dense foods and sedentric lifestyle are known to exert pressure on energy balance regulation, thus leading to increased adiposity in genetically predisposed individuals. (4). Overeating due to some environmental mechanisms arising from modern food industry promotions on consumption of cheap energy-dense foods, and nutritionally poor foods, had been the major factor affecting the understanding of the physiological mechanisms that determined the frequency at which some nutrients are being consumed. (5,6).

II. FOOD PREFERENCE AND CHOICE

Energy from three macronutrients and adequate intake of other essential nutrients, vitamins and minerals are needed for survival. They are obtained in mixed form naturally and processed, but adequate intake of each of their component is extremely difficult and complex in putative control system. (7). Selection of the three macronutrients (protein, carbohydrate, and fat), to provide animals and humans with casein, sugar and lard having specific sensory properties to drive the selection instead of the nutrient composition itself. (8).

Carbohydrate and fat intake have recently received much attention from obesity, diabetes, and other metabolic diseases, where dietary sugar and calorie intake are thought to be risk factors for these chronic diseases. (9, 10). There are mechanisms for nutrient conditioning actions of carbohydrates using various sugars, maltodextrins, or starches. (11). Carbohydrates condition preferences is a form of “flavor-calorie” learning, which is ineffective on isocaloric carbohydrates. (12, 13-15). Flavour preferences vary as a function of fat source, with long-chain triglycerides being more effective than medium-chain triglycerides. (16).corn oil and safflower oil are examples of triglyceride fat sources that are more effective than beef tallow and vegetable shortening. Some studies showed that orally consumed or postorally administered dietary proteins can condition flavor preferences in animals. (11, 17). It is also likely that postoral signaling is mediated by one or more common amino acids e.g. Glutamate. (18-20). In animals and humans, there are separate signals for acceleration (appetition, reward) and deceleration (satiation) of intake, the combined effects are major determinants of total energy intake in the short term (21). In most studies, glucose and water or low and high concentrations of fat emulsion were used in determining or assessing nutrient and food preferences and choices (11, 22, 23). These affirmations can be ascribed as the causes of increasing Body mass Index among the population that is being studied.

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III. MATERIALS AND METHODS

A representative sample of two hundred and forty adults (male-120, female-120) within the age bracket of 20 years and 64 years were systematically selected within some localities in Abeokuta. A pre-tested questionnaire was used to collect information on the anthropometric measurements which include height and weight to detect the changes in body composition and pattern of growth and development of an individual. The anthropometric measurement was used to compute the Body Mass Index. Validated questionnaires were used to record detailed information. The heights and weights of the subjects were taken to compute the BMI (kg/m^2) adopting the World Health Organization (34) classification of body weight in adults: *normal weight 18.5 – 24.9; Overweight 25.0 – 29.9; obese ≥ 30.0.* The height measurements were obtained using calibrated standing rule, and measured to the nearest *0.1cm.* The weight measurements were performed on the same digital scale, which was periodically checked for precision with known weights; and measured to the nearest *0.1kg*.

Food frequency questionnaire and 24h dietary recall questionnaire were used to collect information used in assessing meal pattern and dietary habits of the respondents, by identifying numbers of times a specific food item is consumed in a defined time span. (24-28).

The energy consumption was studied for each subject on the same day of anthropometric measurement. The subjects were asked about the types and amounts of foods consumed within the last 24hrs (using food models) which gave the 24hrs dietary recalls.

The energy contents were estimated using food composition tables and other available published and unpublished data for Nigeria (29). The values were compared with the RDA of FAO/WHO (3).

All the data collected were analyzed based on the research question raised. The data were analyzed using descriptive statistics and charts. Statistical analysis was performed with *t*-tests were used for comparison between the urban and rural subjects. Differences were considered to be significant at $p<0.05$. Results were expressed as means ± S.D and percentages (30-32).

IV. RESULTS

The Table 1 showed the results which indicate that mean energy levels are higher than the recommended daily allowance (3, 34) in both rural (305k/cal) and urban (3296.5 kcal/d). Obesity as determined by the body mass index (BMI) was seen to be higher among urban females (BMI 28.49 kg/m^2) than rural females (BMI 27.64 kg/m^2). In the same vein, similar trend was observed among urban males (BMI 29.30 kg/m^2). Table 2.

Table 1: Consumption Pattern of meals

Urban	Male		Female	
Was intake usual?	N %	Y%	N%	Y%
	26	74	15	85

Rural	Male		Female	
Was intake usual?	N %	Y%	N%	Y%
	25	75	11	89

Table 2: Mean Total Energy Intake (kcal/d) of the respondents

	Energy intake kcal/d		BMI (kg/m^2)	
Rural	**Range**	**Mean (SD)**	**Range**	**Mean (SD)**
Male: n=60	3379-3507	3498 ± 29.29	22.82 – 32.88	26.17 ± 3.63
Female: n = 60	1366 – 2864	2614 ± 23.25	20.75 – 36.43	27.69 ± 6. 01
Urban				
Male: n = 60	3416 – 3708	3691 ± 29. 91	22. 31 – 44.61	29. 30 ± 4. 69
Female: n = 60	2331 – 2924	2892 ± 33.14	25. 80 – 46. 13	28. 49 ± 5.80

The macronutrients which fall under the food groups carbohydrates, proteins and fats, cereals and product (CP), root / tubers and products, legumes and products (LP), fats and oils (FO), bakery products (BP), were found to be the major contributors to the development of weight gain and subsequent obesity. Contribution of visceral appetition signals to long-term food intake and body weight regulation was also identified (33).

Food preferences and choices are determined by the frequencies at which these food groups are consumed, and the patterns of their consumption.

Table 3a showed the rural settings, where some foods were taken more than 3 times / day according to male and female respondents, CP (83.33% vs 81.61%), RTP (66.61% vs 50%), LP (68. 33% vs 66. 66%), FVP (75% vs 83. 33%), DP (33. 33% vs 41.67%), BACD (33. 33% vs 43. 33%), MP (25% vs 35%), FO (100% vs 100%), BP (41. 67% vs 46. 67%).

However, the food consumption patterns of the rural respondents also follow a pathway of taken food less than 3 times / day according to male and female respondents, CP (16. 67% vs 18. 33%), RTP (33. 33% vs 50%), LP (31. 67% vs 33. 33%), FVP (25% vs 16. 67%), DP (66. 67% vs 58. 33%), BACD (66.67% vs 56. 67%), MP (75% vs 65%), FO (0% vs 0%), BP (58. 83% vs 53. 33%).

The manipulation of these sub-populations based on the choices and preferences for energy –dense foods is a good tool to understanding the significant role played by the rural and metabolic regulation of Macronutrient intake, in each individual body and the population as a whole.

There was collection of over 30 essays by leading scientists laying out their evidence (or lack) of self- regulation of nutrient intake (25).

Table 3a: Frequency of Consumption and Consumption Patterns of the respondents based on Food groups (Rural).

	Rural		
Food Groups	≥ 3 times/day frequency / %	<3 times / day frequency / %	
	M: n = 60 F: n = 60	M: n = 60	F: n = 60
Cereals and pdts	50 (83.33%) 49 (81.61%)	10 (16.67%)	11 (18.33%)
Roots /tubers and pdts	40 (66.67%) 30 (50%)	20 (33. 33%)	30 (50%)
Legumes and pdts	41 (68. 33%) 40 (66.66%)	19 (31. 67%)	20 (33.33%)
Fruit/vegetable & pdts	45 (75%) 50 (83.33%)	15 (25%)	10 (16. 67%)
Dairy pdts	20 (33. 33%) 25 (41 .67%)	40 (66.67%)	35 (58. 33%)
Beverages /Alcohol/ Carbonated drinks	20 (33. 33%) 26 (43. 33%)	40 (66.67%)	34 (56.67%)
Meat and pdts	15 (25%) 60 (100%)	45 (75%)	39 (65%)
Fats / oils	60 (100%) 60 (100%)	0 (0%)	0 (0%)
Bakery pdts	25 (41. 67%) 28 (46.67%)	35 (58.83%)	32 (53. 33%)

Among the urban sub-population, as reflected in Tables 3b the foods are taken more than 3 times/ day according to male and female respondents; CP (100% vs 10%), RTP (68.33% vs 75%). LP (56.67% vs 60%); FVP (81.67% vs 78. 33%); DP (58. 33% VS 65%); BACD (65% vs 70%), MP (86. 67% vs 91. 67%); FO (100% vs 100%); BP (61. 67% vs 75%).

Table 3b: Frequency of Consumption and Consumption Patterns of the respondents based on Food groups (Urban).

	Urban		
Food Groups	≥ 3 times/day frequency / %	<3 times / day frequency / %	
	M: n = 60 F: n = 60	M: n = 60	F: n = 60
Cereals and pdts	60 (100%) 60 (100%)	0 (0%)	0 (0%)
Roots /tubers and pdts	41 (68.33%) 45 (75%)	19 (31. 67%)	15 (25%)
Legumes and pdts	34 (.5667%) 36 (60%)	26 (43. 33%)	24 (49%)
Fruit /vegetable &pdts	49 (81.67%) 47 (78.33%)	11 (18. 33%)	13 (21.67%)
Dairy pdts	35 (58. 33%) 39 (65%)	25 (41. 67%)	21 (35%)
Beverages /Alcohol/ Carbonated drinks	39 (65%) 42 (72%)	21 (35%)	18 (30%)
Meat and pdts	52 (86.67%) 55 (91. 67%)	8 (13. 33%)	5 (8. 33%)
Fats / oils	60 (100%) 60 (100%)	0 (0%)	0 (0%)
Bakery pdts	37 (61. 67%) 45 (75%)	23 (38. 33%)	15 (25%)

Also, the study analyzed the food taken less than 3 times/day according to male and female respondents; CP (0% vs 0%), RTP (31.67% vs 25%), LP (43.33% vs 40%), FVP (18.33% vs21.67%), DP (41.67% vs 35%), BACD (35% vs 30%), MP (13.33% vs 8.33%), FO (0% vs 0%), BP (38% vs 25%%).

Above descriptions are typical digestive behaviour and possible development factors for obesity, which are also the evidence of patterns of the food preferences and food choices. The frequency of consumption; also supports the data on the consumption pattern of the meal intakes based on the usuality of the intakes. Table 1.

V. DISCUSSION

Translation to real world situations is a bit difficult because of the complex nature of food choices and preferences, and bearing in mind the species differences and macro-nutrient choice behaviours. The postoral nutrient sensing and signaling is an essential part in shaping preferences and choices associated with flavours and tastes in foods (33). Food rich in sugar, starch and fat that are significant factor in the current obesity epidemic were consumed by these respondents and contributed to the BMI levels reported in this study.

Current research which suggests a potential relevance of sugar-conditional preferences for treating or preventing obesity can be developed for protein and fat to curb this menace of obesity. Development of learning systems to further enhance the wanting and liking of foods high in these conditioned nutrients need to be encouraged. As much as human food appetite and preferences contribute to long-term food intake

and body weight regulation, resulting in under-reacting or over-reacting, development of sensing mechanism and signaling pathway for high-fibre food is required.

Berthoud et al 2021, further stressed the need for an unanswered question of whether changes in energy intake as experienced between the rural and urban settings have any long-lasting effects on energy regulation and the development of obesity. They also affirmed that quantitative or qualitative changes in food intake do not necessarily lead to changes in body weight.

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Author contributions

The authors conceived and designed the experiments, performed the experiments, analyzed the data, interpreted the data, wrote the first draft, and contributed to the final paper. All authors approved the final version. All authors are involved in the preparation of manuscript.

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