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ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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# Nutrient Intakes of Adolescent Girls in Secondary Schools and Universities in Abia State of Nigeria

J.U. Anyika[1], A.C. Uwaegbute[1], A.O. Olojede[2] and J.U. Nwamarah[3]
[1]Department of Human Nutrition and Dietetics, Michael Okpara University of Agriculture, Umudike, P.M.B. 7267, Umuahia, Abia State, Nigeria
[2]Sugar Beet and ORC Improvement Programme, National Root Crops Research Institute, Umudike, P.M.B. 7006, Umuahia, 440001, Abia State, Nigeria
[3]Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka, Nigeria

**Abstract:** A total of 160 adolescent girls aged 10 to 19 years were surveyed for nutrient intake. Three-days weighed food intake was the technique used for this study. Subjects were from model secondary schools and universities in Abia State, Nigeria. The values for food nutrients were calculated using food composition tables. Foods that were not in the food composition tables were analyzed chemically in the laboratory to know their nutrient contents. Values from the chemical analysis were used for the calculation of food nutrients. The mean intakes in all the nutrients tested for adolescent female university students were significantly higher ($p<0.05$) than those of adolescent female secondary school girls. Both adolescent female secondary school and university students, however, had nutrient intakes higher than FAO requirements except for iron intake where the secondary school girls did not meet the requirement for iron (36-42 g/day). Snacks contribution to the daily nutrient intakes of the adolescent female secondary school students were significantly higher ($p<0.05$) than those of the university students except for the carbohydrate intake (146.66 g vs 170.26 g) respectively. It is therefore necessary to evaluate the quality of meals and snacks served to both secondary school and university students to know their contribution to nutrient intake in order to alleviate the problem of malnutrition in adolescent female Nigerian students.

**Key words:** Adolescent females, nutrient intake, malnutrition, secondary school students

## INTRODUCTION

Adequate nutrient intake during adolescence is very important for many reasons. Adolescence is a particularly unique period of life because it is a time of intense physical, psychological and cognitive development. Adolescence is a transition phase to adulthood. The age of adolescence encapsulates a window of time when bodies are metamorphosing and evolving into that of an adult. It is a time when the adolescent tries to establish his own identity yet desperately seeks to be socially accepted by his peers (Lulinski, 2001). During adolescence hormonal changes accelerate growth in height. Growth is faster than at any other time in the individual's life except the first year (Brasel, 1982). Increased nutritional needs at this juncture relate to the fact that adolescents gain up to 50% of their adult weight, more than 20% of their adult height and 50% of their adult skeletal mass during this period (Brasel, 1982). The adolescents therefore face series of serious nutritional challenges which would impact on this rapid growth spurt as well as their health as adults. However, the adolescents remain a largely neglected, difficult-to-measure, hard-to-reach population. Consequently, their needs, particularly those of adolescent girls are often ignored (Kurz and Johnson -Welch, 1994).

At this developmental stage, protein requirements are maximal. Increased physical activity, combined with poor eating habit and other considerations, for example, menstruation, oral contraceptive use and pregnancy contribute to accentuating the potential risk for adolescents of poor nutrition. The main nutritional problems affecting adolescent populations worldwide and Nigeria in particular include under-nutrition in terms of stunting and wasting. Others are deficiencies of micronutrients such as iron and vitamin A, obesity and other specific nutrient deficiencies (Kurz and Johnson-Welch, 1994).

Adolescents because they are still growing, who enter into marriage with poor nutritional status are likely to give birth to smaller infants than mature women of the same nutritional status (WHO, 1995) because of the competition for nutrients between the growing adolescent and the growing fetus (Scholl *et al*., 1990) and poorer placental function (Olson, 1987). Under-nourished adolescent girls and women give birth to underweight and often stunted babies. These infants are less able to learn as young children and are more likely themselves to be parents to infants with intrauterine growth retardation and low birth weight. However, they are less able to generate livelihoods and are less well equipped to resist chronic diseases in later life. Such lifecycle and intergenerational links demand sustained, long-term ameliorative action (ACC/SCN, 2000).

As a result of all these factors, attention will be focused on strategies for assessing the nutrient intakes of adolescent girls in secondary schools and universities in Abia State.

## MATERIALS AND METHODS

**Study area:** This study was conducted in Umuahia North and Ikwuano Local Government Areas (LGAs) of Abia State, Nigeria. Umuahia North LGA occupies a land mass of 14.464 square kilometers while Ikwuano LGA occupies a land mass of 268.710 square kilometers. Majority of the indigenes in Abia State are farmers and others are civil servants, teachers, business men and craftsmen.

**Population and sample-size determination:** The sample size was calculated using the formula:

$$n = \frac{Z^2 P(100-P)}{X^2}$$

Since the sample was large n > 30 an acceptable margin of error (Z) of 1.96 at 95% Confidence Interval was used.

Since Z = 1.96, it was approximated to 2.

P = Percentage of adolescent girls assumed have poor nutritional status. P was taken to be 62% since National Micronutrient Survey (1993) found prevalence of poor iron status in women of reproductive age to be 62%.

100-P = Percentage of adolescent girls assumed to have good nutritional status.

X = Width of Confidence Interval or required precision level taken to be 5%.

n = Sample size

This gave the sample size of 376.96 which was approximated to 377.

This figure for one school was increased to 400 to make up for drop-outs. Four hundred adolescent girls aged 10-19 years were chosen from each school (two Secondary Schools and two tertiary institutions). The total population of adolescent girls studied was 1600.

A sub-sample of 160 adolescent girls (10% of total population) was used for nutrient intake study. Forty adolescent girls were systematically selected from each school.

**Preliminary visits:** List of all the Secondary Schools with boarding facilities in Umuahia North and Ikwuano LGAs were gotten from Ministry of Education out of which, two Secondary Schools (one school from Umuahia North LGA and the other from Ikwuano LGA) and two tertiary institutions (one from Umuahia North and the other from Ikwuano LGA) were selected. Preliminary visits were also made to the Principals of schools and the Head of Departments of the chosen Universities. The purpose of the study and methods of the study were explained to them and their cooperation was sought.

**Sampling:** Names of all the boarding schools in Umuahia North and Ikwuano LGAs of Abia State were compiled and a random selection of schools was done to select two Secondary Schools and two tertiary institutions with hostel facilities. The Secondary Schools selected were Girls Secondary School Umuahia in Umuahia North LGA and Senior Science School Ariam in Ikwuano LGA. The Universities selected were Michael Okpara University of Agriculture, Umudike (MOUAU) in Ikwuano LGA and Abia State University (ABSU), Umuahia Campus in Umuahia North LGA.

**Study design:** The study used WHO (2000) definition of adolescents. Quantitative data collection method was used. The age groups were 10-13 years, 13.1 month-16 years, 16.1 month-19 years.

**Food intake:** Three days weighed food intake was used to measure the nutrient intake of adolescent girls. Two out of the three days was a weekday while the third day was a weekend. Schools were visited early in the morning and data on food intake collected until after supper. Their nutrient intake was calculated according to the methods given by Olusanya (1977).

Subjects were asked to estimate snacks/meals eaten outside school/home food service, using household measures and selling weights. Nutrient intakes from snacks/meals that are not in the food composition table were calculated using results from chemical analysis of these foods.

**Chemical analysis:** Chemical analysis of local recipes for which no values were available in the food composition tables was done. Samples of food items were collected from subjects in sealed plastic bags and preserved in a cooler with ice packs for storage in a deep freezer (-20°C) before they were analyzed by a method that estimates the nutrient content of these foods.

**Nutrient analysis:** All nutrients were determined in triplicates. Proximate, minerals and ascorbate were determined using the standard methods of Association of Official Analytical Chemists (AOAC, 1995). Total fat was determined using Tecator-Soxtec apparatus according to the manufacturer's instructions (Pearson, 1976).

**Data analysis:** Information gathered from nutrient intake study was coded using the computer program Excel Microsoft worksheet and analyzed using the computer program Statistical Software package (SAS) Genstat

Discovery edition. Mean energy and nutrient intake (protein, fat, carbohydrate, vitamin A, iron and vitamin C) values for the three days dietary intake for each subject were obtained from Tables of representative values of foods commonly used in tropical countries (Platt, 1975), and Nutrient composition of commonly eaten foods in Nigeria-raw, processed and prepared (Oguntona and Akinyele, 1995). Analyzed foods were also used for the calculation of nutrient intake. Mean energy and nutrient intakes were compared with FAO standards.

## RESULTS AND DISCUSSION

The energy and nutrient intake of foods and energy and nutrient intake contribution of snacks of subjects are shown in Table 1 and 2 respectively. As shown in Table 1, the mean energy intake of the secondary school girls was 16059.54 KJ per day while those of the university girls were 24077.76 KJ per day. The mean energy intake of both the secondary school and university girls were significantly different from each other ($p<0.05$) and were higher than the FAO/WHO/UNU (1985) standards recommended for their age and activity pattern. The FAO/WHO/UNU standard recommended that the energy intake per day for adolescent girls aged 10-19 years should range from 8190-9030 KJ/day for the different age groups.

Table 1: Energy and nutrient intake of subjects*

| Nutrient | Secondary School | University |
|---|---|---|
| Energy (KJ) | 16059.54$^b$ | 24077.76$^a$ |
| Carbohydrate (g) | 757.10$^b$ | 937.60$^a$ |
| Protein (g) | 93.45$^b$ | 135.39$^a$ |
| Fat (g) | 49.97$^b$ | 157.09$^a$ |
| Iron (mg) | 31.68$^b$ | 37.14$^a$ |
| Vitamin A (µg retinol) | 6296.10$^b$ | 9135.20$^a$ |
| Ascorbic acid (mg) | 94.15$^b$ | 179.71$^a$ |

*Mean of energy and nutrient intake; $^{a,b}$Values with different superscript letters on the same row differ significantly at $p<0.05$

Table 2: Contribution of snacks to energy and nutrient intake of subjects*

| Nutrient | Secondary School | University |
|---|---|---|
| Energy (KJ) | 4142.61$^a$ (25.80%) | 3831.35$^b$ (15.91%) |
| Carbohydrate (g) | 146.66$^a$ (19.37%) | 170.26$^a$ (18.16%) |
| Protein (g) | 16.90$^a$ (18.09%) | 12.62$^a$ (9.32%) |
| Fat (g) | 34.64$^a$ (69.32%) | 13.17$^b$ (8.38%) |
| Iron (mg) | 5.63$^a$ (17.77%) | 4.35$^b$ (11.71%) |
| Vitamin A (µg retinol) | 409.76$^a$ (6.50%) | 299.87$^b$ (3.28%) |
| Ascorbic acid (mg) | 21.59$^a$ (22.93%) | 12.29$^b$ (6.84%) |

*Mean of energy and nutrient intake; $^{a,b}$Values with different superscript letters on the same row differ significantly at $p<0.05$

This study contrasts with Nnanyelugo and Okeke's (1987) study of university students in halls of residence which showed that energy intake decreased from the late teens to early adulthood. The energy intake was higher than the FAO/WHO requirements in all the schools studied. Requiring resolution is whether there is either an advantage or disadvantage in maintaining such high energy intakes.

Snacks contributed 4142.61 KJ and 3831.35 KJ which yielded 25.80% and 15.91% to the total daily energy intake of secondary school and university adolescent girls respectively. The energy contribution of snacks for the secondary school and university girls were significantly different from each other ($p<0.05$) (Table 2). The adequate energy intake observed for both secondary and university adolescent girls actually resulted from the student's high snack intake. The lower intake of snacks by university girls as compared with their secondary school counterparts could be explained by the observational study which revealed that most of the university girls either cooked their own meals or ate from hawkers around which resulted in their choosing from the varieties available and their eating what they liked while the secondary school girls must ate whatever that was offered in the school refectory and resorted more to snacks.

This finding agrees with Ene-Obong and Akosa (1993) which stated that female adolescents had more varieties of snacks and skipped meals less often. The contribution of snacks to the daily energy intake in this study was lower than what was observed in Scottish children where snacks contributed 26% of the total daily energy intake (Ruxton *et al*., 1996). Cases of high snack intake among adolescents have been reported by Adamson *et al*. (1996) in a survey conducted in 379 UK children, 11-12 years old which revealed that eating outside the home accounted for 30% of daily energy intake. A study of the eating pattern of adolescents in the Western Cape also showed that urban black and white 11-year old children consumed about one third of their mean energy intake as snacks (Steyn *et al*., 1990). The adolescent secondary school and university girls in this study adopted a "grazing" pattern of eating which is characterized by small meals at frequent intervals or a series of snacks.

The CHO intake (Table 1), for both secondary school and university girls was generally high. The mean CHO intake for the secondary school girls was 757.10 g while the university girls had the mean CHO intake of 937.60 g per day. The mean CHO intake of the secondary school and university students was significantly different from each other ($p<0.05$).

The mean CHO contribution of snacks was 146.66 g (19.37%) and 170.26 g (18.16%) of the total daily energy intake for both the secondary and university adolescents. The mean CHO contribution of snacks for both the secondary school and university adolescents were significantly different ($p<0.05$).

The high CHO intake in this study showed that most of the diets consumed by secondary school and university girls were CHO dominated. This was not surprising as the foods commonly consumed are roots and tubers made into various products and cereal grains especially rice. The high CHO intake in the current study agrees with an earlier study by Onimawo (1997) on energy and nutrient intake of male and female students of Federal

University of Agriculture Akure, Nigeria. The mean CHO intake in this study was higher than what Onimawo (1997) observed in the daily CHO intake of University female students. The mean daily CHO intake according to Onimawo (1997) was 355.49 g per day. It is possible that data collection coincided with the period when the students in the present study have more money and food in their possession.

The CHO contribution from snacks is an advantage for both secondary and university students. Anding *et al.* (1998) reported that a healthy snack can be high in carbohydrate. Benton and Owens (1993) stated that glucose is the main fuel source of the brain cells, it is thus expected that a carbohydrate-rich meal might improve cognitive function. A snack in the afternoon was shown to be associated with enhanced utilization of glucose by the brain. Snacks are vital for adolescents and active people such as athletes who have high energy needs. A snack with a high Glycemic Index (GI), immediately after a sports or play, will help refuel working muscles (Lufshitz *et al.*, 1993).

The protein intake was 93.45 g and 135.39 g per day for the secondary school and university adolescents respectively. The mean daily protein intake met the recommended daily intake for protein by FAO/WHO/UNU (1985). The recommended allowance for protein was 36-42 g/day for the different age groups for adolescent girls aged 10-19 years. The daily mean protein intake for all the schools varied and were significantly different from each other ($p<0.05$).

The protein contribution of snacks was 16.90 g (18.09%) and 12.60 g (9.32%) per day for the secondary school and university girls respectively. The protein contribution of snacks for the secondary school and university adolescents were significantly different from each other ($p<0.05$). Protein intake in all schools exceeded the FAO/WHO/UNU (1985) allowances. However, an individual receiving adequate intake of food energy would be able to fully utilize the protein (Ene-Obong and Akosa, 1993). The protein intake values in this study was higher than those reported by Kim *et al.* (1984) who reported the daily protein intake of their subjects to be 67 g. On the other hand, the protein intake in this study is about one and half times higher than those of Onimawo (1997) in his study with male and female students of Federal University of Technology Akure, Ondo State, Nigeria. The protein intake in the current study is almost two times higher than what Bleiberg *et al.* (1981) observed in Upper Volta women.

The student's protein intake constituted mainly those of vegetable origin notably cowpea (*Vigna unguiculata*), groundnuts (*Arachis hypogaea*) and cereals. This is similar to the findings by Nnanyelugo (1982) who reported that protein intake of Anambra State children was very high due to consumption of large quantities of cowpeas. A similar observation has been made by Oguntona *et al.* (1987) who reported high proportion of plant proteins (80%) in the diet of adolescents in Borno State, Nigeria. However, care must be taken in interpreting such intake as plant proteins are known for their low digestibility. This brings to mind the question of quality, quantity and digestibility. Despite the high protein intake, frequency of consumption of some protein rich foods such as meat was low especially among secondary school girls. Other foods rich in protein such as crayfish, fish and egg were not consumed in reasonable quantity. The FAO/WHO/UNU (1985) report recommended good quality and highly digestible protein of 0.75 g/kg body weight as safe level of intake. Though the mean daily protein intake in this study met the quantity aspect, it was not certain whether the good quality and highly digestible aspect was also met. The proteins of animal origin are very expensive, thus cannot be afforded by most students or be included in the daily preparation of their meals.

Fat intake was relatively high for both secondary school and university adolescent girls. WHO (1990) and Nutrition Study Group, EASD (1988) recommended that fat intake should be restricted to 30-35% of total energy requirement for the general population. In the present study, fat intake of the secondary school girls was 49.97 g and 157.09 g per day for the secondary school and university girls. The mean daily fat intake for the secondary school and university adolescents was significantly different from each other ($p<0.05$) (Table 1). Snacks contributed 34.64 g (69.32%) and 13.17 g (8.38%) fat per day for the secondary school and university adolescents respectively. There were significant differences in the fat contribution of snacks for the secondary school and university students ($p<0.05$) (Table 2).

The high fat intake as reported in this study agrees with the values reported from developed countries of Europe and America (Onimawo, 1997). The high fat intake as observed in this study also agrees with the findings of FAO food Balance sheets which showed that the availability of fat for human consumption has increased steadily in both developed and developing countries (FAO/WHO, 1993).

The availability of animal and vegetable fat is closely linked to income (Périssé *et al.*, 1969). The physical environment, local availability of fats and oils, food habits and level of education are other factors which affected the level of fat consumption. Also sociological and individual factors affected fat consumption (FAO/WHO, 1993). Miller *et al.* (1990) studied the relationship between diet composition, energy intake and exercise. They found that as body fat increased, percentage of energy intake derived from fat increased whereas the percentage from carbohydrate decreased and vice verse.

Birch and Deysher (1985) opined that there is no evidence that children have an innate, unlearned preference for high-fat or high-energy foods. Children are predisposed to learn to prefer energy-dense foods over energy-dilute foods by learning to associate the flavours of these foods with the positive physiologic consequences that result from eating energy-dense foods, especially when they are hungry. The high fat intake of the subjects in the current study showed that they have learnt to prefer fat-dense foods.

Ruxton *et al.* (1996) categorized snackers as "high snackers" (>35% of daily energy intake from snacks) and low snackers" (<15% of daily energy intake from snacks). The students in this study are "high snackers" although the secondary school students had higher percent fat contribution from snacks than the university students. Popular belief is that snacks are typically high in fat and therefore "fattening". This theory was tested by Summerbell *et al.* (1995), who found that when total snacks are considered, snacks tended to be lower in fat and higher in carbohydrates than meals. This agrees with the university adolescents but contrasts with the secondary school girl's intake of snacks in this study.

In the Child and Adolescent Trial for Cardiovascular Health (CATCH) study in the USA, 1493 children were interviewed and most of the subjects reported eating snacks. Lunches and dinners were higher in fat than breakfasts and snacks. As the number of eating occasions increased, sugar and total carbohydrate increased, while total fat decreased (Dwyer *et al.*, 2001). In the present study, lunches and dinners were higher in fat than breakfast in both the secondary school and university adolescents.

When a snack is taken after a meal, the satiety induced by the first meal is prolonged and excess energy is stored due to the influence of the snack on insulin secretion. Uncontrolled snacking may contribute to over-consumption of energy and may favour weight gain in predisposed individuals. On the other hand, fractioning the total daily intake into smaller meals and snacks tend to minimize post-absorptive insulin secretion via slower glucose absorption due to reduced intra gastric pressure (Marmonier *et al.*, 1999).

The iron intake for the secondary school girls was 31.68 mg while that of the university adolescents was 37.14 mg per day. The iron intake were significantly different from each other in all the schools ($p<0.05$) (Table 1). The iron intake in this study met the FAO/WHO Consultative Group Requirements (1988) for different age groups for both the secondary school and University adolescent girls.

To the total iron intake, snacks provided 5.63 mg iron which contributed 17.77% iron and 4.35 mg which yielded 11.71% iron to the total daily iron intake for the secondary school and university adolescents respectively. The iron intake was significantly different from each other for the secondary school and university adolescents ($p<0.05$) (Table 2).

The high iron intake agrees with previous studies on iron intakes of the Nigerian population (Nnanyelugo *et al.*, 1985; Nnanyelugo and Okeke, 1987; Oguntona *et al.*, 1987; Smith and Oluwoye, 1988). Although this has been attributed to the use of large cast iron pots in cooking the student's meals (Nnanyelugo and Okeke, 1987; Oguntona *et al.*, 1987). Though the calculated value of iron in the diet was high, the level of bioavailability is still questionable. There are three determinants of iron uptake namely, the iron content of the diet, the bioavailability of the iron in the diet and the presence of promoters or inhibitors of iron absorption in the diet (Skikine and Baynes, 1994). These dietary determinants are interrelated and highly dependent of the nature of the diet.

Socioeconomic conditions influence the nature of the diet namely poor populations tend to have diets low in bioavailable iron. The dietary source of iron strongly influences the efficiency of its absorption. The amount of iron absorption varies from less than 1% to more than 20%, depending on the food. Foods of vegetable origin are at the lower end of the range, diary products are in the middle and meat is at the upper end because haeme iron in meat is better absorbed (Dallman, 1990). In developed countries, meat intake is relatively high, not only that the haeme iron in meat is more bioavailable, the meat protein is a promoter of nonhaeme iron absorption. In contrast, in developing countries such as Nigeria and in this present study, intake of meat was low and compounded with greater exposure to inhibitors of iron absorption such as tannins and phytates which interfere with absorption of iron from plant sources thereby leading to very low iron uptake.

The vitamin A intake differed and were significantly different in all the schools ($p<0.05$). The university adolescents had the highest (9135.20 µg retinol) vitamin A intake, while the secondary school adolescents had the least (6296.10 µg retinol) (Table 1). The vitamin A intake of both the secondary school and university adolescents was significantly different from each other ($p<0.05$). The vitamin A intake in all the schools were high and met the FAO/WHO/UNU (1985) recommended allowance.

The secondary school girls had the highest 409.76 µg retinol of vitamin A intake from snacks which contributed 6.50% vitamin A while the university adolescents had the least 299.87 µg retinol which gave 3.28% to the total daily vitamin A intake. The vitamin A intake as snacks were high and significantly different from each other in all the schools studied ($p<0.05$) (Table 2).

The high vitamin A intake of students may be due to their consumption of red palm oil which is a food item in every meal. The richest source of retinol in Nigeria is red palm oil. Traces of retinal, retinoic acid and glycosides of retinol also occur in foods. Carotenoids occur in dark green leafy vegetables and yellow and orange coloured fruits and vegetables (Bates and Heseker, 1994). Carotenoids occur in the form of provitamin A which has to be converted to vitamin A. Provitamin A is the form of vitamin A mostly consumed by students in this study (McLaren and Frigg, 2001). Good sources of vitamin A like liver and eggs are too expensive and quite beyond the reach of most students.

Observational study showed that most of the snacks eaten by both secondary school and University students are either cooked snacks such as moimoi which is made from beans (*Vigna spp.*) and "okpa" which is made from bambara groundnut (*V. subterranea*). These foods are made with red palm oil. Most snacks are fried with red palm oil. This can explain the high contribution of vitamin A intake from snacks.

Vitamin C (ascorbic acid) enhances iron absorption, therefore, intake data was analyzed for ascorbic acid adequacy. The mean ascorbic acid intake for all the schools were high and significantly different from each other ($p<0.05$). The university adolescents had the highest 179.71 mg ascorbic acid intake while the secondary school girls had the least 94.15 mg (Table 1). The recommended intake for ascorbic acid was met by both the secondary school and university adolescents.

Snacks contributed higher level of ascorbic acid in the diet of secondary school girls as compared with the University students. The ascorbic acid intake as snacks were high and significantly different from each other in the secondary school and university adolescents ($p<0.05$). The diet of the secondary school adolescents had the highest 21.59 mg ascorbic acid content which contributed 22.93% ascorbic acid content while the university adolescent girls had the least 12.29 mg ascorbic acid content which yielded 6.84% ascorbic acid content to the total ascorbic acid intake (Table 2).

The high vitamin C intake recorded by the students in this study was due to consumption of fruits in season as snacks. The consumption of vegetables was limited to the small amount included in the school meals. This has also been observed by Ene-Obong and Akosa (1993). Previous studies in Nigeria reported very high intake of ascorbic acid (Okoro, 1991; Nnanyelugo *et al*., 1985). Okoro (1991) attributed the high level of ascorbic acid intake to be due to high consumption of leafy vegetables and fresh fruits by subjects.

**Conclusion:** This study showed that adolescent female university students consumed more nutrients than their secondary school counterparts. The quantity of food available to the students in the dormitory, the regulations regarding school meals, their attitude towards particular foods and the quantity of the meal served made the nutrient intake of the secondary school female students to be lower than those of the their university counterparts who had more freedom in the selection and quantity of food intake. It is therefore necessary to evaluate the quality of meals and snacks served to both secondary school and university students to know their contribution to nutrient intake in order to alleviate the problem of malnutrition in adolescent female Nigerian students.

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