Intelligence Quotient In Relation To Nutritional State and Food Intake of High School Students in Jeddah

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Abstract: Background: Few lifestyle factors have been simultaneously studied and reported for Saudi and non Saudi adolescents. WHO stresses the importance of promoting balance diet among adolescents. Dietary patterns during adolescence may contribute to eating disorders and may increase the risk for several important chronic diseases later in life. Nutrient component of diet is very important, especially for adolescents during the development stages. Diet rich in vitamins and minerals is essential for healthy adolescents and very important during adolescent cognitive development. Therefore, this study was conducted to assess the associations between nutritional status and food intake among high (secondary) school students residing in Kingdom Saudi Arabia Jeddah area and Cognitive function which was measured by intelligence quotient (IQ) test. Blood samples were collected to assess hemoglobin and serum Fe status. Subject and Methods: Demographic and socio-economic data were collected using pre-tested questionnaires. We conducted a cross sectional study to produce representative samples drawn from six Secondary schools in Jeddah Saudi Arabia for a sample of (135)students (65females and 70 males). The nutritional status was assessed by anthropometric and biochemical parameters at KAUH. Dietary habits and food intake were assessed by using 24-hour recall for 3-day dietary recall (food diary) and a food frequency questionnaire. A series parameters of a cross section study about intelligent Quotation(IQ) for 119 adolescents participates (64 males & 55 females) in 6 high school levels (Private & Public) ageing (16- 19)years old residing in Jeddah province KSA. **Result:** The mean age of the participants was 17.53 ±.91years. The mean body mass index was 24.59±6.58 kg/m2. A total of 13% of the adolescents were overweight from adolescents and 22.3% were in the categories obesity classes 1, 2 an3. BMI for students as female and male the percent of obesity in males (38.6%) (27 of 70) more than females (30.7%) (20 of 65). IQ score was high at level ≥75 found in (51% for females) and (39% for males) but (51.4% and 42% for private & public schools respectively). Mean ±SD of IQ of represented Students by (Gender and type of schools) were (64.3± 24.68, 61.1± 25.51, 68.1± 23.38 66.2 ±27.92 for and 63.5 ± 23.35) for total sample, male, female, private and public schools respectively. While the maximum IQ level for all previous variables about 96 & 97. Positive moderate correlation between IQ and total kcalories intake and the differences between IQ and total kcalories was significant at $P < 0.01$.** Positive weak correlation between IQ and protein, fat and CHO intake and statistically differences between IQ and protein, fat and CHO were significant at $P < 0.05$*. Positive moderate correlation between IQ and sodium and magnesium, statistically the differences were significant at $P < 0.01$**. While the statistically differences between IQ and iron, zinc and calcium were significant at $P < 0.05$*. Finally statistically differences between IQ and vitamin A and C and were significant at $P < 0.04$* & 0.008** respectively. Thirty one percent from total sample of Studied Students were had hemoglobin level **<12.9**, while (69%) were had normal level of Hb and correlation between Hb and IQ of Studied Students = 0.26 and $P < 0.05$*. About (12%) from studied students were had iron deficiency anemia at iron level (**<6**), however (88%) of participate were had normal level of iron (**≥6**) and the correlation between iron and IQ of Studied Students = 0.28 and $P < 0.01$**. **Conclusion**: The intelligence quotient (IQ) of adolescent's students is influenced by household income, Macronutrient and micronutrient intakes, Hb and Iron Deficiency Anemia. Sufficient nutrient intake is very important during adolescent cognitive development. There was a significant association between adolescent dietary intake and adolescent's IQ level. Our study results will be helpful to the authorities in KSA in their efforts to improve nutrition and health of the KSA adolescent. It is concluded that sufficient nutrient intake is very important during child cognitive development.

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1.Introduction

Adolescence is the only time following infancy when the rate of physical growth actually increases. This sudden growth spurt is associated with hormonal, cognitive, and emotional changes that make adolescence an especially vulnerable period of life nutritionally. First, there is a greater demand for calories and nutrients due to the dramatic increase in physical growth and development over a relatively short period of time. Second, adolescence is a time of changing lifestyles and food habit--changes that affect both nutrient needs and intake. Third, adolescent drive for individuation means more opportunity to assert food choices and expand or narrow healthy options **(Claire, *et al.,* 2000**)

Adolescents of both sexes and in all income and racial/ethnic groups are at risk for dietary excesses and deficiencies. Dietary excesses of total fat, saturated fat, cholesterol, sodium, and sugar commonly occur. Most adolescents do not meet dietary recommendations for fruits, vegetables, and calcium-rich foods **(Claire, *et al.,* 2000)**.

Nutrition is one of the crucial factors affecting cognitive development of adolescents. The huge and rapid changes in life style during the last 30 years and the rapid increase in fast food availability led to the reduction in the quality of food and its nutrients. Adolescents nowadays consumed foods high in calories and carbohydrate and low in vitamins and minerals which are needed to build their cognition. In majority countries, children and adolescents constitute a group at risk for nutritional deficiencies. During this time, nutritional requirement is high, (**Hasanain *et al.,* 2013).**

Findings from a series of case–control studies indicate that childhood IQ is inversely associated with childhood obesity (**Qian *et al.,* 1994 and Zhang and Li, 1996, 1**). Some studies have explored the relationship of childhood Intelligent Quotient (IQ) with adult obesity (**Halkjaer *et al.,* 2003, Hart *et al.,* 2004),** although there is still no consensus regarding their association. While various studies indicate a decreased IQ with higher body mass index (BMI) compared with those in the normal range, this decrease in risk varies widely across publications, and the effect of childhood (IQ) on later adult obesity is less clear (**Jiang and Li, 1997, and Xia *et al.,* 1998).**

It is not surprising that the brain does not function normally while it is iron deficient (ID). Iron is absolutely necessary for normal neuronal and glial energy metabolism, neurotransmitter production, and myelination (**Lozoff *et al.,* 2006**). A large number of studies in humans and in animal models demonstrate that early ID has a negative effect on these brain processes with concurrent behavioral abnormalities (**Michael, 2011)**

The present study has been carried out to explore the food intake and nutrition status of late adolescent with some socioeconomic factors and the biochemical analysis in relation to the Intelligence quotient.

2. Subjects and Method

The current study is cross-sectional and data was conducted in public and private high school students in Jeddah, Saudi Arabia. One hundred thirty Five students, their ages ranges from 16-19, randomly selected including (70) males and (65) females during either the 2011/2012 school year. The aim of the study was explained to the subjects. Two male students participated in the data collection from male school under investigator supervisor. Face to face specific questionnaires were distributed for the students to collect information from them about; demographic and socio-economic data; Personal data (name, school, gender, mobile number and age). Anthropometric data (weight, height, body mass index, waist and hip Circumferences). Eating Habits (appetite, number of meals/day, main meal, skipping meals, food likes and dislikes, snacking, number of meals eaten outside/week, worrying about weight, dieting and food habits).Dietary food recalls. In the first visit to each school the researchers oriented them about project and gave them the questionnaires to answer questions, after three days they went back to collect the food recall with them and start taking blood samples from each student to analyze their hemoglobin and iron level. The third visit the researchers distributed an IQ test to measure their cognitive abilities.

2.1. **Socio-demographic data**

This includes questions on basic socioeconomic characteristics of the households including information about number of members in the family, the rank of the student in siblings. It also collects data on participants characteristics as the: age, educational status of the fathers and mothers , occupational and employment status, income source, average of household income, place of residence, and type of dwelling. Social status of the family was done according to **(Park and Park, 1979)**.

2.2. Anthropometric measurements

The weight and height of the students in the two groups (boy and girl) were assessed. Height was measured by a meter. The students were standing without shoes on a flat surface with feet parallel and heel together, and the head, back and heels in contact with the vertical board. The height was recorded to the nearest 0.1 cm (**WHO, 1995**). Weight of students was determined by using an electronic scale (Piscover, Poland) and was recorded to the nearest 0.1 kg. The students were weighed with light indoor clothing and without shoes (**WHO, 1995**).

Anthropometric indices are combinations of measurements. They are essential for the interpretation of measurements. In adolescents, the four most commonly used indices are weight-for-height, height-for-age, weight-for-age and BMI-for-age.

2.2.1 Weight (wt):

The plate from scale was used to measure weight for participating adolescents. The scale should be placed on a flat, hard surface. We should make sure that the scale is at zero before measuring prisoners' women weight. The student should stand in the middle of the scale's platform without touching anything and with the body weight equally distributed on both feet. The weight should be read to the nearest 100g (0.1 kg) and should be recorded. The subject asked to be wearing light clothes as possible **(Robert, *et al.,* 2003).**

2.2.2. Height (Ht):

Height was measured using vertical measuring board for adults. The student stood bare footed on a flat platform, with feet parallel and with heels, buttocks, shoulders and back of head touching the upright surface. The head was held comfortable erect, with the over border of the orbit in the same horizontal plane with the external auditory meat us "Frankfort plane". The arms were hanging at the sides in natural manner. The head piece was gently lowered, crushing the hair and making contact with the top of the head. Height was recorded to the nearest ½ centimeter **(Gordon , *et al.,* 1988).**

2.2.3. Body Mass Index (BMI):

This index was obtained by calculating weight by kg / square height by meter (kg/m²), and BMI was then categorized as underweight(> 18.5 kg/m²), healthy weight (18.5-24.9 kg/m²), overweight (25-29.9 kg/m²), obesity (30-34.9 kg/m²), over obesity (35-39.9 kg/m²) and morbid obese (<40 kg/m²) **(Jimmam *et al.,* 1998).**

2.2.4. Waist Circumference:

Fat distribution correlates with health risks and mentioned that the waist circumference is a valuable indicator of fat distribution. To measure waist circumference, the assessor places a non stretchable tape around the person's body, crossing just above the upper hip bones and making sure that the tape remains on a level horizontal plane on all sides. The tape is tightened slightly, but without compressing the skin **(Whitney and Rolfes, 2008).** A measurement of greater than 40 inches (102 cm) for men and greater than 35 inches (88 cm) for women is an independent risk factor for disease. These measurements may not be as useful for those less than 60 inches tall or with a BMI of 35 or above **(CDC and Prevention, 2002)**.

2.2.5. Waist-to-Hip Ratio:

The waist-to-hip ratio also assesses abdominal obesity, but provides no more information than using the waist circumference alone. In general, female with a waist-to-hip ratio of 0.80 or greater and male with a waist-to-hip ratio of 0.90 or greater have a high risk of health problems. To calculate the waist-to-hip ratio, we divided the waistline measurement by the hip measurement **(Whitney and Rolfes; 2008).**

2.3. Food intake:

Food intake was assessed by a food frequency questionnaire and a 3-day, 24-hour diet recall (2 weekdays and 1 weekend) **(Kristal *et al.,* 1994**). In the same day of interview, the students were asked to recall type and quantity of all foods and beverages or snakes that consumed during the previous 24 hours, and they were also asked to record the food intake during the another two days in their homes and the amount in units or parts then collect the questioners from them when they could write. The students whom could not write were interviewed again, or by telephone (day by day). Then the researchers conformed these units or parts into grams to calculate the daily intake from different nutrients and by using food composition tables **(Robert, *et al.,* 2003).**

Data of the 24-hour food intake were coded and entered into the computer program of food analysis. The food intake data were analysis by this program is based on food composition tables of the (**Egyptian National Nutrition Research Institute, 2006).** Results were compared with current recommendations for nutrient intakes (**Mahan. Kathleen and Sylvia Escott-Stump, 2008).**

2.4. Food habits and dietary data

A questionnaire was used for recording food habits through a personal interview using items from the validated youth and adolescence food frequency questionnaire. It includes questions about the appetite, food allergy, and dietary supplement, number of meals/ day, main meal, skipping meals, food likes and dislikes, snacks, number of meals eaten outside/week, smoking cigarettes, drinking coffee or any caffeine beverages and exercise (**Rockett *et al.,* 1995 & Rockett *et al.,* 1997).**

2.4. Biochemical Measurement:

We asked for help from the laboratory department in King Abdul-Aziz university hospital to collect the blood samples from the students by technician.

2.4.1. Blood Level of Iron and Hemoglobin:

We had an approval from the Ministry for Planning and Development in Jeddah to make this step, we also asked the principle of each school to inform the students' parents about this process.

2.5. Intelligent Quotient:

The aim of the study was to estimate how nutritional status could affect the students thinking and cognitive abilities so we gave them special IQ test given by the psychology department in king Abdul-Aziz department.

The test we used in the present study was Raven's Standard Progressive Matrices: (SPM) (**Raven *et al.*, 1998 updated 2004**). The booklet comprises five sets (A to E) of 12 item each (e.g., A1 through A12), with items within a set becoming increasingly difficult, requiring ever greater cognitive capacity to encode and analyze information. All items are presented in black ink on a white background. And then the result represents as IQ Percentile (percentile is the point on the distribution of its replication percentages of grand total, splitting the distribution to one hundred part equal), the goal of conversion degree crude to the point where the other facilitates the process of comparison. The percentile is the degree lower than, or offset a percentage of the individuals (the relative position of the individual in his group).Each percentile has a rank and vice versa, so the class occupied showing position of the person (individual) relative within a given distribution, and it's wrong to say that the degree of the person equal to percentile 90 means that he got 90 degrees of the 100 but it can be said that the percentile 90 is better than the percentile 85.

2.6. Ethical Consideration:

Permission was attained from Ministry of occupation for Planning and Development in Jeddah city, Kingdom of Saudi Arabia.

2.7. Statistical Analysis:

The statistical analysis of data was conducted using SPSS version 15**(1994**). The statistical analysis included:

2.7.1. Descriptive Statistics: arithmetic mean or average, median and standard deviation. Explore provides more descriptive statistics, including the standard errors, minimum, maximum, percentiles and other descriptive statistics and information.

2.7.2. The results were analyzed by SPSS statistical package version 15 (1994) and the results were tabulated and used the Harvard graphics packages version 4 for representing the results graphically **(Harvard, 1998**).

2.7.3. Qualitative variables were expressed as percentages and association measures available within cross tabs are used as tests of independence between the categorical variables, $\chi 2$ test (chi-square) was used for comparison among proportions (**Armitage *et al.*, 2002).**

Quantitative variables from normal distribution were expressed as mean ±SD.

Independent t-test was used to compare between the two sample means and F-test (One way ANOVA) were used for comparing between groups, there are two assumptions underlying the analysis of variance and corresponding F test. The first is that the variable is normally distributed. The second is that the standard deviation between individuals is the same in each group. If the F ratio is significant, then SPSS conduct post hoc tests as LSD test (Least Significant Difference) (**Betty and Jonathan, 2003**).

A correlation greater than 0.75 is generally described as strong, whereas a correlation between 0.75 and 0.50 Is generally described as moderate and correlation less than 0.50 is generally described as weak.

3. Result

A total of 135 students were enrolled in this study. The study sample comprised participants from six high private and government schools in Jeddah. The students ages range was from 16 to 20 years, 70 (51.9%) of whom were males and 65 (48.1%) of whom were females.

Table (1): (Mean ± SD) and percent distribution of Socioeconomic status of **Studied Students** (N= 135).

Variables	**(Mean ± SD)**	**Min**	**Max**
Age in years	17.53 ±.91	16	20
Family size	7.28±1.85	3	13
Birth Order	3.12 ± 1.72	1	8
Rooms	4.36 ± 1.63	2	10
Characteristics	No.		%
Mother's Education			
Primary	16		11.9
Secondary	70		51.9
University	49		36.2
Father's Education			
Primary	5		3.7
Secondary	64		47.4
University	66		48.9
Working mothers			
No	102		75.6
Yes	33		24.4
Working fathers			
No	25		18.5
Yes	110		81.5
Income/RS			
moderate	27		20.0
High	108		80.0

The table (1) summarizes the mean and standard deviation (Mean ± SD) and distribution of some of the socioeconomic factors. The mean age in years was (17.53 years) with a maximum (Max) of (20 years) and a minimum (Min) of (16 years), while the mean of family size (7.28) member (±1.85) with a Max of (13) members in the family and a Min of (3) members, the mean of birth order (3.12) with a Max of (8) and a Min of (1), while the mean of the number of rooms (4.36) room with a Max of (10) rooms and a Min of (2) rooms. The same table showed that Most of student mother's education levels were secondary school followed by university and primary, 51.9%, 36.2%, and 11.9% respectively. However the majority percent of their father's education levels was for university followed by secondary and primary schools by 48.9%, 47.4%, and 3.7% respectively. Regarding percentage of student's mother working, 75.6% were occupied jobs and 24.4% were not. And for the percentage of working student's father was (81.5%) and (18.5) were not. The majority (80%) of the participants parents income was high (more than 6000 RS/month) followed by (20%) moderate income (3000 - <600RS/ month).

Table (2) shows the mean and standard deviation of the anthropometric measurements as height, weight, Body Mass Index (BMI), waist circumference, hip circumference, and the ratio between the waist and hip circumferences. The mean height of the participants was (162.79 cm) with a Max of (189 cm) and a Min of (120 cm), while the mean of weight (66.3 kg) with a Max of (158 kg) and a Min o(f 35 kg), and the mean of BMI (24.59 kg/m^2) with a Max of (50.4 kg/m^2) and a Min of (14 kg/m2) , and the waist circumferences mean (81.69 cm) with a Max of (149 cm) and a Min of (57 cm), while the hip circumferences has a mean of (17.69 cm) with a Max of (156 cm) and a Min of (63cm) , with a ratio between them of 0.09 (±0.81) with a Max of 1.15 and a Min of 0.69.

Table (2): (Mean ± SD) of Anthropometric measurements of Studied Students (N=135).

Variables	(Mean ± SD)	Min	Max
Height	162.79±9.14	120	189
Weight	66.3±19.97	35	158
BMI	24.59±6.58	14	50.4
Waist Circumference	81.69±18.12	57	149
HIP Circumference	97.61±17.69	63	156
Ratio	0.81±0.09	0.69	1.15

Table (3) shows the percent distribution of BMI for students as female and male we noticed that the percent of obesity in male 38.6% (27 of 70 male students) than female 30.7% (20 of 65) (in categorizes of overweight, obesity class 1, 2, 3). The same table verify that overweight ranges from 12.6% to 14.1% and obesity ranges from 14% to 22% as whole about 35% from adolescents participates between overweight and obesity class one, two and class three.

Table (3): Percent Distribution of BMI of Students (Male & Female) (N=135).

BMI	Male		Female		Total	
	No.	%	No.	%	No.	%
<18.5 (Underweight)	7	10.0	12	18.5	19	14.1
18.5- (Normal)	36	51.4	33	50.8	69	51.1
25- (Overweight)	9	12.9	8	12.3	17	12.6
30- (Obesity class1)	11	15.7	8	12.3	19	14.1
35- (Obesity class 2)	4	5.7	3	4.6	7	5.2
≥40 (Extreme Obesity class3)	3	4.3	1	1.5	4	3.0
Total	70	100.0	65	100.0	135	100.0

T**able (4): Percent distribution and (Mean ± SD) of IQ according to gender and** type of school **(N=119).**

IQ	Male		Female		Private		Public		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
<25	5	7.8	2	3.6	3	8.6	4	4.8	7	5.9
25-	14	21.9	12	21.8	5	14.3	21	25.0	26	21.8
50-	20	31.2	13	23.6	9	25.7	24	28.5	33	27.7
≥75	25	39.1	28	50.9	18	51.4	35	41.7	53	44.5
100.0	64	100.0	55	100.0	35	100.0	84	100.0	119	100.0
Mean	61.1		68.1		66.2		63.5		64.3	
SD	25.51		23.38		27.92		23.35		24.68	

Table (4) show the percent distribution of IQ scores between male students with highest percent for (39.1%) with an IQ score more than 75%, and the least (7.8%) with a score lower than 25. The IQ score between female students half of the student (51%) having a higher score 75%, and only (3.6%) having an IQ score lower than 25%. shows the percent distribution of IQ in private schools with highest percent (51.4%) higher than or equal to 75%, and lower percent (8.6%) with 25% of IQ score. The percent distribution of IQ in public school, (41.7%) of the student had an IQ more than or equal to 76%, while only (4.8%) had a score lower than 25%.

Table (5): presented (Mean ± SD) of Macronutrient for IQ of Studied Students. It shows that the highest Mean of T.kcalorie (1623 ± 652) appear in categories of IQ **≥75** whoever the lowest value of Mean T.kcalorie (1402 ± 543) appear in categories of IQ **< 25**. Lowest value of Mean protein show in group IQ <25 categories, whoever the highest value of mean protein in group IQ ≥75.

The mean for macronutrients protein, fat and carbohydrate in categories of IQ less than (25%) consume (54g) (56.3g) and (160.8 g) respectively, and in group IQ more than (75%) consume around (65.4g), (62.8 g) and (251.3g) respectively.

Figure (1) show a positive moderate correlation between T. kcalories intake and IQ scores of studied students with r =0.28 and statistically significant difference at ***P*** < 0.01. **

Figure (2) show a positive weak correlation between protein intake and IQ scores of studied students with r =0.20 and statistically significant difference at ***P*** < 0.05*.

Figure (3) show a positive weak correlation between fat intake and IQ scores of studied students with r =0.19 and statistically significant difference at ***P*** < 0.05.*

Figure (4) show a positive weak correlation CHO intake and IQ scores of studied students with r = 0.21 and statistically significant difference at ***P*** < 0.05*.

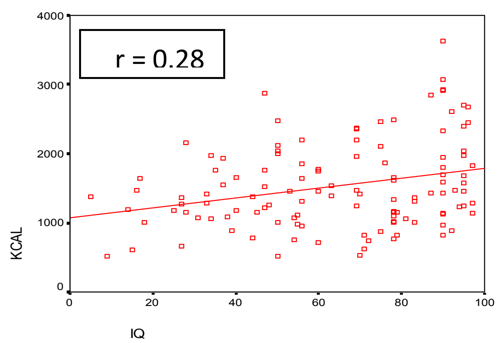

Fig. (1): Correlation between KCAL and IQ of Students (boys & girls).

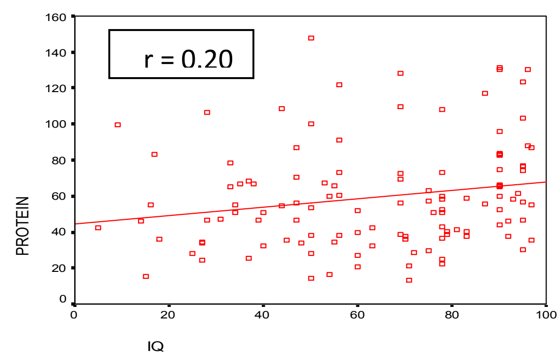

Fig. (2): Correlation between Protein and IQ of Students (boys & girls).

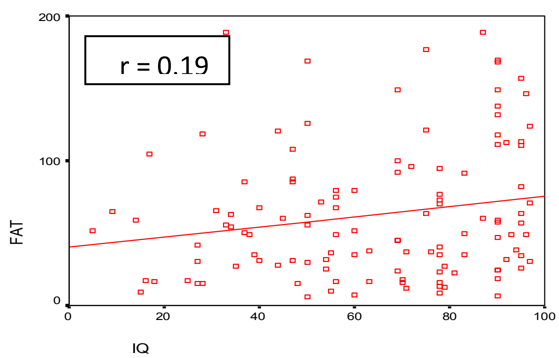

Fig. (3): Correlation between Fat and IQ of Students (boys & girls)

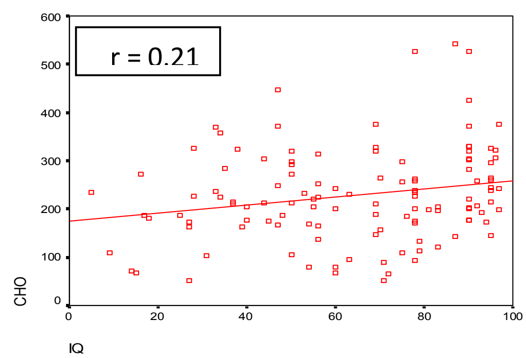

Fig. (4): Correlation between CHO and IQ of Students (boys & girls)

Table (5): (Mean ± SD) intake of Macronutrient and their Correlations with IQ scores of Studied Students

IQ	Mean ± SD KCAL	Mean ± SD Protein	Mean ± SD Fat	Mean ± SD CHO
<25	1402 ± 543	53.9 ± 28.7	56.3 ± 32.3	160.8 ± 79.7
25 -	1533 ± 614	54.7 ± 22.8	60.4 ± 16.5	235.1 ± 90.3
50 -	1402 ± 606	55.6 ± 34.5	61.8 ± 17.3	200.3 ± 88.9
≥75	1623 ± 652	65.4 ± 28.0	62.8 ± 23.6	251.3 ± 99.6
Total	1529 ± 625	59.7 ± 29.1	61.6 ± 20.9	228.3 ± 96.5
r	0.28	0.20	0.19	0.21
***P* -value**	***P*** < 0.01**	***P*** < 0.05*	***P*** < 0.05*	***P*** <0.05*

* *p*<0.05; ** *P*<0.01; *** *P* <0.001

Table (6) shows the mean ± SD of Minerals and Vitamins intake and their Correlations with studied students. Mean ± SD intake of calcium was (1117 ± 441) for those with an IQ score <25, and it was (1353 ± 351) for those with an IQ score ≥75, for iron the mean ± SD was (13.0 ± 5.0) for those with an IQ score <25 and (13.7 ± 4.1) for those with IQ ≥75, for Magn the mean ± SD was(290 ± 121) for those with an IQ score <25 and it was (386 ± 156) for those with IQ ≥75, and the mean ± SD of sodium was (1971 ± 568) for those with an IQ <25, and it was (2250 ± 502) for those with an IQ ≥75, for zinc the mean ± SD was (12.4 ± 4.9) for those with an IQ <25, and it was (14.2 ± 5.9)for those with an IQ ≥75, finally for vitamin A & C mean ± SD were (530±255 & 40.52 ± 4938) respectively for total participates.

Figure (5) shows a positive weak correlation between Calcium intake and IQ scores of studied students with r = 0.20 and statistically significant difference at ***P*** < 0.05. **

Figure (6) shows a positive weak correlation between iron intake and IQ scores of studied students with of r = 0.20 and statistically significant difference at ***P*** < 0.05. **

Figure (7) shows a positive moderate correlation between magnesium intake and IQ scores of studied students with r =0.24 and statistically significant difference at ***P*** < 0.01. **

Figure (8) shows the positive moderate correlation between sodium intake and IQ scores of studied students with r =0.26 and statistically significant difference at ***P*** < 0.01. **

Figure (9) shows a positive weak correlation between zinc intake and IQ scores of studied students with r =0.21 and statistically significant difference at ***P*** <0.05*

Fig. (10): shows a positive weak correlation between Vitamin A intake and IQ scores of studied students with r = 0.19 and statistically significant difference at ***P*** <0.04*

Fig. (11): shows a positive moderate correlation between Vitamin C intake and IQ scores of studied students with r = 0.24 and statistically significant difference at ***P*** <0.008**.

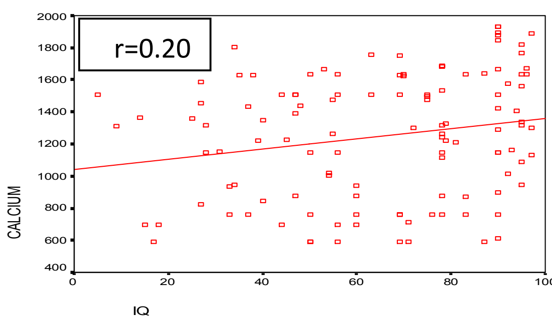

Fig. (5): Correlation between Calcium and IQ of Students (boys & girls).

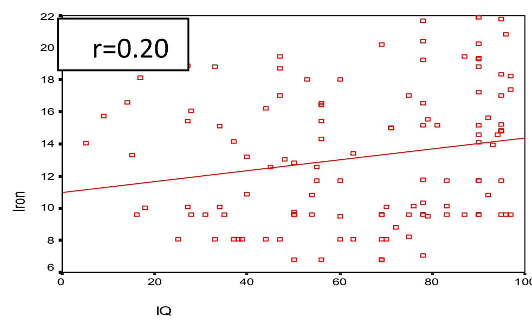

Fig. (6): Correlation between Iron and IQ of Students (boys & girls).

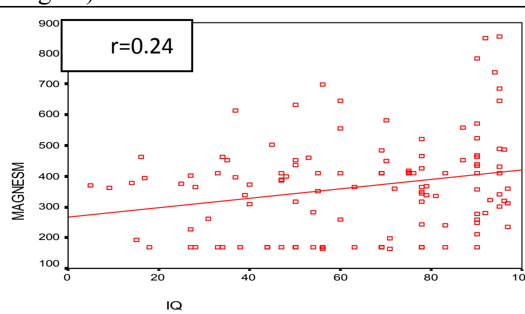

Fig. (7): Correlation between Magnesium and IQ of Students (boys &girls)

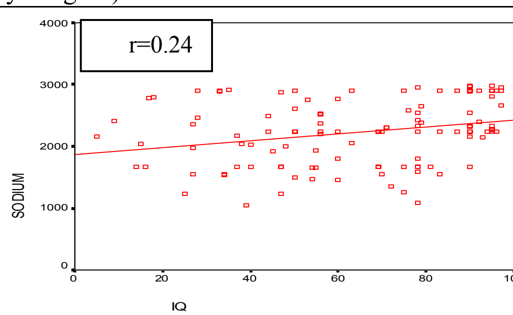

Fig. (8): Correlation between Sodium and IQ of Students (boys &girls)

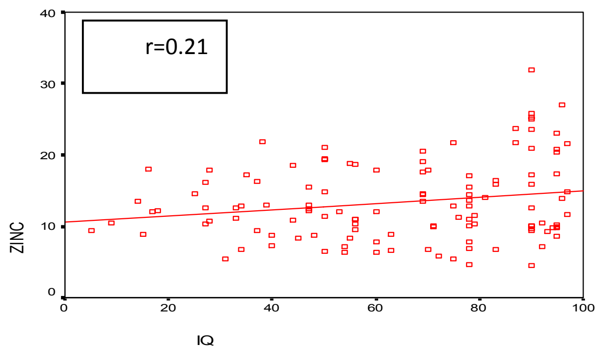

Fig. (9): Correlation between Zinc and IQ of Students (boys &girls)

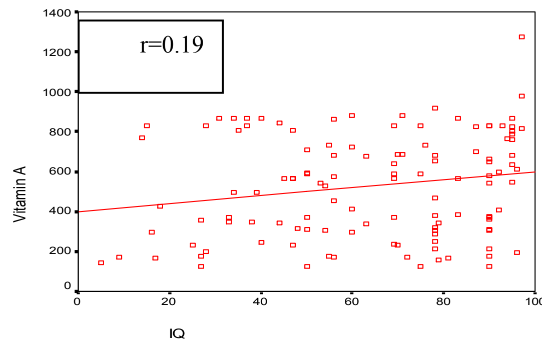

Fig. (10): Correlation between Vitamin A and IQ of Students (boys &girls)

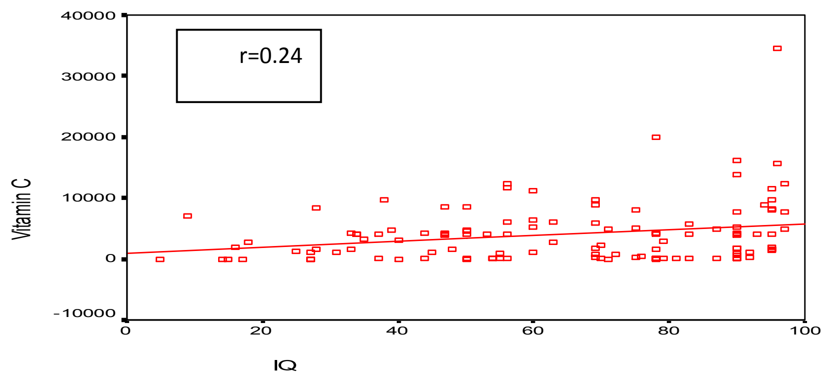

Fig. (11): Correlation between Vitamin C and IQ of Students (boys &girls).

Table (6): (Mean ± SD) of Minerals and Vitamins intake and their Correlations with IQ scores of Studied Students.

IQ	Mean ± SD Calcium	Mean ± SD Iron	Mean ± SD Magn.	Mean ± SD Sodium	Mean ± SD ZINC	Mean ± SD VITA	Mean ± SD VITC
<25	1117 ±441	13.0 ± 5.0	290±121	1971± 568	12.4±4.9	602±215	32.48±29.00
25 -	1160 ±375	13.1 ±4.61	364±152	2225 ± 524	13.3±5.2	591±253	56.17±46.62
50 -	1167 ±428	13.1 ± 4.8	358±166	2228± 594	12.7±5.2	508±232	32.64±39.23
≥75	1353 ±351	13.7 ± 4.1	386±156	2250 ± 502	14.2±5.9	504±274	38.82±57.18
Total	1246 ±391	13.4 ± 4.4	368±156	2222 ± 534	13.5±5.5	530±255	40.52±49.38
R	0.20	0.20	0.24	0.26	0.21	0.19	0.24
***P* -value**	***P*** < 0.05*	***P*** < 0.05*	***P*** <0.01**	***P*** < 0.01**	***P*** <0.05*	***P*** <0.04*	0.008**

Table (7) shows that the prevalence of anemia according to total sample of Studied Students were (31%) which had hemoglobin level <12.9, while (69%) of Studied Students were had normal level of hemoglobin ≥12.9. While (12.0%) from total sample of Studied Students were had iron deficiency anemia (iron level < 6), and (88%) were had normal level of iron (≥6).

Table (6) shows the mean ± SD of Minerals and Vitamins intake and their Correlations with studied students. Mean ± SD intake of calcium was (1117 ± 441) for those with an IQ score <25, and it was (1353 ± 351) for those with an IQ score ≥75, for iron the mean ± SD was (13.0 ± 5.0) for those with an IQ score <25 and (13.7 ± 4.1) for those with IQ ≥75, for Magn the mean ± SD was(290 ± 121) for those with an IQ score <25 and it was (386 ± 156) for those with IQ ≥75, and the mean ± SD of sodium was (1971 ± 568) for those with an IQ <25, and it was (2250 ± 502) for those with an IQ ≥75, for zinc the mean ± SD was (12.4 ± 4.9) for those with an IQ <25, and it was (14.2 ± 5.9)for those with an IQ ≥75, finally for vitamin A & C mean ± SD were (530±255 & 40.52 ± 4938) respectively for total participates.

Figure (5) shows a positive weak correlation between Calcium intake and IQ scores of studied students with r = 0.20 and statistically significant difference at P < 0.05. **

Figure (6) shows a positive weak correlation between iron intake and IQ scores of studied students with of r = 0.20 and statistically significant difference at P < 0.05. **

Figure (7) shows a positive moderate correlation between magnesium intake and IQ scores of studied students with r =0.24 and statistically significant difference at P < 0.01. **

Figure (8) shows the positive moderate correlation between sodium intake and IQ scores of studied students with r =0.26 and statistically significant difference at P < 0.01. **

Figure (9) shows a positive weak correlation between zinc intake and IQ scores of studied students with r =0.21 and statistically significant difference at P <0.05*

Fig. (10): shows a positive weak correlation between Vitamin A intake and IQ scores of studied students with r = 0.19 and statistically significant difference at P <0.04*

Fig. (11): shows a positive moderate correlation between Vitamin C intake and IQ scores of studied students with r = 0.24 and statistically significant difference at P <0.008**

Table (7): Number and Percent distribution of Hemoglobin and Iron and their correlation with IQ scores of Studied Students

Variables		
Hemoglobin **(Hb)**	N	%
<12.9(anemic)	31	31
≥12.9(normal)	69	69
Total	100	100
r	0.26	
p-value	P < 0.05*	
IRON	N	%
<6(iron deficiency)	12	12.0
≥6(Normal)	88	88.0
Total	100	100.0
r	0.28	
p-value	***P*** < 0.01**	

* p<0.05; ** P<0.01; ***P<0.001

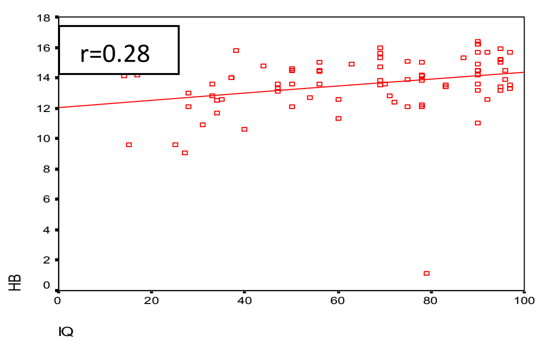

Fig. (12): Correlation between Hb and IQ of Students (boys &girls).

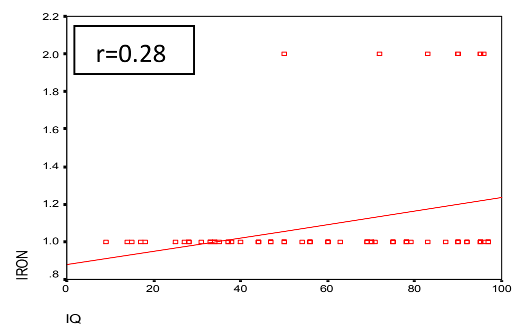

Fig. (13): Correlation between Iron and IQ of Students (boys &girls)

Nutritional needs during adolescence increase because of the increased growth rate and changes in body composition associated with puberty. Attention to the global childhood obesity epidemic is focused on the effects of food and beverage marketing **(WHO and FAO, 2003**). Researchers have found that diet does play a role in IQ and brain development throughout childhood. The degree to which IQ is affected later in life by food choices isn't as well documented. It is best to avoid eating processed foods to boost intelligence. Individuals who eat a lot of processed foods tend to have lower intelligence scores than people who eat healthier non-processed items. The researchers found that diet influenced IQ regardless of other factors. (**GLOOM, 2013).**

The cognitive, physical, social, and lifestyle changes during adolescence can create profound changes in eating patterns. Teens as a group tends to snack, miss meals, eat away from home, consume fast foods, and diet more frequently than younger children. In recent decades, diets have changed rapidly in the Kingdom of Saudi Arabia (KSA) because the Western diet is replacing the traditional Arabic diet. This has resulted in an alarming increase in the number of overweight and obese children and adolescents in KSA. It is well documented that lifestyle is strongly associated with the development of obesity. Nevertheless, this remains to be demonstrated in adolescents from a rapidly developing country in the Middle East such as Saudi Arabia. (**Washi and Ageib, 2010).**

A cross sectional descriptive study was conducted among 135 adolescents students, (16-19 years old) randomly selected including (70) males and (65) females (90.4%) Saudi and (9.6%) non-Saudi students was conducted in six public and private high school students in Jeddah province Kingdom Saudi Arabia after an informed consent agreement. An interview questionnaire which includes information about Socio-economic status demographic data including; age, sex, date of birth, social status, housing, educational level of parents, income, and family size according to **(Park and Park, 1979).**

The nutritional status was assessed by anthropometric measurement;(weight, height, Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity, waist and hip circumferences) and biochemical parameters (blood samples were collected to assess hemoglobin and serum Fe status) in the Clinical Chemistry Laboratory at King Abdul-Aziz University Hospital, Jeddah. Dietary intake, food habits were evaluated by a 3-day dietary recall (food diary) and a food frequency questionnaire. A detailed analysis of IQ trends on the Raven's Progressive Matrices tests to examine the interrelationships among these factors on Cognitive function which was measured by intelligence quotient (IQ) test. The data collection was initiated in October 2011 and completed in May 2012 by investigators. The goal of this study was explained to the subjects.

Socioeconomic status (SES) Characteristics:

Socioeconomic Characteristics of our study; revealed that the mean age , family size, birth order; and room's number of the studied adolescents in this study were (17.53 ±.91, 7.28 ±1.85, 3.12 ± 1.72,and 4.64 ± 1.69, and 4.36 ± 1.63) respectively as shown in table (1) which reflect the socioeconomic status of our study. The country of Saudi Arabia is among the richest and highest per caption income countries of the world. This high income combined with food affluence and lack of nutritional awareness has led to a state of over-nutrition of macronutrients and malnutrition of micronutrients among the population. The over-nutrition of macronutrients is one of the leading causes of the prevalence of overweight and obesity among adult population (**Al- Nuaim *et al.,* 1997; and El-Hazmi and Warsy, 1997; Al-Shoshan, 1992; Madani *et al.,* 2000).** The present study verified that the majority (80%) of the participants parents income was high (more than 6000 RS/month) as shown in table (1). This result verified that most of our sample in high Socioeconomic status (H-SES).

Anthropometric measurement

BMI can be considered as an alternative for direct measures of body fat. Additionally, BMI is an inexpensive and easy-to-perform method of screening for weight categories that may lead to health problems. For children and teens, BMI is age and sex specific and is often referred to as BMI-for-age (**Center of Disease control, 2011**). In Saudi Arabia, obesity is a common health problem among all age groups, Our study verify that total overweight ranges from 12.6% to 14.1% and obesity ranges from 14% to 22% as whole about 35% from adolescents participates between overweight and obesity class one, two and class three as seen in tables (2&3). This result was higher than the observed in other studies at different societies such as the study **by Rômulo *et al.,* 2011** which verified that different risk factors for overweight are associated with SES, and strongly related to parent's overweight, independently of SES. Our study results were supported by other studies such as study done in 2005 in eastern region, in student shows that overweight ranges from 11.7% to 20.5% and obesity ranges from 9.5% to 20.5% (**Al-Nuaim, *et al.,* 1996; Al-Shammari *et al.,* 2001; and Al-Rukban, 2003**). These studies agreeing with our findings, since a positive association was observed between higher SES and elevated overweight presence.

Dietary intake & Correlation with IQ

Livingstone and Robson (2000) stated that the accurate assessment of food intake in children and adolescents is of concern because dietary habits formed early in life in response to physiological requirements and psycho-social pressures may have considerable impact on long-term health status.

The 1994 to 1996 CSFII (Counting Survey of Food Intakes by Individuals) data showed that, on average, most children and adolescents ate fewer servings of the 5 major food groups (grains, vegetables, fruits, dairy, meat/meat substitutes) than the US Department of Agriculture Food Guide Pyramid recommends. Most ate fewer than the minimum recommended 3 servings of vegetables, 2 servings of fruit, 2 to 3 servings of dairy products, and 2 servings of meat/meat substitutes **(Gleason P, and Suitor C 2001**). Among the stages of life, adolescence is characterized by rapid growth and maturation. It is also the period at which girls and boys become more autonomous and develop food habits that may determine their individual life course. This period is also a crucial time for the development of future food habits. Hence, sufficient energy and nutrient intake from a balanced diet and healthy snacks should be provided for optimal growth and the acquisition of early healthy diet habits (**Yannakoulia**

***et al.*, 2004**). In our study, a 3-day, 24-hour (food dairy) recall was averaged for the participants, and this revealed that (Mean ± SD) intake of Macronutrients as Kcalories, protein, fat and CHO were (1529 ± 625, 59.7 ± 29.1, 61.6 ± 20.9and 228.3 ± 96.5) respectively as presented in table (5). Also the mean ± SD intake of Minerals and vitamins were (1246 ±391, 13.4 ± 4.4, 368±156, 2222 ± 534, 13.5±5.5, 530±255 and 40.52±49.38) for calcium, iron, magnesium, sodium, zinc vitamin A and vitamin C respectively) as seen in table (6). Positive moderate correlation between IQ and total kcalories and the differences between IQ and total kcalories was significant at $P < 0.01$.** Positive correlation between IQ and protein and the differences between IQ and protein was significant at $P < 0.01$. **Positive moderate correlation between IQ and sodium and magnesium, statistically the differences were significant at $P < 0.01$. ** While the statistically differences between IQ and iron, zinc and calcium were significant at $P < 0.05$.* But statistically differences between IQ and vitamin A and C and was significant at $P < 0.04$* & 0.008** respectively.

IQ interpretation in the present study and correlations with others results

An intelligence quotient, or IQ, is a score derived from one of several different standardized tests designed to assess intelligence. The term "IQ" comes from the German Intelligent-Quotient. When modern IQ tests are constructed, the mean (average) score within an age group is set to 100 and the standard deviation (SD) to 15 **(Neisser, 1997).** IQ scores have been shown to be associated with such factors as morbidity and mortality, parental social status **(Neisser *et al.*,1996)** and, to a substantial degree, parental IQ. While the heritability of IQ has been investigated for nearly a century, controversy remains regarding the significance of heritability estimates, **(Turkheimer and Eric, 2008; Johnson *et al.*, 2009 and)** and the mechanisms of inheritance are still a matter of some debate **(Devlin *et al.*,1997**). The estimation of the intelligence quotient (IQ) by means of psychometric tests is indispensable in the application of psychological assessment to several fields. Therefore the most widely used intelligence classification systems **(WHO, 1992, 2001; and APA, 2000)** require IQ score to evaluate the existence and degree of intellectual disability, and to provide the patient with the right treatment. Our Findings from a series parameters of a cross section study about intelligent Quotation(IQ) for 119 adolescents participates (64 males & 55 females) in 6 high school levels (Private & Public) ageing (16- 19)years old residing in Jeddah province KSA.

This study indicate that Mean ±SD of IQ of represented Students (Gender and schools) were 64.3 ± 24.68, 61.1± 25.51, 68.1± 23.38 ,66.2 ±27.92 for and 63.5 ± 23.35 for total sample, male, female ,private and public schools respectively while the maximum IQ level for all previous variables about 96 & 97 **as shown in table (4)**.

Regarding the percent distribution of IQ of students according to (Gender & type of Schools) as follows**:** When IQ at level **≥75** about 51% for female participates and 39% for male but 51.4% and 42% for private & public respectively. At **50 –** less 75 about 23.6% for female & 31.2 for male an 25.7%& 28.5 % for private & public respectively. At 25- less 50 about 21.8% female &21.9% for male and 14.3% & 25% for private & public respectively. Less 25 about 3.6% female &7.8 % for male and 8.6 % &4.8 % for Private & public respectively as seen in table (4).

Biochemical analysis of our study (Hemoglobin and iron) and its correlation with IQ.

Anemia is one of the most commonly recognized disorders. It is estimated to affect half the school-age children and adolescents in developing countries (**WHO 1994**). The main cause of anemia is iron deficiency due to inadequate intake of bioavailable iron from the diet (**Lόpez, and Martos. 2004**). Other causes include infectious diseases, deficiencies of micronutrients such as folate, vitamin B12, inherited conditions such as thalassaemia (**WHO, and CDC 2005**) and environmental pollutants such as lead (**Choi, and Kim 2005).** The WHO estimated that 27% of adolescents in developing countries are anemic (**WHO and FAO, 2003**).

Our results demonstrate that (31%) from total sample of Studied Students were had low blood level Hb at <12.9, while (69%) were had normal level of hemoglobin at (≥12.9). While (12.0%) from total sample of Studied Students were had iron deficiency anemia (iron level **< 6**), and (88%) were had normal level of iron (≥ **6)** as shown in table (7). Other study by **Al-Sayes *et al.*, 2011** revealed the prevalence of iron deficiency (ID) and iron deficiency anemia was (25.9%) and IDA (23.9%) among Saudi young females apparently healthy at University stage, in Jeddah Province.

Anemia has been shown to affect mental development and learning capacity. In infancy it may cause a permanent loss of IQ later in life, shortened attention span, irritability, and fatigue, difficulty with concentration, lethargy, weakness and increased susceptibility to infection. Consequently, anemic children tend to do poorly on vocabulary, reading, and other tests (**Kordas *et al.*, 2004**). Adolescents are another risk group for the development of IDA because of rapid growth and increased iron demands during puberty. This is particularly true for adolescent girls due to menstrual losses (**Thane *et al.*, 2003; Maria Iglesia I *et al.*, 2010 andHermoso *et al.*, 2011)**

The present study revealed that a positive weak correlation between hemoglobin level and IQ scores of Studied Students with r =0.26 and statistically significant difference at $P < 0.05$. *

Likewise a positive weak correlation between iron level and IQ scores of Studied Students with r =0.28 and statistically significant difference at $P < 0.01$. **

Conclusion:

Sufficient nutrient intake is very important during adolescent cognitive development. There was a significant association between adolescent dietary intake and adolescent's IQ level. Our study results will be helpful to the authorities in KSA in their efforts to improve nutrition and health of the KSA adolescent.

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