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Nutrient Adequacy of Foods Consumed among Adult Population Residing in Urban Parts of Dar-es-salaam, Tanzania

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Abstract:

Nutritional adequacy is the key element for human growth and development. Inadequate or excess intake of the nutrients may result to poor nutritional status. However, determining the level of nutrient intakes may be used to establish nutritional adequacy of the diet consumed. Therefore, this study aimed at assessing nutrient adequacy of diet consumed by adult's population in urban area of Dar-es-salaam. A cross sectional study was conducted among 270 adult's population aged 25 to 64 years. Dietary intake was assessed by using a repeated 24hr dietary recall method and Nutrient adequacy ratio for energy, protein, fat, carbohydrates, fiber, cholesterol, iron, zinc and calcium was calculated. Mean age (years) of the subject was 38 ± 10.5 years. On average energy intake was 2295.6 ± 264.6 Kcal. Average intake for protein, fat and carbohydrate were $65.6 \pm 11.5g$, $79 \pm 18.5g$ and $337.2 \pm 46.8g$ respectively. Mean saturated fat intake was $53.9 \pm 14.9g$. Other nutrients analyzed were fibre ($23.9 \pm 5.3g$), iron ($11.7 \pm 2.8mg$), zinc ($8.2 \pm 1.5mg$) and calcium ($299.8 \pm 204.4mg$). Mean dietary diversity score was 8 where by more than 50% of the subjects consumed at least 8 food groups. Average nutrient adequacy ratio for energy was (0.86), fat (1.27), protein (1.05), carbohydrate (1.1), saturated fat (4.15), fiber (1.07), iron (0.31), zinc (0.89), calcium (0.3) and the mean adequacy ratio (MAR) for energy intake and 8 nutrients was 1.22. Food consumed provided adequate nutrients due to composition of different foods groups. However, the nutrient adequacy ratio for calcium was very low compared to saturated fat which had a cut-off of 1, indicating that more fat has been consumed than recommended level. This may result in developing metabolic risk factors that contribute to the increase of non-communicable diseases. Therefore, promotion of diversified diets in a right proportion should be advocated to build a health society.

Keywords: Nutritional adequacy, adults, 24hrs recall, nutrient adequacy ratio

1. Introduction

Nutritional adequacy is the comparison between requirement and intake of nutrient of a certain individual or population (Castro-Quezada, Román-Viñas, & Serra-Majem, 2014). It is a key element for human growth and development. Inadequate or excess intake of the nutrient may result in poor nutritional status. The adequacy of the diet is a key determinant of the extent to which its contribution in particular nutrients meets the needs of individual. Therefore, nutritional adequacy can be used to determine the low or high intakes of nutrients in food consumed. However, the complexity of relationships between dietary intake and pathology cannot be attributed to a single nutrient rather, to multiple nutrients and foods varieties (Román-Viñas *et al.*, 2009). It should be noted that, every food group contain particular nutrient and each nutrient has specific function in the human body, therefore consumption of various foods in the right proportion from different food groups is vital to the wellbeing of individual. In addition, several factors such as social cultural behaviors and lifestyle may influence the adequacy of diet; thus, supply of all essential nutrients in a diet in each stage of life is the major concern for researchers in nutrition. Ballard and Morrow (2013), reported that only human milk during the infancy stage contain adequate nutrients, hence consumption of varieties of foods will provide adequate nutrient in adulthood.

Dietary factor has been associated with increase of metabolic risk factor and under nutrition; several studies have shown that the overall nutritional quality of the diet improved with increasing number of food items and food groups ((Hatloy, 1998; Rathnayake, Madushani, & Silva, 2012; Torheim et al., 2004). Studies show that consumption of assorted diet is coupled with higher intake of macro and micronutrients(Azadbakht, Mirmiran, & Azizi, 2005). Adults are at greater risk of developing nutritional problems due to physiological changes accompanied by change in life style and technological advancement(Ahmed, 2010). In Tanzania, metabolic risk factors related to nutritional problems are rapidly increasing among the adult population (Shayo and Mugusi, 2011). To assess these problems adequate information on the dietary consumption of individuals and populations is required to establish reliable data on nutritional composition so as to develop appropriate strategies to reduce expected risks for non-communicable diseases in the country. Therefore, this study aimed at determining the overall nutrient adequacy of the diet consumed by adult population in Dar es Salaam, Tanzania. In turn appropriate interventions can be thought in efforts to build a health society.

2. Methodology

2.1. Study Design and Subjects

A cross sectional study design was conducted in 9 wards of Ilala municipality in Dar es Salaam. A total of 270 adults aged above 25 years were interviewed on socio demographic characteristics and dietary intake. Multistage, stratified and random sampling procedures were used to obtain a representative subject. Subjects involved were permanent residents of the area or who have stayed in the area for not less than one year prior to the commencement of the study.

2.2. Methods

2.2.1. Socio Demographic Characteristics

A structured questionnaire tool was used to capture information on socio demographic characteristics such as sex, age, education level and occupation of respondents. The questionnaire was administered through face to face interview with respondents.

2.2.2. A 24-hour recall form

A 24hrs recall dietary form was used to determine type and amount of food consumed for the past 24 hours. The selected subjects were asked about their intake for previous 24-hour period or preceding day meal in three days of the week including one day in weekend. During the interview subjects were asked to recall food consumed for the past 24hrs bearing in mind all foods consumed within and outside their homes. The detailed descriptions of all foods and beverages consumed, including cooking methods and the type of cooking oil were recorded. The quantities of food consumed were estimated using household measures like spoons, cups and bowl and estimated in milliliters and/ or grams. Fruits were recorded by using their common names and the amount was later measured to determine how much was consumed. Bought cooked foods like African doughnut were recorded in terms of piece and price, whereas the price was used to determine the size of food item. The amount of nutrient consumed was then estimated and calculated using Tanzania food composition table (Lukmanji *et al.*, 2008).

2.2.3. Individual Dietary Diversity Score (IDDS)

Information on dietary diversification was extracted from a 24hrs recall form, where the consumed food items were grouped into twelve food groups. A modification of IDDS was done from Household Dietary Diversity Scores (HDDS)(Kennedy *et. al.*, 2013) to include food groups of interest that contribute to energy density such groups included sweets, fats and oils. Each group comprised of food items with mainly similar nutrients. These food groups were; cereals, roots and tubers, vegetables, fruits, legumes, nuts and seeds; meat, fish and other sea food, eggs, milk/milk products, oil/fats, sweets (sugar, honey, sugar cane); condiments and beverages. A maximum score of one was given if a household consumed specific food within a food group and a score of zero was given to a household which did not consume any food in a particular food group. Total dietary diversity score was then calculated by summing the number of those food groups consumed at home or outside the home.

2.2.4. Nutrient Adequacy Ratio

In this study energy intake and eight nutrients were selected, and their nutrition adequacy was calculated based on the individual food items consumed using a 24-hour reference period. The selected nutrients included; energy, protein, fat, saturates fats, carbohydrates, fiber, iron, zinc and calcium. Nutrition contents of each of the individual foods consumed were obtained from Tanzania Food composition table based on the selected eight nutrients. In order to obtain nutrient adequacy ratio (NAR) nutrient content of each food were taken and divided by recommended daily allowance of specific nutrient for specific sex. The following formula was used

$$\text{NAR} = \frac{\text{Actual nutrient intake of a nutrient (per day)}}{\text{recommended daily allowance of the nutrient}} \quad (\text{Margaret et al., 1995}).$$

The cut-off of 1 was used for NAR since requirements for nutrients are independent of one another as each performs a specific function and they cannot substitute each other (Margaret *et al.*, 1995). The NAR greater than 1 means the requirement has been met and if below 1 it may be sufficient as the Recommended Daily Allowance was set at the mean requirement of 77% RDAs. However, the more decrease in NAR the higher the chance the diet will fail to meet individual needs. The mean adequacy ratio was calculated based on 8 NARs using the following formula

$$\text{MAR} = \frac{\sum \text{NAR}}{\text{Number of nutrients}} \quad \text{Hatloy et al., (1998)}$$

MAR of 1 indicates that the intake of all nutrients is equal to or above the recommended intake, and a MAR below one indicates lower than the recommended intake for one or more nutrients

2.2.5. Analysis

Statistical Package for Social Science (SPSS) version 16 was used to analyze data. Descriptive statistics such as means, and confidence interval were used to summarize continuous variable such as age, energy consumption and other nutrient consumed. Frequencies were computed to summarize categorical variables such as age groups and sex, in respect, to dietary adequacy. Inferential statistics such chi square and student's t test were performed to determine the significance association between subject sex and consumption pattern. Pearson's correlations were used to measure associations between MAR and DDS. All values were considered significant at $P < 0.05$.

3. Results

3.1. Subject Characteristics

The number of subjects assessed was 270, among them 145 were females and 125 were males. The mean age (in years) of the subjects was 38 ± 10.5 (95% CI), for male subjects was 38.9 ± 1.9 (CI) and for female subjects was 37.7 ± 1.7 (CI). About 45% of the subjects were aged between 25-34 years old, 31% were aged between 35-44 years old, 13% aged between 54-54 years old and 11% of the subjects were aged above 54 years. About 38% of the subjects were employed; other subjects were self-employed (32%), housewives (14%), farmers (13%) or students (3%). Furthermore, 55% of the subjects had primary education followed by ordinary secondary education (22%), college/advance education (10%), university (7%) and 6% of the subjects did not attend school.

3.2. Dietary Consumption Pattern

Table 1 shows the average intake of energy, protein, fat, carbohydrate, fiber, iron, zinc and calcium. The mean energy (in Kcal) intake of the subject was 2295.6 ± 264.6 (SD). The average intake for protein, fat and carbohydrate (in grams) were 65.6 ± 11.5 (SD), 79 ± 18.5 (SD) and 337.2 ± 46.8 (SD) respectively.

Nutrients	ALL (n = 270)	Male (n = 125)		Female (n = 145)	
	$\bar{X} \pm \text{SD}$	RDA	$\bar{X} \pm \text{SD}$	RDA	$\bar{X} \pm \text{SD}$
Energy (kcal/day)	2295.6 ± 264.6	2600	2324.0 ± 264.7	1800	2271.2 ± 263.0
Protein (g/day)	65.6 ± 11.5	68	67.3 ± 11.3	58	64.2 ± 11.5
Carbohydrate(g/day)	337.2 ± 46.8	344	338.4 ± 47.4	275	336.2 ± 46.5
Fat (g/day)	79 ± 18.5	69	80.7 ± 19.7	57	77.6 ± 17.4
Saturated fat(g/day)	53.9 ± 14.9	13	55.0 ± 15.4	13	53.0 ± 14.5
Fiber (g/day)	23.9 ± 5.3	25	23.9 ± 5.5	20	23.9 ± 5.1
Calcium (mg/day)	299.8 ± 204.4	1000	327.2 ± 207.5	1000	276.2 ± 199.1
Iron (mg/day)	11.7 ± 2.8	8	12.0 ± 2.8	18	11.5 ± 2.8
Zinc (mg/day)	8.2 ± 1.5	11	8.5 ± 1.7	8	8.0 ± 1.4

Table 1: Mean nutrient intake and recommended amounts for the subjects

3.3. Consumption of Selected Nutrients based on the Adequacy

Findings of current study also indicated that 96% of subject consumed less protein compared to acceptable macronutrient distribution range (AMDR) of 15-25% of energy. Similarly, dietary calcium was observed to be inadequate among subjects (Table 2). There was significant difference in iron consumption among male and female subjects at p value < 0.05 . About 100% of male consumed adequate diet that has iron content which meets the RDA (8mg/day) compared to female counterparts. Furthermore, excess consumption of saturated fat was observed among the subjects (Table 2).

Nutrients	Adequate			Inadequate			Excess		
	All (n=270) %	Male (n=125) %	Female (n=145) %	All (n=270) %	Male (n=125) %	Female (n=145) %	All (n=270) %	Male (n=125) %	Female (n=145) %
Proteina	4.4	5.6	3.4	95.6	94.4	96.6	0	0	0
Carbohydratea	78.1	70.4	84.8	3.0	6.4	0	18.9	23.2	15.2
Fatb	77.0	75.2	78.6	1.1	0.8	1.4	21.9	24	20
Saturated fatb	1.1	1.6	0.7	0	0	0	98.9	98.4	99.3
Fibera	77.4	75.2	79.3	18.1	20.0	16.6	4.4	4.8	4.1
Ironc	52.6	100	11.7	47.4	0	88.3	0	0	0
Zincc	65.6	86.4	47.6	34.4	13.6	52.7	0	0	0
Calciumb	2.2	2.4	2.1	97.8	97.6	97.9	0	0	0

Table 2: Consumption status/level of selected nutrients based on the adequacy

aIOM (2002/2005): Adequate intake for protein 10-35% of total energy consumed, Inadequate intake = <10% and excess = >35%; Adequate carbohydrate intake 45-65% of total energy consumed, Inadequate intake = <45% and excess = >65%; Adequate fiber intake 20-35% of total energy consumed, Inadequate intake = <20% and excess = >35%

b FAO (2010). Adequate fat intake 20-35% of total energy consumed, Inadequate intake = <20% and excess = >35%. Saturated fat: adequate <10% of total energy consumed and excess > 10% of total energy consumed

cIOM (1997). Iron (Upper tolerable level 45mg/d) zinc (Upper tolerable level 40mg/d) and

dIOM (2011) Calcium(Upper tolerable level 2500mg/d).

3.4. Dietary Diversity

The mean dietary diversity score was 8 ± 1.2(SD), and more than 50% of the subjects consume at least 8 food groups. All subjects (100%) consumed cereals based foods, oil and fats. Similarly, fruits and vegetables were more consumed though the amount consumed is questionable. Roots, tubers/bulbs were less consumed, followed by eggs, milk and milk products (Fig. 1).

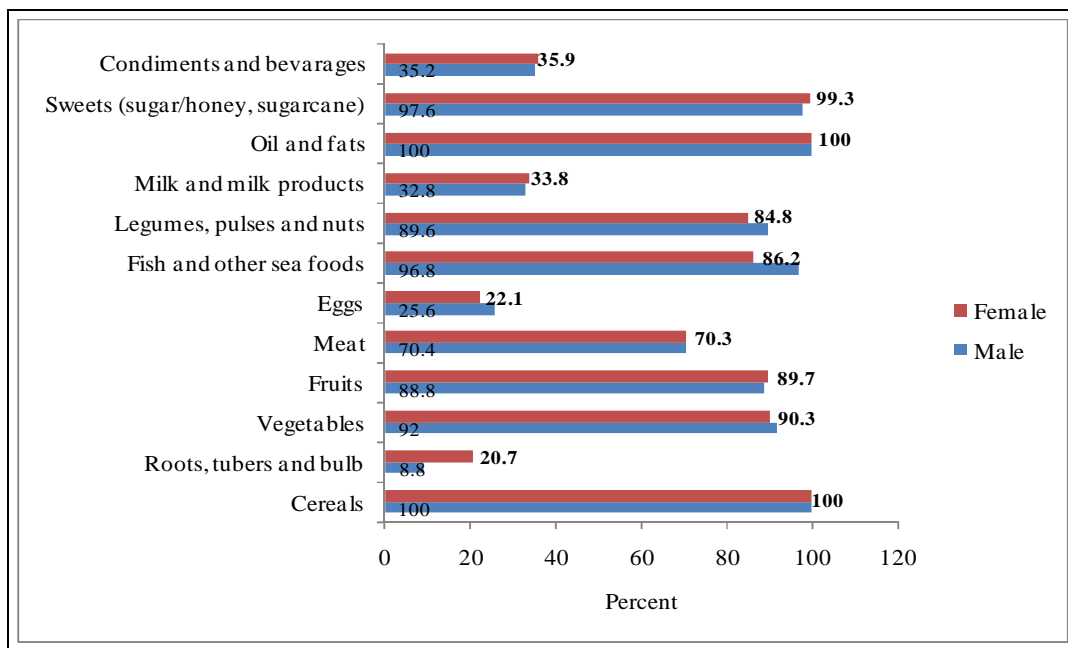


Figure 1: Consumption pattern of various food groups

3.5. Nutrient Adequacy

The mean adequacy ratio for diet was 1.22 ± 0.19. Analysis of variance indicates that there was significance different in NAR among subject sex and MAR was significant correlated with IDDS at p value < 0.05. The average nutrient adequacy ratio for energy was (0.86), fat (1.27), saturated fat (4.15), iron (0.31) and calcium (0.3). The NAR of protein, fat, saturated fat, and calcium were positively correlated with the individual dietary diversity score and has statistical significance at p value < 0.05 (Table 3). Furthermore, the NAR of carbohydrate, fiber and iron were negatively correlated with IDDS. The nutrient adequacy ratio indicates no significant difference in energy intake, iron, zinc and IDDS.

Nutrients	Nutrient adequacy ratio (NAR)			NARs and IDDS	
	All	Male	Female	r	p-value
Energy	0.86	0.85	0.87	0.119	0.051
Protein	1.05	1.11	0.99	0.166**	0.006
carbohydrate	1.10	1.22	0.98	-0.151*	0.013
Fat	1.27	1.36	1.17	0.252**	0.000
Saturated fat	4.15	4.08	4.23	0.287**	0.000
Fiber	1.07	1.19	0.95	-0.140*	0.022
Calcium	0.30	0.28	0.33	0.173**	0.004
Iron	0.31	0.31	0.31	-0.016	0.792
Zinc	0.89	1.00	0.77	0.028	0.652
MAR	1.22	1.27	1.18	0.313**	0.000

Table 3: Nutrient adequacy ratio and correlation between the NARs and IDDS

* Correlation is significant at 0.05

** Correlation is significant at 0.01

^a correlation between NARs and IDDS

4. Discussion

Findings from this study revealed high consumption of energy dense foods from cereals, oil/fats and sugars among the study population. Fruits and vegetables were also frequently consumed though the amount consumed may be questionable as recommended amount per day may not be met as reflected to the observed nutrient adequacy ratio values of iron and calcium (Table 3). Similar finding was found by Balegu (2014), who reported that consumption of fruits and vegetables was less than five recommended servings per day. Low consumption of milk, eggs, roots, tubers and bulb also was observed. The higher consumption of energy dense foods, fruits and vegetables observed may be due to availability and accessibility of these foods in the area. For examples in the study area fruits like watermelon and pineapple are sold in cut pieces and in low price which is affordable to most people. Furthermore, traditional behavior of most families in the study area, used to consume cereal based meal almost in all meals in a day. It is also a custom to use cooking oil and fats in most relish and use of sugar in tea for the breakfast. Roots, tubers and bulbs are consumed seasonally and most often are used to substitute maize, rice and wheat dishes.

Evidence documented from literature (Hatløy *et al.*, 1998; Torheim *et al.*, 2003; Mirmiran *et al.*, 2004), suggest that MAR of 1 means a diet has met recommended nutrients intake. In this study the mean adequacy ratio was 1.22, indicating that the overall dietary adequacy of the population was met. The increment of 0.22 may be attributed by overconsumption of specific dietary nutrient as reported in Table 3. For instance, the nutrient adequacy ratio of saturated fat was four times higher than the truncated value of 1 which indicates more than adequate amount was consumed (Hatløy *et al.*, 1998). Therefore, the higher the observed value for saturated fat the more the chances for fat deposition within the body which may result into increase in metabolic risk factors that are related to chronic diseases which is also reported by Majili and Kinabo (2015). In addition, the observed increment of MAR may be attributed by amount and type of food consumed. For example, the results from IDDS showed that majority of subjects frequently consumed energy dense foods such as cereal based foods oil/fats and sugar (Fig.1). The results also indicated that more than 95% of subjects consume saturated fat beyond acceptable distribution range of 10% of total energy consumed (Table 2). These results are also in line with findings reported by Azadbakht *et al.*, (2005), who observed that consumption of disproportionate different foods groups might be associated with increase in metabolic risk factors that are related to increase in the prevalence of chronic diseases. Moreover, the used formula for MAR may mask the true status of specific nutrients that has been consumed in extra or less amount. For instance, the NAR of calcium and iron was below truncated value of 1 indicating the requirement was not met while the NAR for saturated fat, fat, protein and carbohydrate was beyond 1. Therefore, averaging them will mask inadequacies of other nutrient as each nutrient has its own level of adequacy.

Furthermore, the correlation coefficients of NAR of calcium iron and IDDS was also very low. Similar findings are also found in other studies (Mirmira *et al.*, 2004, Kennedy *et al.*, 2007 and Sealey- Polts *et al.*, 2014) where the correlation coefficient of calcium and iron is less than 0.5. This brings a great concern on using dietary diversity scores as a measure of nutrient adequacy. Despite of high consumption of fruits and vegetables observed among the subjects, most of them consume less micronutrient as indicated by the nutrient adequacy ratio value of iron and calcium (0.3) which was less than 1. It has been observed that high proportion of female subject consumed diet low in iron compared to RDA of 18 mg/day. This may place them in a risk of iron deficiency. More than half of the subjects consumed diet with low zinc content compared to recommended levels of 8mg/day of zinc for female and 11mg/day of zinc for male subjects (FAO & WHO, 2001). The observed micronutrient inadequacy may be contributed by low quantity of micronutrient rich foods that has been consumed by the subjects.

5. Conclusion/Recommendation(s)

Despite the relatively high overall nutrient adequacy ratio observed in this study, the diet consumed by majority of respondents was inadequate in-terms of micronutrients intake such as iron, zinc and calcium. This was because of higher level of consumption of energy dense foods which exceeded the recommended energy intake levels hence pulled the overall mean adequacy ratio for all the studied nutrients. Consumption of energy dense foods among the study population increases the metabolic risk factors for non-communicable diseases. The low NAR of iron, zinc and calcium indicates the requirements were not met and the intake of micronutrient rich foods were sub-optimal hence this will pre-dispose them to diseases and infection. Therefore, the performance of dietary diversity as contributor in nutrient adequacy will depend upon the quantity and proportion of each food group consumed. Therefore, it is important to promote consumption of diversified diets in a right proportion. Further researches are needed to explore the use of overall mean adequacy ratio in determining nutrient adequacy of foods consumed in a population as it involve all inadequacies, adequacies and over consumption of different nutrients.

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