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Pattern and contribution of some fruits and vegetables consumption to academic performance among students of YUSUF MAITAMA SULE UNIVERSITY KANO STATE, NIGERIA

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ABSTRACT

University is a vulnerable period of the life course with regard to nutrition because of the increasing independence of students from parents and nutrition is one of the most important factors that may affect brain development and therefore academic performance. The present study reports on the contribution of some fruits and vegetables intake to academic performance among university students. Questionnaires were administered to the participants and the frequently consumed fruit and vegetable which are orange (*Citrus sinensis*) and tomato (*Solanum lycopersicum L.*) respectively were selected and various analytical test such as mineral element, phytochemical and vitamins analyses were carried out on the selected samples. The level of minerals found in the samples is low. Other chemical analyses are quite satisfactorily to the study. The relationship between fruits and vegetables intake with academic performance was analyzed. The correlation coefficient between fruit intake by male student and academic performance was found to be 0.993 ($p = 0.007$).

The correlation coefficient between BMI of male students and academic performance was found to be 0.937 ($p = 0.227$). The correlation coefficient between male vegetable intake and their academic performance was 0.112 at $p = 0.888$. The correlation coefficient between female fruit and vegetable intake and their academic performance was also found to be 0.501 and 0.025 at p values of 0.449 and 0.975 respectively. The correlation coefficient between female body mass index and academic performance was 0.707 at $p = 0.5$. The results from the correlational analysis show that there was no correlation between fruits and vegetables intake among male and female students and their academic performance among the studied population except for the male fruit intake and their academic performance where the correlation is strongly positive. The findings of this study show that fruits and vegetables has low percentage contribution to academic performance among the studied population, is suggestive that there is more to academic performance than fruit and vegetable intake only among university students.

Keywords Academic Performance, Citrus Sinensis, Solanumm Lycopersicum L

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1. Introduction

Adolescence is a period of life when major psychosocial and biological changes occur, resulting in higher nutrient requirement at any time across the lifecycle [1]. It is also an important stage for brain development, characterized by synaptic pruning, myelination and a growing number of neural connections, especially in the prefrontal cortex [2]. It is a vulnerable period of the life course with regard to nutrition because, with increasing independence from parents, food choices are more frequently made by adolescents. During this time of development, peer pressure and media promotion exerts relatively greater influence on food purchases, often in favor of his healthy nutritional choice [1].

The academic performance of children and adolescents has been a focus for public health researchers. School performance influences future education, which ultimately shapes an individuals' socioeconomic status; in which in turn, is associated with health and health behavior [3]. Nutrition is one of the most important and modifiable environmental factors that may affect brain development, and therefore cognition and academic performance [4].

A number of factors are recognized as affecting school performance including gender, ethnicity, and quality of school and school experience, nutrition, child health and socioeconomic factors [5]. Fruit and vegetables consumption is another area that has been explored for its impact on academic performance.

It is important to understand the relationship between health behaviors, such as diet and physical activity, and school performance. This will allow policy makers to be better informed, which can lead to more effective health strategies. Health promotion programs and policies that are delivered through the schools can help children develop and practice healthy behaviors from an early age.

It has been documented that malnutrition has a strong negative effect on the academic achievement in school. However, relatively little research has reported the contribution of fruits and vegetable on academic performance of students especially in Nigeria. Knowledge on the nutritional status of the university students especially in poverty stricken areas is crucial because it will assist in designing appropriate programmes in order to tap full academic potential from these students.

Hence the aim of this study is to provide essential information on the contribution of fruits and vegetables consumption toward academic performance among the studied population.

2. Materials and method

2.1. Study population

A total number of 150 university students between the age of 17 and 27 selected from Northwest University Kano State participated in this study. Participants were selected from the Faculty of Science, Basic Medical Science, Education and Humanities.

2.2. Study site

Yusuf Maitama Sule University Kano is a Kano State government owned University with a temporary campus located at the center of the city of Kano and a main campus located along Gwarzo Road off Kofar Kabuga in Kano State, Nigeria. It is one of the newest universities established in Nigeria in 2012.

2.3. Administration of questionnaire

Questionnaire was the instrument for data collection. A questionnaire was designed as to comprise of seven sections, namely: socio-demography, food frequency, reason for choice of selected food consumption, dietary assessment, academic performance, anthropometry measurement and lifestyle behavior. To gather data on food consumption patterns and nutrient intake for each student, a food frequency questionnaire (FFQ) was used. Food items which are commonly consumed by students were chosen. The participants were requested to tick the foods that they ate from the given list in the food items. Each student had to indicate what applies to them by marking in the appropriate boxes. The completed questionnaires were then collected on the same day. The result of the questionnaire administration shows that orange and tomato are the frequently consumed fruits and vegetables respectively by the students in the institution.

2.4. Anthropometric measurements

Anthropometric measurements i.e., height and weight of the students were collected. The body mass index of participants was calculated using the quatelet equation, weight (kg)/height (m^2).Weight of the participants was obtained using the bathroom scale which is an already validated instrument while the height was measured using a tape measure. To ensure that the bathroom scale measured what it was supposed to measure, the researcher ensures that the starting point of the instrument before any weighing was zero. Body mass index of participants was then classified using WHO (2006) classification: < 18.5 underweight (1), 18.5-24.9 'normal' (2), 25-29.9 'overweight' (3) and > 40 'obesity' (4).

2.5. Collection of samples

The two samples; Orange (*Citrus sinesis*) and Tomato (*Solanum lycopersicum L.)* were collected from yan-lemo market of Kumbotso Local Government Area, Kano state. The plants were identified at the herbarium section of the

Department of Biological Sciences, Bayero University Kano, where an Accession Number BUKHAN 0339 and BUKHAN 0367 were assigned to them respectively.

2.6. Preparation of sample

The two samples namely orange and tomato were cut into pieces and air dried. The dried samples were pulverized into powder using mortar and pestle. The powdered samples obtained were kept in the laboratory for subsequent analysis.

2.7. Mineral element analysis

2.7.1. Wet digestion of sample

The method of A.O.A.C. was employed for the determination of mineral content. Two grams (2g) of the pulverized sample was placed in a crucible and ignited in a muffle furnace at 550^oC for 6 hours. The resulting ash was dissolved in 10ml of 10% HNO_3 and heated slowly for 20 minutes. After heating, it was filtered and the filtrate was left to cool down and the contents of the tubes were transferred to 100 ml volumetric flasks and the volume of the contents were made to 100ml with distilled water. The wet digested solution was transferred to plastic bottles labeled accurately. The digest was stored and used for elemental determination.

2.7.2. Determination of Iron (Fe), Zinc (Zn), Calcium (Ca) by atomic absorption spectrometry (AAS) (AOAC, 2003)

The digested sample was analyzed for mineral contents by atomic absorption spectrophotometer. Different electrode lamps were used for each mineral. The equipment was run for standard solutions of each mineral before and during determination to check that it is working properly. The dilution factor for all minerals was 100. For the determination of Ca, 1.0 ml lithium oxide solution was added to the original solution to unmask Ca from Mg. The concentrations of minerals were recorded in mg/l by using the equation from calibration curve by multiplying it with dilution factor, 100 and dividing by 2.

2.7.3. Determination of Sodium (Na) by flame photometer

Na analysis of the sample was done by the method of flame photometry. The same wet digested food sample solutions as used in AAS were used for the determination of Na. Standard solutions of 20, 40, 60, 80 and 100 milli equivalent/L were used both for Na. The calculations for the total mineral intake involve the same procedure as given in AAS.

2.8. Quantitative phytochemical screening

2.8.1. Preparation of plant extract

The air dried finely ground samples (4 g) were taken separately in air tight bottles and 200ml of distilled water was added and kept under dark. After 3 days, the contents were stirred well and filtered using Whatmann no: 1 filter paper. Thereafter, the filtrate was evaporated to dryness by means of a water bath. The extracts were stored in refrigerator until needed for further analysis.

2.8.2. Determination of total phenolic compounds

Folin-ciocalteu method: 100mg of the extract sample was weighed accurately and dissolved in 100ml of triple distilled water (TDW). 1ml of the solution was transferred to a test tube, then 0.5ml of the folin-ciocalteu reagents and 1.5ml (20%) of Na_2CO_3 solution were added and the volume was made to stand for 2 hours after which the absorbance was taken at 765nm [6].

2.8.3. Determination of total flavonoids:

Flavonoids-Aluminium complex method was used 100µl of the extracts was mixed with 100µl of 20% aluminium trichloride in methanol and a drop of acetic acid, and then diluted with methanol to 5ml. the absorbance at 415nm was read after 40 minutes [7].

2.8.4. Determination of oxalate

The titrimetric method of Day and Underwood [8] was used in the determination of oxalate in the sample. 150ml of 15N H_2SO_4 was added to 5g of the pulverized samples and the solution was carefully stirred intermittently with a stirrer for 30 minutes and filtered using whatman No 1 filter paper, after which 25ml of the filtrate was collected and titrated against 0.1 N $KMnO_4$ solution until a faint pink colour appeared that persisted for 30 seconds.

2.9. Qualitative phytochemical screening

2.9.1. Detection of flavonoids

Lead acetate test: extracts were treated with few drops of lead acetate solution. Formation of yellow colour precipitate of dilute acid, indicates the presence of flavonoids [9].

2.9.2. Detection of proteins and amino acids

Xanthroproteic test: the extracts were treated with few drops of concentrated nitric acid. Formation of yellow colour indicates the presence of proteins [9].

Ninhydrin test: to the extract (2ml), 2 – 5 drops of 0.25% w/v ninhydrin reagent was added and boiled for few minutes. Formation of blue-purple colour indicates the presence of amino acid [9].

2.9.3. Vitamin Content Determination

Determination of Vitamin A and C

Into a conical flask containing 25ml of 95% ethanol, 5g of macerated sample was placed and maintained at a temperature of about 70^{o}c to 80^{o}c in a water bath for 20 minutes with periodic shaking. The extract was decanted, allowed to cool and its volume was measured by means of measuring cylinder and recorded as initial volume.

The ethanol concentration of the sample was brought to 80% by adding 7.5ml of distilled water. It was further cooled in a container of ice water for about 5 minutes. 1ml of the analyzed liquid was transferred to the test tube 1 (centrifugal) with a tight stopper and 1ml of KOH solution was added, the tube was plugged and shaked vigorously for 1 minute. The test tube was placed in a water bath (60^{o}C for 20 minutes) and then it was cooled down in cold water. To the test tube, 1 ml of xylene was added. The tube was again plugged and shaken vigorously for a minute. The test tube was centrifuged at 1000rpm for 10minutes. The whole of the separated extract was collected and transferred to the test tube II made of soft (sodium) glass. The absorbance A1 of the obtained extract was measured at 335nm. The extract in the test tube II was irradiated to the UV light for 30 minutes. The absorbance was taken at the same wavelength [10].

For Vitamin C Accurately 5g of ground sample was dissolved in 500cm^3 of volumetric flask and made up to the mark and filtered. 50cm^3 of the filtrate was then pipetted into a 100cm^3 volumetric flask. 25cm^3 of 20% metaphosphoric acid was then added and made up of distilled water. 10cm^3 of the solution was then pipetted into a flask and 2.5cm^3 of acetone was added. This was titrated with indophenol solution until a faint pink colour which persisted for 15 seconds was observed.

2.10. Statistical analysis

The results of the elemental analysis, phytochemical analysis and vitamin content determination were expressed as mean ± standard deviation.

3. Results and discussion

3.1. Results

Table 1 shows the socio- demographic characteristics of the participants in the university. About 150 participants in this study were recruited from four faculties in northwest university. There are 39% (n=59) of male students and 61% (n=91) of female students that participated in this study. The age of the participants in this study range from 17 to 27 years of age. About 96% (n=144) of students live off campus and 4% (n=6) reside in the university campus. Most of the family income of the participants is in the range of below 2000 (7.33%, n=11), 2000 –5000 (10%, n= 15), 5000 – 10000 (7.33%, n=11) and above 10000 (60%, n=90). 15.33% (n=23) of students preferred not to answer. There are more females than males. More than 75% of the participants were single.

Table 1 Result of socio-demographic characteristics.

Gender	Number of students	%Number
Male	59	39%
Female	91	61%
Residence		
Off campus	144	96%
On campus	6	4%
Household income (₦)		
Below 2000	11	7.33%
2000 – 5000	15	10%
5000 – 10000	11	7.33%
Above 10000	90	60%
Preferred not to answer	23	15.33%
Marital status		
Married	33	22%
Single	117	78%

Table 2 shows the mineral content in mg/l of orange and tomato. Sodium content of orange and tomato was found to be 100.03±0.03 and 200.01±0.01 respectively. Orange was found rich in calcium (333.37±0.01). Tomato was found rich in sodium as given above. The amount of iron and zinc detected in orange and tomato were 3.72±0.02; 1.41±0.01 and 5.56±0.01; 4.16±0.01 respectively. The level of calcium found in tomato was 33.36±0.01mg/l.

Table 2 Mineral element (mg/l) composition of orange and tomato.

Elements	Orange	Tomato
Zinc	1.41 ± 0.01	4.16 ± 0.01
Calcium	333.37 ± 0.01	.36 ± 0.01
Sodium	100.03 ± 0.03	200.01 ± 0.01
Iron	3.72 ± 0.02	5.56 ± 0.01

Values are expressed as mean ± SD (n=3).

3.1.2. Result of phytochemical analysis

Table 3 shows the result of quantitative phytochemical analysis of orange and tomato. The level of oxalate in orange and tomato was found to be 119.5±0.45mg/ml and 232.7±0.60mg/ml respectively. Total phenolic was found to be 262.03±34.30 µg/ml and 444.6±66.88 µg/ml in orange and tomato respectively. It was observed that orange contains 263.73±70.65 µg/ml of total flavonoid while tomato contains 162.93±23.99 µg/ml of total flavonoid.

Table 3 Result of quantitative phytochemical analysis of orange and tomato.

Phytochemicals	Orange	Tomato
Oxalate (mg/ml)	119.5 ± 0.45	232.7 ± 0.60
Total phenolic (µg/ml)	262.03 ± 34.30	444.6 ± 66.88
Total flavonoid (µg/ml)	263.73 ± 70.65	162.93 ± 23.99

Values are expressed as mean ± SD (n=3).

In the Table 4, the qualitative analysis of orange and tomato shows the presence of flavonoid. Amino acid is present in tomato but not detected in orange. Protein was not detected in both orange and tomato.

Table 4 Result of qualitative phytochemical analysis of orange and tomato.

Phytochemicals	Orange	Tomato
Flavono	+	+
id	-	-
Protein	-	+
Amino acid		

Table 5 shows the vitamin content of orange and tomato. The result of the analysis revealed vitamin A content of orange and tomato to be 2.71±1.88 µmol/L and 7.64±6.59 µmol/L respectively. Vitamin C (ascorbic acid) content of orange was found to be 35.81±0.09 mg/L and 22.65±0.06 mg/L in tomato. An analysis of fruit frequency intake brings forth the fact that more females take in fruit once daily. Male students take in more fruits less than two times in a week among other frequency of intake. The level of fruit intake among male and female students at all meals is the lowest. A study of frequency of vegetable intake among the participants shows that female students take in more vegetables that their male counterpart. The level of vegetable intake among female students is highest at one time daily likewise male students. The Percentages of male students that consume vegetable at all meals and three to six times weekly are the lowest.

Table 5 Result of vitamin content determination in orange and tomato

Vitamins	Orange	Tomato
Vitamin A (µmol/L)	2.71 ± 1.88	7.64 ± 6.59
Vitamin C (mg/L)	35.81 ± 0.09	22.65 ± 0.06

Values are expressed as mean ± SD (n=3).

The academic performance among students is detailed in Figure 3. The percentage of female students with second class upper is the highest, likewise the percentage of male students. The percentage of students with third class is the lowest. The percentage of female students with first class is higher as compared to the male students. A study of the BMI values of the participants in the figure above shows that female students have higher BMI value than their male counterpart. Male students with normal weight are higher in percentage as compared to female students. Both male and female students have the same percentage of underweight.

After the coding, the data were subjected to Pearson correlation analysis to determine the effect of fruit intake, vegetable intake and body mass index on students' academic performance using SPSS version 20 at 0.01 level of significance.

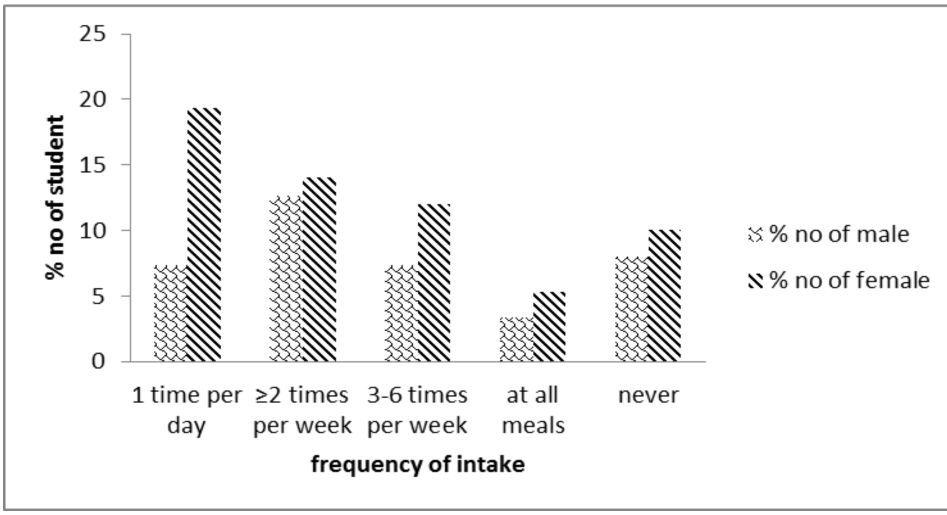

Figure 1 Percentage frequency of fruit intake among students.

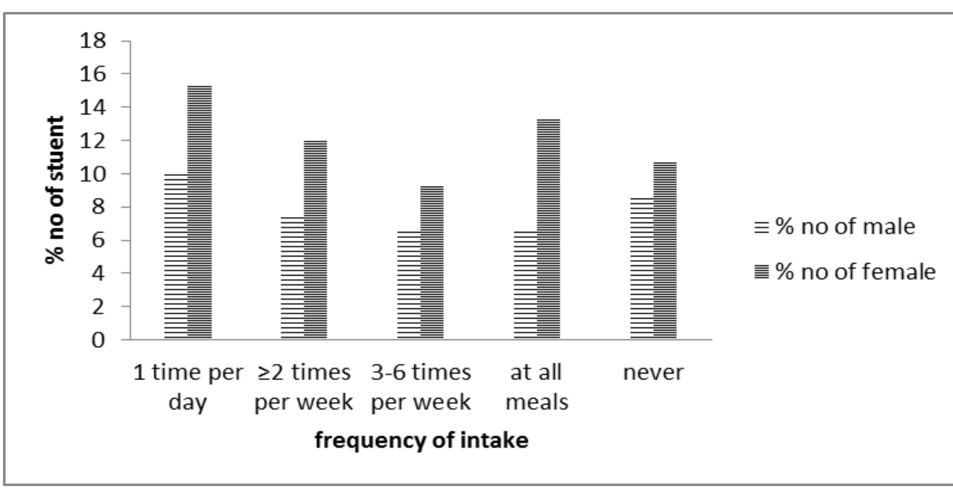

Figure 2 Percentage frequency of vegetable intake among students.

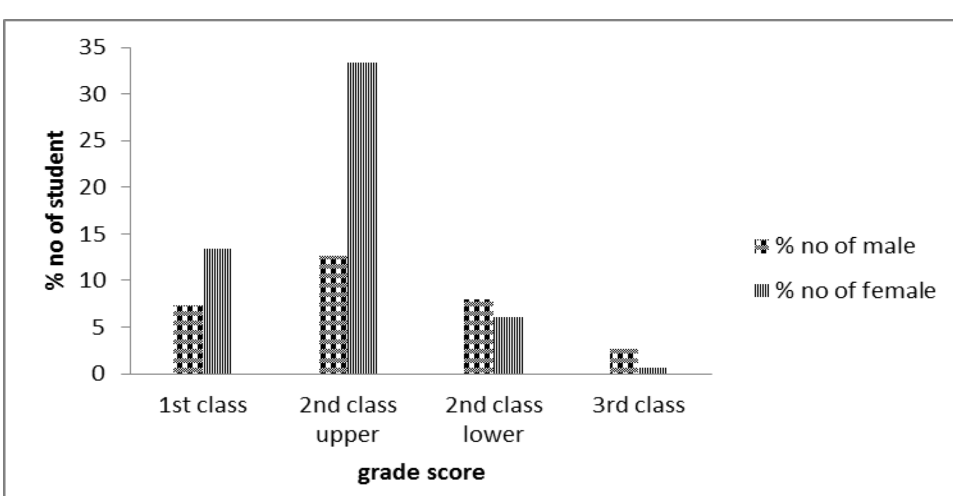

Figure 3 Academic assessment among students.

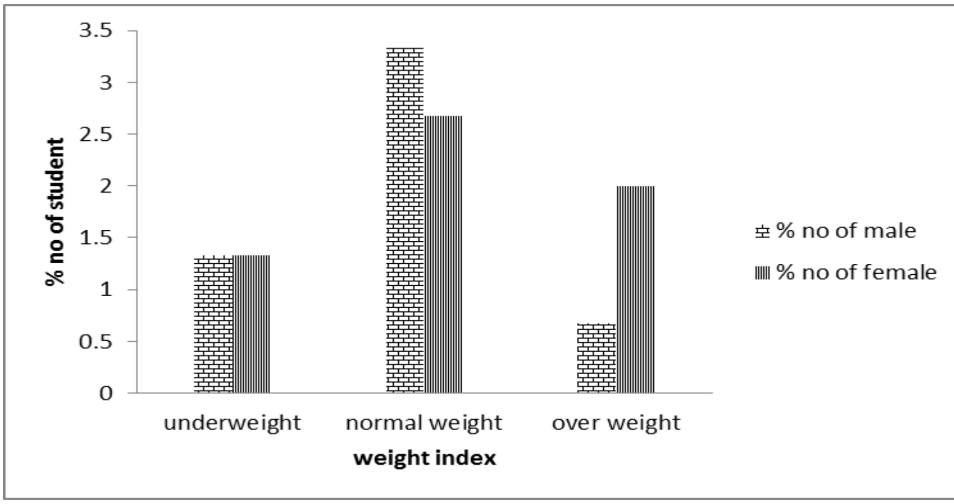

Figure 4 Result of body mass index (BMI) among students.

3.2. Discussion

In Table 1, mineral elemental determination shows the level of calcium in tomato which is lower than the RDA value of 800mg/day. This may be due to a number of factors that influence the concentration of mineral elements on and within plants, these factors include climate, atmospheric deposition, and nature of soil. These observations were made by Anyawu *et al* [11] and Khaira *et al* [12]. The level of sodium in both samples is moderately high. Sodium and calcium play a role in message transmission and the thinking process [13]. The iron content of the two samples investigated is low when compared with the RDA value which is 20mg/day. It is evident that iron modulates cerebral development [14]. The presence of iron in the brain is critical for myelination [15]. Iron also has important effects on neurochemistry and neurometabolism through its effect on monoamine metabolism and oxidative phosphorylation [9]. The level of Zn in the fruit sample is low while its level high in tomato. The value of Zn in tomato 4.16±0.01 is similar to ones reported by Asaolu *et al* [16] and Ayoola *et al* [17]. Zinc play a role in cognitive development [18]. Part of cerebral zinc (10 to 15%) is present in synaptic vesicles for some glutaminergic neuron [19]. Zinc has a direct effect on brain growth and morphology through its role in enzymes that mediate protein and nucleic acid synthesis [20-21]. Wood [22] cited a test of mental function called verbal memory, scientists found that volunteers' abilities to remember every day words slowed significantly only after three week of low zinc diet. Fruits and vegetable are good source of micronutrients which may play significant role in the cognitive development of adolescents. Phytochemical analysis of the fruit and the vegetable shows the presence of flavonoid. Fruits and vegetables are good sources of flavonoid, which is responsible for antioxidant, anti-carcinogenic and health promoting properties [23]. Flavonoids, a group of phenolic compound are free radical scavengers which prevent oxidative cell damage through their water soluble property and also possess strong anti-cancer activity [24].

This study also shows the presence of amino acid in tomato. The concentration of certain amino acid in the blood let the brain to create many of its neurotransmitters such as serotonin, acetylcholine, dopamine and norepinephrine. Amino acid is a precursor molecule required for the brain to function normally. Flavonoids also potentiate the action of vitamin C and protect cell from oxidative damage leading to cellular damage especially in the brain. The analysis shows the presence of oxalate. Oxalate is a toxicant which affects the absorption of certain mineral elements such as calcium. However at low concentration, its toxic effect is not manifested. Vitamins are necessary factors, which must be present in the food in minute amount to enable growth, health and life to be maintained. The common and easy sources of vitamin are fresh fruits. The highest content of β-carotene and ascorbic acid fruits are orange, tomato and amla (indian groose berry). Vitamin A and the retinoid are implicated in synaptic plasticity in brain region, the hippocampus suggesting they have a role in the establishment and maintenance of cognitive function [14]. Vitamin A participates with other micronutrient in the protection of tissues, in particular nervous tissues from aggression by free radicals and reactive forms of oxygen. Vitamin C plays many roles. Its presence is required for the transformation of dopamine into noradrenaline. The biosynthesis of catecholamines occurs in tissues rich in ascorbic acid like the brain and the adrenal gland. Vitamin C plays an important role in protection against harmful oxidation reactions that involve molecular oxygen because of its properties as a reducing agent.

An analysis of the fruit and vegetable intake survey data brings forth that female students consume more of fruits and vegetables as compared to male students. As such the percentage of students that came First class and Second class upper are mostly females. In figure 4, BMI shows that the percentage of female students that are overweight is higher than the male students. This is may be in part because excessive fruit intake sometimes leads to obesity. Male students have higher percentage of normal weight as compared to female students.

The correlation coefficient between fruit intake by male student and academic performance was found to be 0.993 (p = 0.007). This denotes a strong positive correlation between male fruit intake and academic performance of the study group. The correlation coefficient between BMI of male students and academic performance was found to be 0.937 (p = 0.227). The BMI level of male student is not correlated to academic performance. There is no correlation between male vegetable intake and their academic performance (r = 0.112, p = 0.888). There is no correlation between female fruit and vegetable intake and their academic performance given the r values (r =0.501, p =0.449 and r = 0.025, p = 0.975) respectively. There is no correlation between female body mass index and academic performance (r = 0.707, p = 0.5).

The present study generally shows that there is no correlation between fruit and vegetable intake and student academic performance among the studied population except for the male fruit intake only. However Florence *et al* [25] and Maclellan *et al* [26] both reported a better academic performance among adolescent with increased fruit and vegetable intake. This deviation from their study may be in part due to factors like genetic variation among others.

4. Conclusion

The findings of this study show that fruit and vegetable intake has low percentage contribution on the academic performance among students. This suggests that there is more to academic performance than fruit and vegetable intake only among students. Other factors not controlled in this study such as students' motivation, health status of students, dietary pattern, physical activity level, teachers' competency among others must have also had their contributions on the academic performance of these students.

Conflict of Interest

The authors of this article declare no conflict of interest through the processes of this work.

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