A Comparison of Food and Nutrient Intake of Normal and Obese College Girls

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ABSTRACT Thirty normal and thirty obese subjects from two colleges each from an urban and rural location were chosen randomly to study the underlying dietary causes of obesity and to understand rural-urban epidemiologic transition of obesity among youngsters. 29.4 and 34.6 percent higher BMI and body fat was observed among obese girls in comparison to normal girls, respectively. The higher dietary intakes of energy, protein, carbohydrates and fat were the most significant determinants of obesity among both urban and rural girls. Despite higher energy intake, the intake of vitamins and minerals were significantly (p< 0.01) higher in obese girls which may have positive impact on their overall health. The consumption of rice, root vegetables, whole milk, chocolates, biscuits and fried snacks were significantly (p< 0.01) higher in both urban and rural obese girls. Thus, nutrition awareness needs to be promoted among young girls through various educational programs, so that they can achieve optimum body composition and desirable body weights.

INTRODUCTION

Obesity is a condition of excess fat in body that may increase both the size and number of fat cells. A healthy body requires a minimum amount of fat for the proper functioning of the hormonal, reproductive, and immune systems. The fat also supports body as thermal insulation, as shock absorption for sensitive areas, and as energy for future use. But the accumulation of too much storage fat can impair movement and flexibility, and can alter the appearance of the body. Being obese is a common condition, especially where food supplies are plentiful and lifestyles are sedentary (National Institute of Health 1985).

Obesity has become a global epidemic with an estimated 1.3 billion people overweight or obese. Its prevalence in developed countries, such as United States is high. National Health and Nutrition Examination Survey in United States indicated that an estimated 33.9 percent of US adults aged 20 and over are overweight, 35.1 percent obese and 6.4 percent are extremely obese (Ogden et al. 2014). However, obesity is not only a problem of developed nations but is also becoming an increasing problem in countries undergoing epidemiological transition such as India, South Africa, Mexico and South American countries (Goedecke et al. 2006). Prevalence of overweight / obesity among adolescents and young adults are being continuously reported from different states of India. Prevalence was higher among adolescents from Tamil Nadu (BMI³ 25) even though the studies from Delhi used lower criteria (BMI ³ 23). Prevalence in Delhi was 18 percent (Misra et al. 2004), while in Tamil Nadu it was 20 percent (Ramachandran et al. 2002). Augustine and Poojara (2003) reported 24 percent prevalence of overweight / obesity (BMI > 23) among urban college going girls in Kerala.

Although, the mechanism of obesity development is not fully understood, it is confirmed that obesity occurs when energy intake exceeds energy expenditure. Availability of a large variety of foods these days offers an opportunity to the food lovers to try new dishes at social gatherings. The recent proliferation of fast food restaurants and convenience food markets encourage the consumption of high-fat foods. Most of the time, this extra food provides more calories than are actually required which keeps on accumulating in adipose as fat. A comparison of diet and lifestyle of normal and obese girls from urban and rural groups will pinpoint the underlying dietary causes of obesity. It will also help to understand rural-urban epidemiologic transition of obesity among youngsters as this has become a public health issue that characterizes the modern times and must be efficiently, addressed.

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MATERIAL AND METHODS

A group of thirty normal and thirty obese subjects were chosen randomly from two colleges each from an urban and rural location. College of Home Science, Punjab Agricultural University, Ludhiana represented for urban college while Guru Nanak National College for Women, Nakodar, represented rural college.

Basic anthropometric measurements such as height, weight, waist and hip circumference and skinfold thickness at four sites, that is, biceps, triceps, sub-scapular and supra-iliac were measured using methods given by Jelliffe (1966). Body mass index (BMI) was calculated from the recorded values of height and weight (Garrow1981). Waist/hip ratio was calculated. The percent body fat was calculated from the skinfold thicknesses measured at four sites, that is, biceps, triceps, sub-scapular and supra-iliac using equations given by Durnin and Womersley (1974).

The weekly consumption frequency of common foods present in the regular meals of the selected subjects and the foods particularly related to obesity was recorded. '24-Hour Recall Method' for three consecutive days was used to assess the food intake of the subjects. The nutrient intake was calculated using MSU Nutriguide Computer Program (Song et al. 1992). The adequacy of nutrients was evaluated by comparing the nutrient intake with Recommended Dietary Allowances (RDA) of ICMR (2010).

Means, standard deviations and percentages were computed. Analysis of Variance was employed to compare food and nutrient intake of normal and obese urban and rural girls using factorial experiment in completely randomized design. Data was analyzed using "SAS 9.3" Statistical Software.

RESULTS AND DISCUSSION

Anthropometric Measurements

The anthropometric measurements of the subjects have been shown in Table 1. No significant difference in height of urban and rural as well as normal and obese girls was found. The subjects in all the groups had height higher than the average height (1.51 m) of Indian women (ICMR 1990). A non-significant difference in the body weights of urban and rural girls was found. The body weight of normal girls in both urban and rural groups was close to the weight of reference Indian woman, that is, 55 kg (ICMR 2010).

Table 1: Anthropometric measurements of normal and obese girls

	Urban		Rural		P value	
	Normal (n=30	Obese (n= 30)	Normal (n=30	Obese (n= 30)	Urban/ Rural	Normal/ Obese
Height, m						
Range	1.39-1.71	1.42-1.66	1.50-1.69	1.16-1.69		
Mean±SD	1.59±0.07	1.58±0.06	1.58±0.05	1.59±0.10	0.9377[NS]	0.8659[NS]
Weight, kg						
Range	41.5-67.7	50-94.6	45.5-58.3	46-100.6		
Mean±SD	54.88±5.73	69.68±10.18	52.63±2.95	69.74±12.55	0.4931[NS]	<0.0001[***]
Waist Circumference, cm						
Range	63-80.5	73.5-100	62-83.5	71-97.5		
Mean±SD	72.68±3.78	84.26±7.04	70.32±5.00	84.15±11.88	0.3725[NS]	<0.0001[***]
Hip Circumference, cm						
Range	90-106.5	95.5-134.62	86-108	89-122		
Mean±SD	98.01±4.34	107.69±9.12	97.22±17.81	111.12±8.90	0.5190[NS]	<0.0001[***]
Body Mass Index, Kg/m²						
Range	20.09-23.01	23.11-38.87	20.5-22.83	23.15-38.81		
Mean ± SD	21.62±0.90	27.97±4.20	21.20±0.92	27.44±3.82	0.3706[NS]	<0.0001[***]
Waist/Hip Ratio						
Range	0.67-0.84	0.68-0.91	0.065-0.083	0.69-0.89		
Mean ± SD	0.74±0.04	0.78±0.06	0.73±0.08	0.76±0.09	0.1675[NS]	0.0167[**]
Percent Body Fat						
Range	18.03-29.65	24.56-57.25	17.88-29.29	26.78-40.39		
Mean ± SD	25.39±3.02	33.85±5.75	24.70±2.82	33.55 ± 3.49	0.4921[NS]	<0.0001[***]

[NS] Non significant; [*]Significant at 10%; [**]Significant at 5%; [***] Significant at 1%

As expected, the body weight of obese urban and rural girls was 26.7 percent higher than the reference weight of Indian woman. Sharan and Puttaraj (2006) reported that mean body weight of 20-29 years old women from Bangalore, India was 53.2 kg, whereas, Schutz et al. (2002) found the average body weight of healthy Caucasian adult women was 73.3 kg. The results of present study showed that normal girls had body weight closer to their counterparts from Bangalore but quite lesser than the healthy Caucasian adult women. Another study reported that over a decade, there has been an increase in mean BMI among adult Australian women (Pasco et al. 2013).

A non- significant difference in waist-hip ratio of urban and rural girls, however, a highly significant (p < 0.01) values were observed in case of obese subjects when compared to normal subjects. Babitha and Kusuma (2009) reported that the waist circumference of obese and non-obese Rajasthani women were 83.2 and 67.7 cm, respectively. The results of the present study were close to the reported study. Similar results have been shown by Nande et al. (2009)found the hip circumference of overweight, obese Grade I and obese Grade II women from Maharashtra ranged between 99.6 to 126.0 cm. The results of the present study were close to the one observed in the reported study.

No significant difference was found between the BMI, waist/hip ratio and percent body fat in urban and rural groups. A higher BMI and body fat was, that is, 29.4 and 34.6 percent was observed in obese girls in comparison to normal girls, respectively. According to Garrow (1981), the persons with BMI between 20 to 25 kg/m^2 are considered normal while World Health Organization (WHO 2004) gave the cut-off for Asian population as 23.0 kg/m^2, equal to or above which, the person is categorized as obese. A cut-off point of 0.8 for waist and hip ratio has been taken as reference value (Ghafoorunissa and Krishnamurthy 2000). All the girls had waist/hip ratio below the cut-off value. The optimum waist/hip ratio of the obese girls was attributed to higher values for both waist and hip circumference when compared to normal girls. Nande et al. (2009) found that the waist/hip ratio of normal, overweight, obese grade I and obese grade II women was 0.83, 0.82, 0.81 and 0.82, respectively. The subjects in all groups had lower waist/

hip ratio values in comparison to the reported study.

Food Consumption Frequency

The weekly consumption frequency of various foods has been shown in Table 2.Out of cereal products, the maximum consumption frequency by all four groups was for *chapati* followed by *parantha*, rice, noodles, bread and *poori*. The consumption of rice and *poori* was significantly (p < 0.05) higher in urban group while *parantha* consumption was significantly (p < 0.01) higher in rural group. No significant difference was observed in the consumption of cereal products among normal and obese subjects except rice which was significantly (p < 0.05) higher in obese group. The consumption frequency of dehusked and whole pulses also did not differ significantly among normal and obese girls. However, a significantly (p < 0.01) higher consumption frequency of whole pulses had been reported by the rural subjects as compared to urban subjects.

Out of three vegetable groups, a significantly (p < 0.05) higher consumption of root vegetables particularly potatoes was reported by the obese girls. The consumption frequency of root vegetables as well as green leafy vegetables was significantly (p < 0.1 and 0.01) higher in rural girls when compared with their urban counterparts. No significant difference was observed in the consumption of fruits between urban and rural groups as well as between normal and obese groups. The consumption of milk and milk products namely whole milk, skimmed milk, tea/coffee, cheese and ice cream did not differ significantly in urban and rural groups. However, a significantly (p < 0.1) higher consumption frequency of curd was in urban group and of buttermilk in rural group.

Consumption frequency of whole milk was significantly (p < 0.05) higher in rural group whereas, of skimmed milk, it was higher in urban group. Such results indirectly indicated that fat intake through whole milk was higher in obese girls as compared to normal girls. The consumption frequency of butter and ghee showed no significant difference in urban and rural groups as well as in normal and obese groups. Forslund et al. (2005) reported that a positive relationship between snacking frequency and energy intake exist which directly leads to weight gain. Guo et

Table 2:Weekly food consumption frequency of normal and obese girls

	Urban		Rural		P value	
	Normal (n=30	Obese (n= 30)	Normal (n=30	Obese (n= 30)	Urban/ Rural	Normal/ Obese
Bread	2.13±1.25	2.41±1.62	2.63±1.61	2.57±1.43	0.3133[NS]	0.7827[NS]
Chapati	6.83±0.75	6.73±0.64	6.97±0.19	7±0	0.3801[NS]	0.7917[NS]
Parantha	3.62±1.98	4.29±2.05	5.72±1.62	5.69±1.67	<0.0001[***]	0.1904[NS]
Poori	1.67±1.54	2.0±1.52	1.39±0.98	1.18±0.50	0.0224[**]	0.7801[NS]
Rice	3.15±1.80	4.90±1.78	3.19±1.69	3.04±1.40	0.0129[**]	0.0125[**]
Noodles	2.64±1.84	2.95±1.56	2.36±1.56	2.64±1	0.5059[NS]	0.2146[NS]
Dehusked pulses	3.54±1.40	3.46±1.47	2.83±1.72	3.38±1.61	0.1257[NS]	0.4536[NS]
Whole pulses	3.78±1.95	4.90±1.74	2.79±1.61	2.54±1.69	<0.0001[***]	0.1820[NS]
Root vegetables	4.27±1.84	4.82±1.83	3.35±2.14	4.6±1.71	0.0875[*]	0.0126[**]
Green vegetables	2.23±1.87	2.18±1.39	3.33±2.35	3.87±2.12	0.0003[***]	0.3723[NS]
Other vegetables	4.27±1.84	4.82±1.83	3.35±2.14	4.6±1.71	0.4320[NS]	0.5630[NS]
Fruits	3.88±1.68	3.82±1.54	4.33±1.88	3.5±1.99	0.9403[NS]	0.2182[NS]
Whole milk	4.89±1.97	5.7±1.73	4.58±2.34	6±1.79	0.8792[NS]	0.0142[**]
Skimmed milk	5.15±2.43	2.55±2.25	4.77±2.68	3.70±2.91	0.8197[NS]	0.0092[***]
Tea/Coffee	5.55±1.84	5.41±1.8	5.64±2.14	6.13±1.9	0.4667[NS]	0.6972[NS]
Curd	6.14±1.56	5.50±1.87	4.96±2.24	5.5±2.15	0.0988[*]	0.8577[NS]
Cheese	2.04±1.48	2.18±1.47	2.33±1.91	2.61±1.56	0.2533[NS]	0.3999[NS]
Ice cream	2.37±1.61	2.29±1.23	2.22±1.26	2.42±1.45	0.1939[NS]	0.3553[NS]
Buttermilk	3.57±2.01	4.38±1.95	5±2.33	4.44±1.69	0.0890[*]	0.5944[NS]
Butter	3.38±2.16	4.27±1.78	3.67±2.22	3.30±1.59	0.4175[NS]	0.2596[NS]
Ghee	4.38±2.33	5.33±2.08	4.70±2.47	5.25±2.4	0.9976[NS]	0.1830[NS]
Toffees	2.61±1.65	2.87±1.68	3.55±2.28	3.24±1.64	0.1341[NS]	0.9550[NS]
Chocolates	2.35±1.53	4.2±1.89	3.26±2.12	3.27±1.43	0.9498[NS]	0.0086[***]
Cake and pastries	1.91±1.58	2.18±1.01	3.64±2.5	2.29±1.72	0.1582[NS]	0.4204[NS]
Biscuits	2.41±1.71	4.11±1.71	4.24±2.24	5.58±1.77	<0.0001[***]	<0.0001[***]
Namkeen	2.95±2.38	4.1±1.88	4.64±2.42	4.36±1.66	0.0262[**]	0.1077[NS]
Soft drinks	2.46±1.45	4.32±2.04	3.65±2.15	3.19±1.65	0.6059[NS]	0.1591[NS]
Indian sweet meats	1.71±0.95	2.5±1.38	2.87±1.13	3±1.41	0.0225[**]	0.3059[NS]
Fried snacks	2.20±1.06	4.22±2.22	2.79±1.75	4.46±1.38	0.1933[NS]	<0.0001
Fast food	1.45±0.93	2.09±1.27	2.88±1.25	2.75±1.77	0.1363[NS]	0.3337[NS]
Nuts	2.25±2.01	3.35±2.08	4±1.77	4±1.41	0.0210[**]	0.1419[NS]

[NS] Non significant; [*]Significant at 10%; [**]Significant at 5%; [***] Significant at 1%

al. (2004) reported that people become obese or overweight because they increase their consumption of foods which contain high levels of fat.

Most of the snacks items consumed by the girls were high in refined cereals, sugar and fats. Consumption frequency of snack foods namely *namkeen*, biscuits, Indian sweets and nuts mainly groundnuts was significantly (P < 0.05, 0.01) higher in rural girls in comparison to their urban counterparts.

The consumption frequency of chocolates, biscuits and fried snacks were found to be significantly (p < 0.01) higher in obese girls. The results revealed that rural girls indulge themselves more frequently to fat and sugar rich snack foods than the urban girls, the reason being that the urban girls may be more aware of negative effects of these foods which may lead to lower

consumption of these foods in urban girls. Further, the foods which were found to be the major determinants of obesity were chocolates, biscuits and fried snacks.

Nutrient Intake

The daily nutrient intake of normal and obese girls has been given in Table 3.The average daily intake of energy by urban and rural normal girls was 77 and 76 percent of the recommended dietary allowance (ICMR 2010). The corresponding values for urban and rural obese girls were 142 and 145 percent of the recommended level. No significant difference between energy intake of urban and rural girls was found, however a significantly (p < 0.01) higher energy intake was observed in obese girls in comparison to normal

Table 3: Daily intakes of nutrients by normal and obese girls

	Urban		Rural		P value	
	Normal (n=30	Obese (n= 30)	Normal (n=30	Obese (n= 30)	Urban/ Rural	Normal/ Obese
Energy, kcal	1472±296	2698±689	1442±286	2750± 585	0.9068[NS]	<0.0001[***]
Protein, g	49.12± 11.60	81.08± 23.00	48.25±10.48	72.59± 6.15	0.0860[*]	<0.0001[***]
Carbohydrates, mg	220.17± 39.18	388.33±105.86	186.00±37.21	345.98± 94.57	0.0041[***]	<0.0001[***]
Total Fat	47.42± 19.33	92.93± 32.63	50.54± 15.06	110.80± 27.12	0.0413[**]	<0.0001[***]
PUFA, mg	5.01± 2.23	8.04± 5.11	3.23± 1.85	6.07± 4.51	0.0044[***]	<0.0001[***]
Saturated fats, mg	18.22± 6.12	34.17± 16.12	22.86± 9.75	42.20± 14.28	0.0094[***]	<0.0001[***]
Cholesterol, mg	9.34± 22.41	33.39± 43.42	2.70± 14.54	9.89± 3.05	0.0035[***]	0.0031[***]
Thiamin, mg	1.11± 0.27	3.09± 7.74	1.78± 1.43	2.33± 3.22	0.9423[NS]	0.1147[NS]
Riboflavin, mg	0.79± 0.34	1.76± 2.27	0.96± 0.36	1.69± 0.87	0.8877[NS]	0.0004[***]
Niacin, mg	9.55± .78	15.27± 6.72	8.07± 1.80	12.62± 4.11	0.0099[***]	<0.0001[***]
Folacin, µg	180± 69	256.42± 114.05	159.43± 34.94	258.40± 76.49	0.4064[NS]	0.0049[***]
Vitamin B_{12}, µg	2.71± 11.23	0.90 ± 1.32	2.67± 12.35	0.97± .55	0.9795[NS]	0.2428[NS]
Vitamin C, mg	46.1± 41.6	74.7± 70.8	40.6± 26.0	65.9± 9.6	0.4489[NS]	<0.0001[***]
Vitamin A, µg	1311± 906	2028± 1083	919±522	2142±1509	0.4137[NS]	<0.0001[***]
Iron, mg	11.63± 2.44	16.56± 4.36	10.36± 2.15	15.91± 4.92	0.1194NS	<0.001[***]
Calcium, mg	878± 285	1387± 356	1118±412	1641± 486	0.0013[***]	<0.0001[***]
Phosphorus, mg	1254± 255	1915± 537	1266±286	1864± 419	0.6820NS	<0.0001[***]

[NS] Non significant; [*]Significant at 10%; [**]Significant at 5%; [***] Significant at 1%

girls. Obesity is the result of over-consumption of calories.

The results revealed that protein intake of normal girls was lesser, that is, 89 and 88 percent while, of obese girls, it was higher, that is, 147 and 132 percent, respectively of the RDA. The urban girls had significantly (p < 0.1) higher protein intake than rural girls. Similarly, obese girls also had significantly (p< 0.01) higher consumption of protein than their normal counterparts.

A significantly (p< 0.01) higher intake of carbohydrates was found among urban girls in comparison to rural girls. Obese girls consumed significantly (p< 0.01) more carbohydrates than their normal counterparts. Jain and Singh (2003) found that the average carbohydrate intake of sedentary women in the age group of 25-35 years from Jaipur was 228 g/d. The normal girls in the present study had carbohydrate intake close to the reported value. The normal urban and rural girls consumed only 19 and 26 percent higher fat in comparison to the RDA while obese urban and rural girls consumed 132 and 177 percent higher fat intake (Fig.1). This excessive consumption of fat among Punjabi women has also been reported in literature (Kaur et al. 2013; Dhir 2013). The consumption of type of fat also varied among different groups. The intake of polyunsaturated fatty acids (PUFA) and cholesterol was significantly (p < 0.01) higher in urban girls while saturated fatty acids (SFA) was signifi-cantly (p < 0.01) higher in rural girls. On the other hand, obese girls from both urban and rural groups had significantly (P < 0.01) higher consumption of PUFA, SFA and cholesterol. An undesirable ratio of PUFA: SFA was observed in all groups.

The consumption of vitamins namely thiamin, riboflavin, folacin, vitamin B_{12}, vitamin C and vitamin A did not differ significantly among urban and rural girls. However, niacin intake was found to be significantly (p < 0.01) higher in urban girls. When normal and obese girls were compared, a significantly (p < 0.01) higher intake of riboflavin, niacin, folacin, vitamin C and Vitamin A was observed by the obese girls. The results clearly indicated that the obese subjects consumed large meals resulting in high intakes of energy, protein, carbohydrates and fat but on the other hand, the large meals also provided them with more vitamins which have positive effect on their overall health. Similar results have been reported by Jain (2005) as it was found that overweight and obese school children had higher intake of vitamins and minerals as compared to their non-obese counterparts. On comparison with RDA, the adequacy of thiamin, riboflavin, niacin, folacin, vitamin B_{12}, vitamin C and vitamin A was 144, 80, 73, 85, 269, 109 and 186 percent for normal girls, respectively. The corresponding values for obese girls were 271, 157, 116, 129, 94, 176 and 348 percent (Fig. 2).
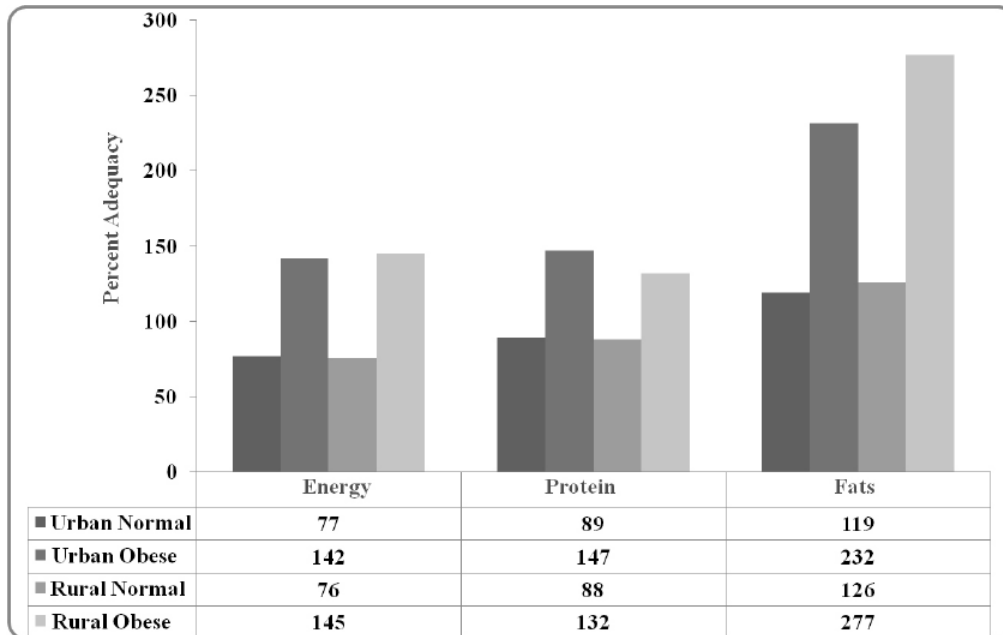
	Energy	Protein	Fats
■ Urban Normal	77	89	119
■ Urban Obese	142	147	232
■ Rural Normal	76	88	126
■ Rural Obese	145	132	277

Fig. 1. Percent adequacy of energy, protein and carbohydrates among urban and rural normal and obese college girls

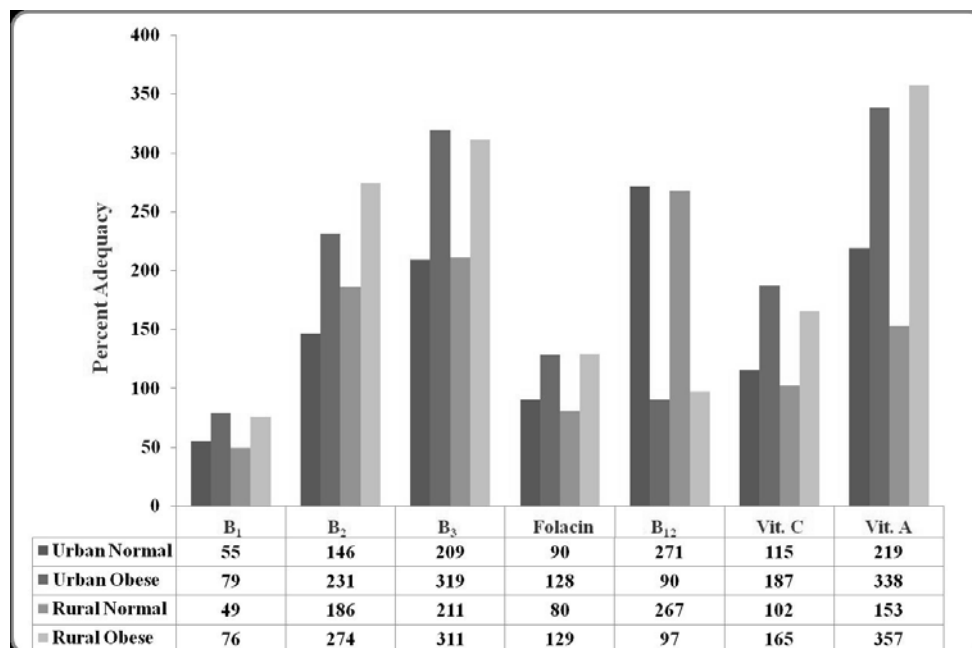|	B_1	B_2	B_3	Folacin	B_{12}	Vit. C	Vit. A
■ Urban Normal	55	146	209	90	271	115	219
■ Urban Obese	79	231	319	128	90	187	338
■ Rural Normal	49	186	211	80	267	102	153
■ Rural Obese	76	274	311	129	97	165	357

Fig. 2. Percent adequacy of vitamin B_1, B_2, B_3, folacin, B_{12} vitamin C and A among urban and rural normal and obese college girls
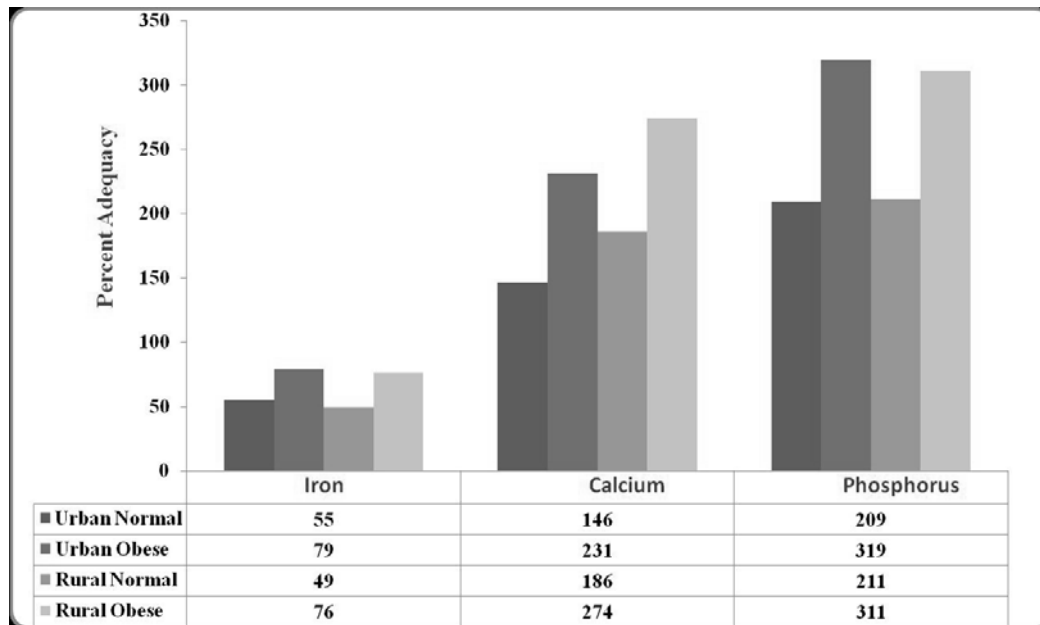
Fig. 3. Percent adequacy of iron, calcium and phosphorus among urban and rural normal and obese college girls

The statistical data revealed that intake of iron and phosphorus did not differ significantly among urban and rural girls, however, calcium intake was significantly ($p < 0.01$) higher in rural girls which could be attributed to higher consumption of dairy products. A significantly ($p < 0.01$) higher intake of iron, calcium and phosphorus was found in obese girls which clearly indicated that the diets of obese girls provided more minerals which has positive impact on their general health. Figure 3 showed that the adequacy of iron, calcium and phosphorus among normal girls was 52, 166 and 210 percent while for obese girls it was 78, 252 and 315 percent, respectively.

CONCLUSION

The study concludes that the higher dietary intakes of energy, protein, carbohydrates and fat were the most significant determinants of obesity among both urban and rural girls. Despite higher energy intake, the intake of vitamins and minerals were significantly higher in obese girls which may have positive impact on their overall health. The foods which were found to be the major determinants of obesity were rice, root vegetables, whole milk, chocolates, biscuits and fried snacks.

RECOMMENDATIONS

Based on the results of the study, it is recommended that nutrition awareness needs to be promoted among young girls through various educational programs, so that they can achieve optimum body composition and desirable body weights.

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