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Original paper

Dietary Variability and Risk of Getting Cancer among Populations in Ilala District, Tanzania

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ABSTRACT: A cross-sectional study was conducted in Ilala district, Tanzania to examine the daily food intake and overall diet of the people, with the aim of determining if there is any correlation between food intake and cancer. The study involved the distribution of questionnaires to 195 students in secondary school that has both day and boarding students in the study area. Questionnaires were designed to collect information about the students' food intake and dietary habits. Data on four type of food: Cereals, Meat and poultry, Fruits and Vegetables were taken to determine the quantity of food taken by the students which enable researcher to determine the amount of micronutrient consumes by the students. Data from the study were analysis using Statistical Package for Social Science (SPSS) version 2010 and results presented in tables. The study reveals that, cereals, meat, poultry and fish, fruits and vegetables are the consumed food groups where by cereals is highly consumed food group(126(64.6%). The micronutrient composition analysis reveal that the students deficient in Fe, Mg and Zn when compared the standard requirement of these micronutrients. The study recommends eating a well-balanced diet to ensure adequate micronutrient intake.

Keywords: Eating habits, micronutrients, cancer
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INTRODUCTION

In the past 50 years, patterns of human food habits and food production have dramatically changed, both in developed and developing countries. From local fresh foods—vegetables, tubers, and animal-sourced foods—and home-cooked basic commodities, we have moved to packaged and processed ready-to-eat or ready-to-heat foods (Novembre and Di Rienzo, Swinburn et al., 2019). These quick modifications, forming part of the so-called "nutrition transition", can severely affect the adaptive biological mechanisms of the human species (Whitmee et a., 2015; Rockström, et al., 2016) and the environment (GBD, 2016).

Gene–nutrient interactions are important contributors to health management and disease prevention. While nutrigenomics and nutrigenetics investigate the relationship between genetic variations and nutrient requirements (Kussmann and Fay, 2008) nutrient-driven epigenetic alterations have been recently proposed as other major contributors that can influence such requirements. Nutrition can alter gene expression, as well as the susceptibility to disease, including cancer, through epigenetic changes (Meeran et al., 2010; Issa, 2008; Suter and Aagaard-Tillery, 2009; Herceg, 2009). During the last decade it has become clearer that nutrition can exert imprinting effects on the human genome, with many studies indicating that early life nutrition could influence the risk of developing chronic diseases in adulthood.

In regard to the role of nutrition in cancer development existing evidence suggests that some dietary components can impact cancer-related epigenetic mechanisms, such as those involved in the activation of tumor suppressor genes, cellular apoptosis, protein translation, and noncoding microRNAs (miRNAs) with roles in mRNA stability and translation (Meeran et al., 2010). Few examples include nutrients such as genistein, resveratrol, polyphenols, and different types of fatty acids. These nutrients, with positive effects on health, are continuously studied in order to establish their epigenetic role as protective factors against cancer, cardiovascular disease, obesity, etc. There are several studies indicating that fruits, tea, vegetables, as well as various dietary compounds, can alter the activation of tumor suppressor genes, increase apoptosis, and the activity of cell survival proteins, thus having a protective role against cancer (Li and Tollefsbol, 2011).

There is convincing evidence indicating that several foods have protective roles in cancer prevention, by inhibiting tumor progression directly or through modifying tumor's microenvironment that leads to hostile conditions favorable to tumor initiation or growth. While nutritional intakes from foods cannot be adequately controlled for dosage, the role of nutrients in the epigenetics of cancer has led to more research aimed at developing nutriceuticals and drugs as cancer therapies. Clinical studies are needed to evaluate the optimum doses of dietary compounds, the safety profile of dosages, to establish the most efficient way of administration, and bioavailability, in order to maximize the beneficial effects already discovered, and to ensure replicability. Thus, nutrition represents a promising tool to be used not only in cancer prevention, but hopefully also in cancer treatment (Issa, 2008).

Problem statement

For their existence, living organisms need food nutrients, however these food nutrients has been closely linked to cause cancer diseases. Nutrients can influence the epigenetic status through several mechanisms, such as DNA methylation, histone modifications, and miRNA-dependent gene silencing. These alterations were associated with either increased or decreased risk for cancer development. The study points on evaluating if there is a link between diet and cancer.

Research questions

1. Is there any relationship between diet and cancer?
2. Is food quantity consumed reduce or increase risk of getting cancer?

Broad objective

To assess dietary variability and the risk of getting cancer.

Specific objectives

Assessment of food groups involved in our daily lives Determination of the food quantity consumed by the people. Assessment of risk increasing and risk reducing type of food.

Literature review

The search for a connection between diet and human cancer has a long history in cancer research, as has interest in the mechanisms by which dietary factors might increase or decrease cancer risk. The realization that altering diet can alter the epigenetic state of genes and that these epigenetic alterations might increase or decrease cancer risk is a more modern notion, driven largely by studies in animal models. However, the conclusion that diet is linked directly to epigenetic alterations and that these epigenetic alterations directly increase or decrease the risk of human cancer is much less certain (Aagaard-Tillery et al., 2018). In fact, many dietary components have the potential to influence the biochemistry of methylation; so far, however, most of the measurable effects have been observed in animal models operating at the extremes of exposure regimes that are of questionable significance to human health. For example, the dietary exposures demonstrated to have the largest measurable effects on the epigenome have been associated most often with effects on offspring after exposure in utero (Patel et al., 2015). In 2003, a supplement was published by the *American Journal of Clinical Nutrition* that is fully devoted to promoting the nutrition ecology discipline as an interdisciplinary science with special consideration of the effects of nutrition on health, environment, society, and economy.

How nutrition is linked to cancer

Migration

Epidemiologic studies have long suggested links between diet, nutrition, and many forms of cancer. Perhaps the most provocative early data that suggested a true link between diet and an individual's risk of cancer were from studies in the 1970s and 1980s, which compared cancer These studies showed multiple differences in site-septic cancer incidence. Upon moving to the United States, Japanese immigrants showed a substantial increase in colorectal cancer and less dramatic increases in breast and ovarian cancers (96), mirroring the site-septic incidence of the European-derived resident population of the United States (Menck, et al., 1975). Menck et al. (1975) compared the incidence of immigrants to the United States and their native-born offspring to the incidence in their place of origin. As a result of such migration studies, many subsequent studies have searched for an association between healthy or prudent diets (characterized, generally, as rich in fruits and vegetables and whole grains low in intake of fats and red and processed meats) and lower cancer risk. Epidemiologic data from individual studies in which diets were categorized by food frequency questionnaires generally found that Western diets were associated with higher risk of colon and breast cancer (Hu et al., 2007; Key et al., 2002; Newmark et al., 2009).

In comparison with prudent or whole-foods diets, but the effects were often small and difficult to reproduce. For these reasons, meta-analyses and systematic literature reviews give a more robust picture of the effects of individual dietary components on cancer risk.

Moreover, there appeared to be a migratory exchange of cancers of the type more common in the country of origin for cancers of the type more common in the adopted country. The Japanese, for example, witnessed a steep decline in the incidence of stomach, liver, and esophageal cancers upon moving to the United States, concurrent with the observed increases in breast, ovarian, and colorectal cancer (Thomas and Karagas, 1987). The decline in stomach cancer, in particular, was also hypothesized to be due to changes in diet (Thomas and Karagas, 1987). In an unfortunate twist on the migration of Japanese people to places where Western diets are consumed, Western diets have increasingly migrated to Japan, with a corresponding increase in the incidence of colon cancer (Takachi et al., 2011).

An additional all-important but unstated assumption implicit in the hypothesis that nutrition and dietary components influence cancer risk by altering the epigenome (and all hypotheses involving a role for the environment in shaping the epigenome) is that an individual's environmental exposure history may be recorded as epigenetic alterations in the cellular genome of normal tissues. Unless such changes are very transient (and thus do not qualify as epigenetic alterations in the original sense of the term), the existence of such a "molecular fossil record" (Turan et al., 2012) of individual environmental exposures has the potential to be both diagnostic and prognostic in any disease in which gene–environment interactions are thought to be significant

Nutrition and cancer

Nutrients can influence the epigenetic status through several mechanisms, such as DNA methylation, haistone modifications, and miRNAs-dependent gene silencing. These alterations were associated with either increased or decreased risk for cancer development (Lundstrom, 2014; Ross SA, Davis,2011; Ong et al., 2011). Nutrient-driven epigenetic alterations have been recently proposed as other major contributors that can influence such requirements. Nutrition can alter gene expression, as well as the susceptibility to disease, including cancer, through epigenetic changes (Meeran et al., 2010; Issa, 2008). Diets that would decrease the risk for cancer were proposed based on epidemiological studies that evaluated the cancer risk correlated with food intakes. Such diets should include an adequate calorie count , daily fruit and vegetables intakes, no refined sugar and flour, no red meat, low fat foods but which have essential fatty acids with a balanced ratio of omega-3 and omega-6 such as flax seed, antioxidants and photochemical (α-carotene, β-carotene, β-cryptoxanthin), chlorophyll, and adequate vitamin intakes that can also be achieved by supplementation with selenium, methylcobalamin (B-12), folic acid, vitamin D, proboscis, and enzymes (Donaldson, 2004).

Apart from the influence of nutrient intakes, the contamination of food with carcinogenic agents was also studied. The grains and peanuts can be contaminated with Aflatoxin B produced by Aspergillus, and it is associated with increased risk for liver cancer. Some carcinogenic compounds are formed during food preparation (World Cancer Research Fund/American Institute for Cancer Research, 2007). Meat cooked at high temperatures, grilled (broiled) or barbecued (charbroiled) over a direct flame, can contain heterocyclic amines and polycyclic aromatic hydrocarbons. Environmental pollution was also associated with foods contaminated with polycyclic aromatic hydrocarbons. Meat and fish preserved with salt or other preservatives, smoked or dried, can contain N-nitroso compounds, which were associated with an increased risk for stomach and colon cancer (World Cancer Research Fund/American Institute for Cancer Research, 2007).

Nutrition and cancer epigenetic

DNA methylation patterns can be altered globally (throughout the entire genome) or at specific sites (Zhang, 2015; Altmann et al., 2012; Dudley et al., 2011). The DNA methylation mechanisms depend on the availability of methyl-donors , such as those provided by the one-carbon cycle, as well as on cofactors that modulate the enzymatic activity of DNA methyltransferases (DNMTs) (Zhang, 2015). S-Aenosylmethionine (SAM) is the only known physiological donor of methyl groups, allowing their transfer to cytosine (which becomes methylated, 5mC) (Feil and Fraga, 2012). S-Aenosylmethionine (SAM) is synthesized, via methionine, from different dietary precursors (folate, choline, and betaine), using homocysteine as methylation substrate (Zeisel, 2009). It was reported that the reduced availability of methyl donors resulted in low SAM synthesis, which resulted in DNA methylation alterations (either hypermethylation or hypomethylation, depending on the tissue type and developmental stage), while increased availability of methyl donors was usually associated with DNA hypermethylation (Cheng and Blumenthal, 2008; Niculescu and Lupu, 2011). DNA hypermethylation can result in the transcriptional silencing of tumor suppressor genes, causing their inactivation and, subsequently, malignant transformation for several cancer types, while DNA hypomethylation is involved in the activation of proto-oncogenes (Wajed et al., 2001).

DNA hypomethylation was associated with increased risk for many types of cancers including chronic lymphocytic leukemia, breast and ovarian cancer, prostate cancer, and liver cancer (Liao et al., 2014; Yang et al., 2001]. The hypomethylation of intragenic regions and repetitive sequences was proved to be causal for genome instability due to DNA breakage, and to induce loss of imprinting for some promoters, thus increasing the risk for cancer development (Daniel and Tollefsbol, 2015). Apart from the role in cancer initiation, DNA hypomethylation in cancer cells was suggested to indicate poor prognosis for specific types of ovarian cancer (Bishop and Ferguson, 2015; Herman and Baylin, 2003).

METHODOLODY

The study will be carried out in Ilala district. Ilala District, officially the Ilala Municipal Council is one of five districts of the Dar es Salaam Region of Tanzania. The district is bordered to the north and northeast by Kinondoni District and Ubungo District, to the east by the Zanzibar Channel, the west by Pwani Region, and to the south by the Temeke District.

Data collection

The study data came from original sources. A structured questionnaire was used to gather the information from 195 students. One school of both day and boarding from Ilala District was chosen because it population size and its closeness to the researcher. The socio-demographic characteristics of 195 students who act as respondents of the study were collected. The characteristic recorded are age group in years and body weight. Data on four type of food: Cereals, Meat and poultry, Fruits and Vegetables were taken to determine the quantity of food taken by the students which will enable researcher to determine the amount of micronutrient consume by the students.

RESULTS

Socio-demographic characteristics

Table 1 shows the socio-demographic characteristics of 195 students who act as respondents of the study. The characteristic recorded are age group in years and body weight. The (Table 1) showed that out of the 195 respondents, 16(8.0%) were 20-35kg, 104(52%) were 36-50kg while 85(40%) were 51-65kg. The most respondents were the age group 16-18 years which is about 130(65.0%), followed by age group 12-15 years with 44(22.0%) and lastly is age group 19-21 years with 21(13.0%).

Food group intake and micronutrients adequacy

The result provided in (Table 2) are the estimation of one meal that is lunch meal and is due to shortage of time and also the school has both day and boarding students so it is only lunch meal that similar to all. By the day research was conducted the student had stiff porridge, beef, spinach and banana as a lunch meal. Therefore estimation will base on this lunch meal specifically. The micronutrients of interest are iron (Fe), zinc(Zn) and magnesium (Mg), so estimation of all micronutrients was based on every food sample in the lunch meal so as to see how much does the lunch meal contribute in micronutrients adequacy. Table 2a and b show the classification of the food groups and food type.

Assumption, all students ate the same amount of the three food groups except cereals, while in cereals had those who choose 150g, 200g and other 250g. And it is cereals group that will differentiate the intake in each group. Table 3 shows the frequency and percentage of each age group in every grams of cereals they take where by a total 126(64.6%) of age group 16-18yrs gives the high readings in all grams.

Estimation of selected micronutrients

Table 4 shows the estimated amount of selected micronutrients in each food sample so that to know how much of lunch contributes to one day intake of micronutrients. From the tables magnesium gives high count of micronutrients from all the food sample while for iron and zinc count depends on specific food sample.

Micronutrients intake of each age group per specific gram of cereals

Tables 5a, b and c show the intake of each micronutrients of each age group per a specific gram of cereals. All the groups had the same intake of meat, poultry and fish, fruit and vegetables group, therefore it is the amount of stuff porridge that is cereals group taken that would differentiate the intake. These tables give the contribution of selected micronutrients from lunch meal, so the results provided are only for lunch so that we can know how lunch can contribute per day intake.

Table 1: socio-demographic characteristics of 195 students.

Demographic data		Frequency	Percentage
Age groups	12-15	44	22.0%
	16-18	130	65.0%
	19-21	21	13.0%
	Total	195	100.0%
Weight	20-35	16	8.0%
	36-50	104	52.0%
	51-65	85	40.0%
	Total	195	100.0%

Table 2a: Food sample in specific food group.

Food groups	Food sample/type
Cereals	Stiff porridge
Meat and poultry	Beef
Fruits	Banana
Vegetables	Spinach

Table 2b: Food weight intake by students.

Food groups	Food sample/type	Food type weight (g)		
Cereals	Stiff porridge	150	200	250

Table 3: Age distribution of students and percentage weight food type intake.

Age group	Amount of stiff porridge taken			Total
	150g	200g	250g	
12-15	19(44.2%)	16(37.2%)	8(18.6%)	43(22.1%)
16-18	74(58.7%)	40(31.74%)	12(9.52%)	126(64.6%)
19-21	10(38.5%)	14(53.8%)	2(7.7%)	26(13.3%)
Total	103(52.8%)	70(35.9%)	22(11.3%)	195(100%)

Table 4: Estimated amount of micronutrient in selected food group/food type.

Food group	Food sample/type		Fe	Zn	Mg
Cereals	\Stiff porridge	Std	1.3mg/100g	0.5mg/100g	4.5mg/100g
		150g	1.95mg	0.75mg	6.75mg
		200g	2.60mg	1.00mg	9,00mg
		250g	3.25mg	1.25mg	11.25mg
Meat and poultry	Beef relish with oil	Std	0.6mg/100g	1.4mg/100g	10.7mg/100g
		2 piece(72g)	0.43mg	1.00mg	7.70mg
Fruits	Banana	Std	0.3mg/100g	0.2mg/100g	27mg/100g
		50g	0.15mg	0.1mg	13.5mg
Vegetables	Spinach relish with oil	Std	2.2mg/100g	0.3mg/100g	45.7mg/100g
		50.66g	1.11mg	0.15mg	23.15mg

Total contribution of each selected micronutrients per grams of stiff porridge

Tables (6a-c) below show the total intake of each micronutrient contributed per each gram of stiff porridge taken with the summation of contributed micronutrients from other food groups. It is the amount of the stiff porridge that differentiate the total intake. Table 7 provides the standard values of micronutrients supposed to be taken per day, therefore we use these values to compare with the total micronutrients taken in a specific age group to see the contribution.

DISCUSSION

Food and nutrition are the way that we get fuel, providing

Table 5a: Intake of each micronutrients of each age group per 150 gram of each food type.

Food groups	micronutrient	Stiff porridge	Beef	Banana	Spinach	Total
12-15 yrs	Fe	1.95mg	0.43mg	0.15mg	1.11mg	3.64mg
	Zn	0.75mg	1.00mg	0.1mg	0.15mg	2.00mg
	Mg	6.75mg	7.70mg	13.5mg	23.15mg	51.1mg
Total		9.45mg	9.13mg	13.75mg	24.41mg	56.74
16-18 yrs	Fe	1.95mg	0.43mg	0.15mg	1.11mg	3.64mg
	Zn	0.75mg	1.00mg	0.1mg	0.15mg	2.00mg
	Mg	6.75mg	7.70mg	13.5mg	23.15mg	51.1mg
Total		9..45mg	9.13mg	13.75mg	24.41mg	56.74mg
19-21yrs	Fe	1.95mg	0.43mg	0.15mg	1.11mg	3.64mg
	Zn	0.75mg	1.00mg	0.1mg	0.15mg	2.00mg
	Mg	6.75mg	7.70mg	13.5mg	23.15mg	51.1mg
Total		9.45mg	9.13mg	13.75mg	24.41mg	56.74mg

Table 5b: Intake of each micronutrients of each age group per 200 gram of cereals.

Food groups	micronutrient	Stiff porridge	Beef	Banana	Spinach	Total
12-15 yrs	Fe	2.60mg	0.43mg	0.15mg	1.11mg	4.29mg
	Zn	1.00mg	1.00mg	0.1mg	0.15mg	2.25mg
	Mg	9.00mg	7.70mg	13.5mg	23.15mg	53.35mg
Total		12.6mg	9.13mg	13.75mg	24.41mg	59.89mg
16-18 yrs	Fe	2.60mg	0.43mg	0.15mg	1.11mg	4.29mg
	Zn	1.00mg	1.00mg	0.1mg	0.15mg	2.25mg
	Mg	9.00mg	7.70mg	13.5mg	23.15mg	53.35mg
Total		12.6mg	9.13mg	13.75mg	24.41mg	59.89mg
19-21yrs	Fe	2.60mg	0.43mg	0.15mg	1.11mg	4.29mg
	Zn	1.00mg	1.00mg	0.1mg	0.15mg	2.25mg
	Mg	9.00mg	7.70mg	13.5mg	23.15mg	53.35mg
Total		12.6mg	9.13mg	13.75mg	24.41mg	59.89mg

Table 5c: Intake of each micronutrients of each age group per 250g of cereals.

Food groups	micronutrient	Stiff porridge	Beef	Banana	Spinach	Total
12-15 yrs	Fe	3.25mg	0.43mg	0.15mg	1.11mg	4.94mg
	Zn	1.25mg	1.00mg	0.1mg	0.15mg	2.5mg
	Mg	11.25mg	7.70mg	13.5mg	23.15mg	55.6mg
Total		15.75mg	9.13mg	13.75mg	24.41mg	63.0mg
16-18yrs	Fe	3.25mg	0.43mg	0.15mg	1.11mg	4.94mg
	Zn	1.25mg	1.00mg	0.1mg	0.15mg	2.5mg
	Mg	11.25mg	7.70mg	13.5mg	23.15mg	55.6mg
Total		15.75mg	9.13mg	13.75mg	24.41mg	63.0mg
19-21yrs	Fe	3.25mg	0.43mg	0.15mg	1.11mg	4.94mg
	Zn	1.25mg	1.00mg	0.1mg	0.15mg	2.5mg
	Mg	11.25mg	7.70mg	13.5mg	23.15mg	55.6mg
Total		15.75mg	9.13mg	13.75mg	24.41mg	63.0mg

energy for our bodies. We need to replace nutrients in our bodies with a new supply every day. Water is an important component of nutrition. Fats, proteins, and carbohydrates are all required. Maintaining key vitamins and minerals are also important to maintaining good health. The effective management of food intake and nutrition are both key to good health. Smart nutrition and food choices help prevent disease. Eating the right foods can help your body cope more successfully with an ongoing illness (Sieri et al., 2012). The study focuses on the contribution of lunch meal in micronutrient adequacy in the meal of the 195 respondents so as to see how much lunch meal contribute per day. The study has established the contribution of food group's intake to micronutrients adequacy from only one meal that is lunch. This was based on areas of food group taken, amounts as well as the micronutrients contained in the specific food group (Tables 2 to 7). The study used stiff

Table 6a: Total intake of each micronutrient contributed per each gram of stiff porridge taken.

		150g			
Food groups	**Food sample**	**Fe**	**Zn**	**Mg**	**Total**
Cereal-based local dishes	Stiff porridge	1.45	0.75	6.75	9.45
Meat, poultry (including eggs), fish-based local dishes	Beef relish with oil	0.43	1.00	7.7	9.13
Fruits	Banana	0.15	0.1	13.5	13.75
Vegetables	Spinach relish with oil	1.11	0.15	23.15	24.41
Total		3.64	2.00	51.10	56.74

Table 6b: Total intake of each micronutrient contributed per each gram of stiff porridge taken.

	200g				
Food groups	**Food sample**	**Fe**	**Zn**	**Mg**	**Total**
Cereal-based local dishes	Stiff porridge	2.60	1	9	12.6
Meat, poultry (including eggs), fish-based local dishes	Beef relish with oil	0.43	1.00	7.7	9.13
Fruits	Banana	0.15	0.1	13.5	13.75
Vegetables	Spinach relish with oil	1.11	0.15	23.15	24.41
Total		4.29	2.25	53.35	59.89

Table 6c: Total intake of each micronutrient contributed per each gram of stiff porridge taken.

	250g				
Food groups	**Food sample**	**Fe**	**Zn**	**Mg**	**Total**
Cereal-based local dishes	Stiff porridge	3.25	1.25	11.25	15.75
Meat, poultry (including eggs), fish-based local dishes	Beef relish with oil	0.43	1.00	7.7	9.13
Fruits	Banana	0.15	0.1	13.5	13.75
Vegetables	Spinach relish with oil	1.11	0.15	23.15	24.41
Total		4.94	2.50	55.60	63.04

porridge as cereals group sample, beef as meat, poultry and fish group sample, banana and spinach as fruit and vegetable food sample respectively.

Food groups taken

The study reveals that, cereals, meat, poultry and fish, fruits and vegetables are the consumed food groups where by cereals is highly consumed food group. These results reflect the feeding patterns of most of the people as well as school settings where cereals are usually taken at large amounts. Also the study confirms that meat, poultry and fish, fruit and vegetables are consumed in low quantity, and the results confirms that about 90% of girls failed to consume the recommended amount of fruits, vegetables and dairy, and about 75% consumed less than the recommended amounts of meat group (1).

Fruits and vegetables food consumption

Also the study shows the contribution of fruits and vegetables food groups where banana and spinach were used as food sample. The two groups are rich in magnesium unlike the other micronutrients but at some point vegetables give high count of iron (Table 6c).

Micronutrients contribution

Based on study, the results confirm that the contribution of lunch meal to recommended micronutrients intake per day is inadequate for zinc and magnesium. This is because of the food sample taken that is some of the food types students had for lunch are poor contributors of zinc and magnesium, for example fruits have 0.1mg of zinc (Table 6).

About all age groups who consumed 150g of stiff porridge they do not get enough micronutrients that can contribute enough in the recommended intake of the day.

Table 7: Recommended Dietary Allowance

Age group	Fe (mg)	Mg (mg)	Zn (mg)
9-13yrs	8	240	8
14-18yrs	18	360	9
19-20yrs	18	310	8

Also for the case of the other two grams, 200g and 250g, Zinc and Magnesium are inadequately taken from lunch meal as compared to the recommended intake (Table 7). This is derived by comparing the total amount of a particular selected micronutrients and the recommended dietary allowance per day of the same micronutrient in specific age group, so that to see how much has been contributed so that to come up the conclusion.

The contribution of food groups and subgroups to micronutrient adequacy depends on several factors—nutrient composition of the individual foods in a group/subgroup, the mix of foods eaten within the food group/subgroup, the amount of each consumed, and the correlation of intakes within and between food groups. For example, whole grain consumption might be correlated with fruit consumption among individuals focusing on a healthy diet while higher red meat intake might be correlated with consumption of starchy vegetables (e.g., French fries) in other individuals. Thus, correlated eating patterns may obscure the true nutrient contribution of individual foods or food groups (2).

On the other hands, nutrient density can affect the intake, this concept means food samples in the same food group can have count of micronutrients of which this also affect the contribution. For example, one person can have rice with and another person can have ugali with beans, if you estimate micronutrients taken for the two cases, you might find the difference though rice and ugali are from the same food group. Therefore nutrients density of the food sample is also one of the factor that affect the intake.

Conclusion

The study shows that majority of adolescents girls does not meet the dietary intake recommendations and is due to poor balance diet. Most of the students at school consume a lot of cereals that lead to inadequate of several micronutrients which are rich in other food groups such as dairy and vegetable. Also the amount a person consumes has effects on the quantity of micronutrients gained from particular food stuff. So if a person consume below the normal amount, obviously this person will have low count of micronutrients gained and vice versa. For adequate micronutrients count, adolescent secondary school girls should have a diet mixed up with energy dense, nutrients rich foods and less energy dense food so that to attain the recommended dietary allowance one should have per day, hence good health.

Recommendations

Intake of various food types is critical in each human being because this is where a human body obtains necessary nutrients for all bodily functions. A balanced diet is the simplest way to obtain many micronutrients from various food groups at the same time. As a result, the study recommends eating a well-balanced diet to ensure adequate micronutrient intake.

Also, the study suggests that one should have a mixer of energy dense food, nutrients rich food such as dairy products and meats and less energy dense food. All this gives a good contribution on micronutrients adequacy.

Knowledge should also be provided regarding what food groups are of more important, how much to have and when to have so that to have a perfect ratio that would lead to micronutrients adequacy among adolescent secondary school girls.

Schools should ensure at some point, students get some nutritious food of which it will boost their micronutrients count.

At individual level, everyone should make sure they comply with the recommended dietary requirements after knowledge provision for the benefit of yourself and national at large since health is the number one capital.

And lastly, a greater focus on the optimal number of food groups/week or per day could increase awareness of the importance of a varied diet and encourage promotion of food based approaches as opposed to fortified single food approaches.

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