ORIGINAL ARTICLE

# Dietary Pattern, Height, Weight Centile and BMI of Affluent School Children and Adolescents from Three Major Cities of Pakistan

Sina Aziz[1], Umm-e-Rubab[1], Wajeeha Noorulain[1], Rukhsana Majid[2], Kehkashan Hosain[3], Intisar Ahmed Siddiqui[4] and Shaheena Manzoor[5]

## ABSTRACT

**Objective**: To compare the dietary pattern, height, weight centile and BMI of affluent school children and adolescents from three major cities of Pakistan.

**Study Design**: Cross-sectional study.

**Place and Duration of Study**: Private Schools of Karachi, Quetta and Lahore, from September 2007 to March 2008.

**Methodology**: The affluent socioeconomic group was identified by the monthly income of the parents (average > Rs.15,000 per month, $246); school fees of child (average > Rs.1,500 per month, $25) and household items such as computer, refrigerator, washing machine, television, car etc. A total of 652 healthy immunized children with no history of chronic infection, inducted through multistage stratified sampling were divided into groups A, B, and C by ages of 6-9, 10-13, and 14-17 years respectively. Height, weight and 24 hours diet recall was obtained. Centre for Disease Control and prevention (CDC), clinical charts with 5th and 95 percentile for standard height and weight were used. Food records subjected to USDA food exchange list were used. Forms were used as inputs to generate tables for Statistical Package for social sciences -SPSS, Window 13.0.

**Results**: In girls calories and food intake in group A and B of Quetta was lower ($p < .005$) vs. other cities. No significant difference was seen in group C. Fat intake was the same in the girls of all 3 groups. In boys caloric carbohydrates and protein intake of group A of Quetta vs. groups B and C was significant by different National Centre for Health Statistics (NCHS) height and weight in groups A and B were at the 50-90 centile and at 25-50 in group C, centile. BMI ($kg/m^2$) in girls and boys of group A were not different. BMI was highest in group B girls (mean 22±5) and group C boys (25±4) of Quetta.

**Conclusion**: Children of affluent schools of Karachi compared to Quetta are taking more junk food but their consumption of protein is lowered and of a poor quality. Overall fat is below normal recommended standards. However, minimum fat intake was seen in school children of Quetta when compared with Karachi and Lahore. Carbohydrate consumption was adequate. BMI was highest in boys of Quetta than Lahore and Karachi. Majority of children on NCHS centile charts plotted between the 50th-90th centiles.

**Key words:** *Dietary pattern. Body mass index. Affluent school children. Height and weight centile. Pakistan.*

## INTRODUCTION

Socioeconomic disparities in health and nutrition are found in almost all parts of the world but the extent and kind of nutritional deficiencies may differ.[1-2] The nutritional transition occurring in Asian countries is one facet of a more general demographic, epidemiological and nutritional transition occurring with socioeconomic development and urbanization.

[1] *Sarwar Zuberi Liver Centre, Dow University of Health Sciences, Karachi.*
[2] *Depatment of Community Medicine, Bolan Medical College, Quetta.*
[3] *Depatment of Nutrition, Sindh Institute of Urology Transplantation, Karachi.*
[4] *Department of Medical Education, College of Physicians and Surgeons Pakistan, Karachi.*
[5] *Depatment of Community Medicine, Institute of Public Health. Lahore.*

***Correspondence:*** *Dr. Sina Aziz, Ahmed House 7/1, 6th Gizri Lane, DHA Phase IV, Karachi.*
*E-mail: sigma_98@hotmail.com*

*Received December 15, 2008; accepted September 03, 2009.*

The nutritional transition has shifted people from a relatively stereotypical diet based on indigenous staple grains, starchy roots and legumes and fruits and vegetables with smaller amounts of foods of animal origin towards more processed and refined foods of animal origin with more added sugar, fat, and preservatives.[3]

The changes in socioeconomic status have affected the lifestyle of both adults as well as children. Eating habits are influenced by lack of time to prepare meals at home, availability of fast food outlets and food vendor machines.[4]

The dietary pattern of school children is available from other countries such as the Philippines, Sri Lanka, USA and India.[4-7] Studies on the frequency of food consumption have been done in the adult population and older children of the rural-urban population.[8] However, cal/kg/day in terms of carbohydrate, protein and fat have not been determined previously. This study was done on affluent school children of three major cities of Pakistan. No published data regarding such a comparison was available up till now. Hence, the objective of this study was to compare the dietary

pattern, height, weight centile and BMI of children and adolescents from three major cities of Pakistan which reflect a different geographical and cultural background.

## METHODOLOGY

This cross-sectional survey of a multistage stratified sampling design was employed covering private schools from three major cities in Karachi, Quetta and Lahore from Sindh, Balochistan and Punjab. The survey was done in 4 months from September 2007 to March 2008. Stratification was performed according to type of school, age level and gender. The preliminary data of 652 school children from the affluent population is being presented as part of an ongoing project of the Higher Education Commission. In the initial stage, a selection of schools was undertaken followed by a selection of the children from each age group. Children were divided into three groups, according to age: group A, B and C representing 6-9, 10-13 and 14-17 years of age respectively.

Pre-designed questionnaires were used to interview the children to obtain information on their dietary pattern. Wherever, necessary data collected was reconfirmed by parents/guardians of the child, especially in children under 6 years of age. The children included were healthy with no history of chronic infection or frequent hospitalization and immunization up-to-date as per schedule of the immunization program of the country. Any child with a chronic illness, requiring hospitalization and those whose parents refused to participate were excluded. Also, children from the very low socio-economic strata whose parents income was < Rs. 15, 000 per month were excluded. The affluent socio-economic group was identified on the basis of the monthly income of parents (average > Rs.15,000 per month approximately $246); school fees of child (average > Rs.1, 500 per month approximately $25) and presence of household items such as computer, refrigerator, washing machine, television, car etc.

A 24 hours diet recall was obtained from the students and in case of younger children of group A, (6 and 7 years of age) diet recall was confirmed from their parents. Information on the dietary pattern was obtained from a record of the actual food and beverages consumed by the child in one day. The interviewers reviewed the records the following day for completeness and clarification. Forms with missing data were excluded or completed by going back to concerned school and filling the missing data with the help of parents.

Consent of the parents was taken by the Principal/health care team of the school prior to collection of the data. Further more, initially a form/letter was sent to parents explaining to them the nature and importance of the project, seeking their help in its successful completion. Parents refusing to give the required information were not included in the study. Data was collected from each individual child.

The intake included foods eaten for breakfast, lunch, supper and snacks. For this, a food key was developed with the help of dieticians using the United States Department of Agriculture (USDA) approved food exchange[9] and another food list from the website of the Allama Iqbal Open University (AIOU), Pakistan. Ten Food groups were divided into the sweet, oil, starch, milk, vegetable, meat and fruit groups. Body weight was measured in minimum clothing to the nearest 0.1 kg using a weight scale with calibration done after every 25 readings. Body height was measured in the erect position, back and hips touching the wall without shoes to the nearest 0.1 cm using wall mounted stadiometers. For BMI, Center for Disease Control and prevention (CDC), clinical charts with 5th and 95 percentile for standard height and weight were used.[11]

The data collected was edited both in the field i.e. concerned school and at Sarwar Zuberi Liver Centre (SZLC), after which master databases were produced. The food records were subjected to the USDA food exchange list. The master files of the various forms were used as inputs to generate the necessary tables using the Statistical Package for Social Sciences (SPSS) for Windows 13.0. Frequencies and percentage were computed to present dietary pattern according to cultural differences. Continuous response data like BMI, intake of calories, protein, fat and carbohydrate (CHO) were presented by mean ± S.D. Analysis of variance (using F-statistic) was applied to compare the mean dietary intake of total calories, protein, fat and CHO among three cities. P-value ≤ 0.05 was considered as statistically significant difference.

## RESULTS

The children included were from affluent schools of the three cities from classes 1-10 representing age group of 6-17 years. Vaccination was done in 93%. No marked history of infection requiring admission into a hospital was present in 84% of the children. Nutrition pattern, height and weight centiles and BMI of 652 school children in three major cities: Karachi, Lahore and Quetta were studied. As shown in Table I when compared, the consumption of sweet and oil group in which the junk food was included was highest in Karachi a cosmopolitan city, followed by Lahore. It was lowest in

**Table I**: Dietary patterns of affluent school children of three cities according to cultural differences.

| Food groups | Karachi | Quetta | Lahore |
|---|---|---|---|
| Starch group | 24.6% | 32.6% | 24.9% |
| Meat group | 11.7% | 8.5% | 12.9% |
| Vegetable group | 1.7% | 6.0% | 3.4% |
| Fruit group | 7.6% | 6.7% | 6.6% |
| Milk group | 10.4% | 8.5% | 13.0% |
| Fat group | 15.8% | 19.4% | 15.1% |
| Sweet and oil group* | 28.2% | 18.3% | 24.1% |

**Bakery item, burgers, pizza, chips, cakes etc.*

Quetta where the intake of carbohydrates (starch group) was highest; consumption of vegetable group was also highest in Quetta. Fruit intake was unremarkable among school children in the three cities when compared.

Table II shows the data of girls where total calories, carbohydrates and protein intake of group A and B from Quetta was lower ($p < 0.05$) compared to other cities. In group C no significant difference was seen. Total caloric intake was seen to decrease as the age group advanced in Karachi and Lahore but a reverse pattern was seen in Quetta. Fat intake was the same in all groups. Among girls the amount of calories taken decreased with age in Karachi and Lahore.

Table III shows the comparison among boys of the three cities. Total caloric intake, carbohydrates and protein intake of group A, Quetta was significantly different as compared to Karachi and Lahore ($p < 0.05$). In group B and C no significant difference in the three cities was seen. BMI (kg/m$^2$) of girls and boys of group A of three major cities was not markedly different from each other. In group B, BMI was highest in girls of Quetta, (mean 22±5), while in group C highest BMI was in boys of Quetta (25±4).

Table IV shows a comparable difference between intake of total calories, protein, carbohydrate and fat among children of three cities with significant difference ($p < 0.05$) among children of Karachi and Quetta.

Figure 1 shows the height and weight centiles of Pakistani children to be parallel when plotted on NCHS centile charts, where the majority of the children were between 50-90 centile while group C was between 25-50 centile.

**Table II**: Intake of calories (Kcal/day), CHO, protein, fat (gm/kg/day) and BMI in affluent school girls of three cities of Pakistan.

| City | | Group A (6-9 years) | Group B (10-13 years) | Group C (14-18 years) | P-value** |
|---|---|---|---|---|---|
| Karachi | Calories* | | | | |
| | mean±SD^ | 2448.25±867 | 472146.9±981.56 | 1878.42±798.49 | 0.002 |
| | CHO† | | | | |
| | mean±SD | 352.37±123.84 | 297.38±136.63 | 262.13±117.37 | < 0.0001 |
| | (%) | (58.45) | (56.0) | (55.92) | |
| | Protein † | | | | |
| | mean±SD | 75.29±25.84 | 61.87±25.22 | 53.25±21.44 | <0.0001 |
| | (%) | (12.50) | (11.82) | (11.56) | |
| | Fat † | | | | |
| | mean±SD | 106.47±52.0 | 89.06±50.07 | 74.74±39.32 | < 0.0001 |
| | (%) | (39.13) | (36.63) | (35.15) | |
| Lahore | Calories * | | | | |
| | mean±SD | 2778.61±1004.54 | 3030.56±1608 | 68 1982±380.88 | 0.29 |
| | CHO† | | | | |
| | mean±SD | 384.11±134.94 | 406.70±280.87 264 | 14±84.86 | < 0.0001 |
| | (%) | (55.56) | (52.07) | (52.36) | |
| | Protein † | | | | |
| | mean±SD | 96.86±39.66 | 95.64±56.85 | 65.43±7.71 | < 0.0001 |
| | (%) | (13.93) | (12.55) | (13.40) | |
| | Fat † | | | | |
| | mean±SD | 94.28±42.08 | 107.62±39.20 | 74.07±11.85 | 0.002 |
| | (%) | (30.15) | (34.13) | (34.24) | |
| Quetta | Calories * | | | | |
| | mean±SD | 1494.90±558.12 | 1665.41±468.3 | 1919.4±648.75 | 0.070 |
| | CHO† | | | | |
| | mean±SD | 191.13±91.22 | 230.22±79.69 | 280.12±91.46 | 0.038 |
| | (%) | (49.82) | (55.94) | (59.03) | |
| | Protein† | | | | |
| | mean±SD | 53.69±16.16 | 55.09±21.98 | 55.92±22.62 | < 0.0001 |
| | (%) | (14.69) | (13.07) | (11.63) | |
| | Fat † | | | | |
| | mean±SD | 56.63±22.32 | 59.99±24.97 | 69.57±35.60 | 0.003 |
| | (%) | (34.79) | (32.01) | (31.84) | |
| BMI†† | | | | | |
| mean±SD^ | Karachi | 17.21±2.66 | 18.86±3.87 | 20.84±4.75 | |
| | Lahore | 14.66±3.25 | 18.03±3.11 | 20.78±2.89 | |
| | Quetta | 14.17±3.89 | 21.92±4.92 | 18.37±2.87 | |

** Kcal/day; † gm/kg/day; †† Body mass index; ^ Standard Deviation; ** one way ANOVA was applied to obtain p-values between groups A, B and C.*

*(All the mean levels are too high as all values have higher standard deviations).*

**Table III**: Intake of calories (Kcal/day), CHO, protein, fat (gm/kg/day) and BMI in affluent school boys of three cities of Pakistan.

| City | | Group A (6-9 years) | Group B (10-13 years) | Group C (14-18 years) | P-value** |
|---|---|---|---|---|---|
| Karachi | Calories * | | | | |
| | mean±SD | 2291±714 | 2378.8±801.24 | 2539.54±965.2 | 0.50 |
| | CHO † | | | | |
| | mean±SD | 352.87±115.07 | 363.52±152.90 | 400.73±160.94 | < 0.0001 |
| | (%) | (62.43) | (60.14 | | (63.24) |
| | Protein † | | | | |
| | mean±SD | 73.87±18.92 | 74.7±23.49 | 76.23±23.52 | < 0.0001 |
| | (%) | (13.39) | (12.81) | | (12.37) |
| | Fat † | | | | |
| | mean±SD | 91.84±34.54 | 85.77±33.62 | 87.86±44.42 | < 0.0001 |
| | (%) | (37.47) | (33.71) | | (31.87) |
| Lahore | Calories * | | | | |
| | mean±SD | 2370±729.8 | 2515.48±837.80 | 2323.93±1086.08 | 0.73 |
| | CHO † | | | | |
| | mean±SD | 327.35±110.52 | 339.69±120.65 | 303.04±153.89 | < 0.0001 |
| | (%) | (55.05) | (53.87) | | (51.79) |
| | Protein† | | | | |
| | mean±SD | 74.37±14.10 | 83.41±23.09 | 78.55±31.17 | < 0.0001 |
| | (%) | (13.06) | (13.59) | | (13.98) |
| | Fat † | | | | |
| | mean±SD | 86.17±34.87 | 96.80±33.62 | 86.11±48.31 | < 0.0001 |
| | (%) | (32.53) | (34.40) | | (32.91) |
| Quetta | Calories * | | | | |
| | mean±SD | 1656.68±316.54 | 2101.71±512.47 | 2389.04±919.7 | 0.02 |
| | CHO † | | | | |
| | mean±SD | 226.76±66.31 | 305.19±91.76 | 323.75±133.94 | 0.038 |
| | (%) | (54.06) | (57.70) | | (53.86) |
| | Protein† | | | | |
| | mean±SD | 53.92±11.18 | 73.58±19.33 | 72.49±27.09 | 0.004 |
| | (%) | (13.09) | (14.04) | | (12.27) |
| | Fat † | | | | |
| | mean±SD | 58.44±13.28 | 67.19±21.33 | 90.54±36.53 | 0.040 |
| | (%) | (32.22) | (29.31) | | (34.45) |
| BMI†† | | | | | |
| mean±SD | Karachi | 17.01±3.24 | 18.92±3.95 | 21.8±5.26 | |
| | Lahore | 15.57±2.9 | 19.44±4 | | 21.01±4.62 |
| | Quetta | 14.72±2.85 | 19.80±5.0 | | 24.76±3.65 |

*** Kcal/day; † gm/kg/day; †† Body mass index; ^ Standard Deviation; ** one way anova was applied to obtain p-values between groups A, B and C. its is significant below 0.05.*

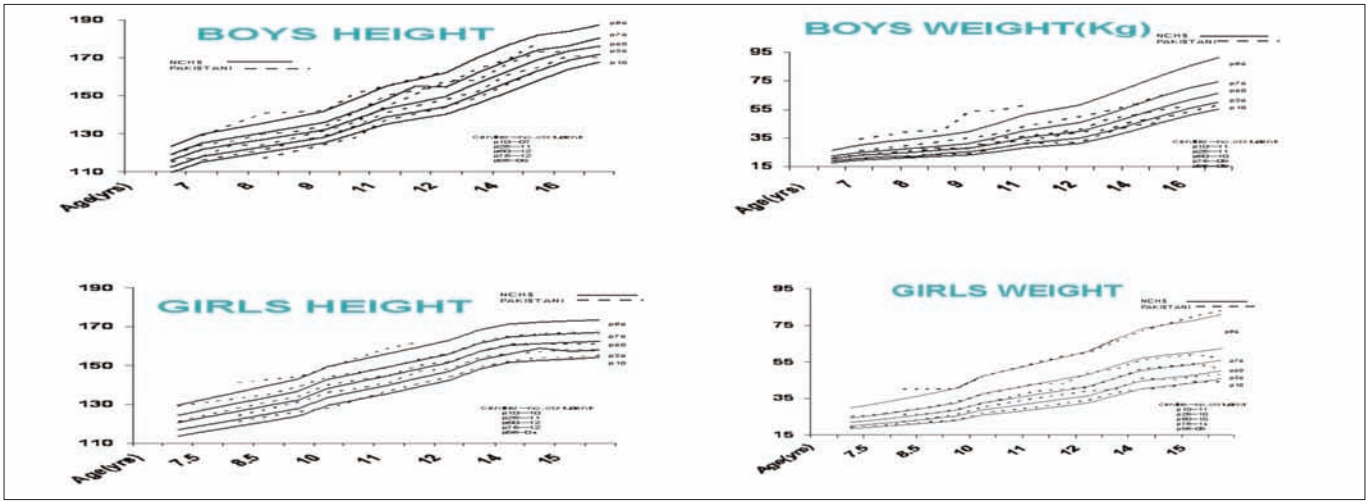


**Figure 1:** The height (cms) and weight (kgs) of girls and boys (age range: 6-17 years) of affluent schools, in three major cities of Pakistan (Karachi, Lahore and Quetta), plotted on NCHS (National centre for Health and Statistics, USA) centile charts.

**Table IV**: Comparison of mean intake of total calories, protein, fat and CHO with p-values of all groups (A, B and C) among affluent school children of three cities of Pakistan.

| | | | p-values |
|---|---|---|---|
| Total calories (mean±SD) | Karachi (2207.01±906.17) | Lahore (2521.16±986.02) | .006* |
| | | Quetta (1887.23±632.66) | .000* |
| | Lahore (2521.16±986.02) | Quetta (1887.23±632.66) | .000* |
| Total protein (mean±SD) | Karachi (65.78±25.14) | Lahore (82.92±31.11) | .000* |
| | | Quetta (57.75±21.97) | .004* |
| Total CHO (mean±SD) | Lahore (82.92±31.11) | Quetta (57.75±21.97) | .000* |
| | Karachi (318.6±139.11) | Lahore (341.28±150.88) | .319 |
| | | Quetta (270.24±94.84) | .001* |
| | Lahore (341.28±150.88) | Quetta (270.24±94.84) | .000* |
| Total fat (mean±SD) | Karachi (88.61±45.76) | Lahore (92.52±39.93) | .715 |
| | | Quetta (67.83±32.22) | .000* |
| | Lahore (92.52±39.93) | Quetta (67.83±32.22) | .000* |

***The mean difference is significant at 0.05 levels.*

## DISCUSSION

In developing countries, urbanization is increasing rapidly and the cities are found to manifest the problems of under and over nutrition simultaneously.[12] Pakistan, a developing country of South East Asia is no exception. With increasing industrialization in the country and the economic development associated with it, people living in rural areas have started to migrate to urban areas on a large scale. With this comes commercialization and changes that are observed as nutrition transition.[9] As found in most studies which have looked at dietary changes, exposure to an urbanized lifestyle causes an increase in the consumption of sweet, fizzy drinks and fast food with migration from the rural to urban Pakistani population.[13]

In the present sample of 652 children, Karachi and Lahore, major business centres and industrialized cities of Pakistan showed a trend among children of taking more junk food when compared to children of Quetta who are still comparatively safe from the degree of urbanization that has occurred in the other two cities. The total caloric intake in Kcal/day among boys and girls showed a decreasing trend with increasing age group, with an exception in children of Lahore where children in group B aged 10-13 years had the highest caloric intake than the other groups but again the majority of their calories were coming from fat (mean 107±39) in gm/kg/day. This supports another study by Jafar *et al.* that states that the unique challenge faced by school aged children in Pakistan i.e. a rapid increase in the proportion of children with over nutrition in the presence of a persistently high burden of under nutrition.[14] This increased fat intake and disproportionate nutrient intake is leading to an increasing number of overweight and obese children in affluent society. In another study done on affluent school children, it was reported that 6% of the children were obese, whereas 20% are overweight.[15]

Though the children studied in our setting were taking adequate calories the type of food taken in was not proper. The US Department of Health and Human Services and the American Heart Association (AHA) along with similar other organizations recommend at least five servings of fruits and/or vegetables per day.[16] But the present observation was a reversal to this recommen-dation as children of all three cities were having fruits and vegetables in a minimal quantity.

Traditionally, a deficiency in macro and micro-nutrients has been the major problem among children in low income countries.[17-21] Nevertheless, owing to progressive urbanization and the associated changes in lifestyle, the energy balance is shifting.[22]

This data shows a high consumption of the sweet and oil group (junk food, bakery items, fast food etc.) among children of Karachi and Lahore. These two cities are the major industrial and cosmopolitan cities. This intake of partially hydrogeneted (trans) fat, commonly found in commercial bakery products and fast foods, increases the risk for cardiovascular diseases and type-2 diabetes in adults.[23] By contrast, unsaturated fats from vegetables and marine sources decrease the risk of these diseases. [23]

Some of the values in Table I-IV show a high standard deviation. This is a reflection of the variation in the dietary intake (carbohydrate, protein and fat) of each child. It is not possible for each child to have a dietary intake which is exactly the same in their respective meals. Especially when the three groups A, B and C are of different age ranges. There is little data from previous studies which have compared a 24 hours dietary recall (in terms of calories, kcal per day and CHO/protein and fat, gm per day) from children of different cultural backgrounds. Hence, a comparison with other studies in the paediatric age group was not possible. However, a variation in caloric intake with a high SD was seen in people who underwent open heart surgery. Although these findings are based on adult people, the dietary pattern suggested to such patients is usually similar to that for growing children.[24]

The BMI (kg/m$^2$) of girls and boys from three major cities was not markedly different from each other. BMI was highest in girls and boys of Quetta (mean 22±5 and 25±4) respectively. There is a gradual increase seen in BMI with age. As the recent WHO guidelines for defining

obesity suggests lower cutoff values of BMI in the Asian population,[25] this increase in BMI may be a risk factor in adolescents (group C) of our study population, reaching their cutoffs for overweight and obesity combined with decreased physical activity with age.

On NCHS (National Centre for Health Statistics) Centile charts children were almost parallel in their height and weights. This was similar to the finding of Akram *et al.* who did a longitudinal study to determine anthropometric measurements in Pakistani children from a high socioeconomic background. Their results also indicated weight and length curves of the study group duplicating NCHS standards at all centiles.[26] The present results showed that a majority of children from group A and B plotted between the 50th to 90th centile, while children in group C were mostly between the 25th to 50th centile. This transition of lifestyle may be due to an excessive exposure to the media, internet, and a more diverse cultural exchange in the last decade or so. A reversal seen in total caloric intake may also be representative of the increasing influence of higher competition for grades in school compelling children to attend extra classes which may lead them to eat less nutritious and more junk food low in nutrients. Similarly, a gradual decrease of caloric intake in girls may show the trend of dieting upto the extent of starving among girls of bigger cities, because of more exposure to media.

## CONCLUSION

Children from the affluent schools of Karachi compared to Quetta are taking more junk food but their consumption of protein has lowered and is of a poor quality. Overall their fat level is below the normal recommended standards. However, a minimum fat intake was seen in school children of Quetta when compared with Karachi and Lahore. Carbohydrate consumption was adequate. BMI was highest in boys of Quetta than Lahore and Karachi. The majority of children between the 50th-90th centiles plotted on the NCHS centile charts.

## REFERENCES


1. Mohan V, Shanthirani S, Deepa R, Premalatha G, Sastry NG, Saroja R; Chennai Urban Population Study (CUPS No. 4). Intra-urban differences in the prevalence of the metabolic syndrome in southern India-the Chennai Urban Population Study (CUPS No. 4). *Diabet Med* 2001; **18**:280-7.
2. Mehta P, Shringarpure B. Diet nutrition and health profile of elderly population of urban Baroda. *Indian J Public Health* 2000; **44**:124-8.
3. Popkin FM, Horton SH, Kim S. The nutrition transition and prevention of diet related diseases in Asia and the Pacific: Executive summary. *Food Nutr Bull* 2001; **22**:3-4
4. Wickramasinghe VP, Lamabadusuriya SP, Atapattu N, Sathyadas G, Kuruparanantha S, Karunarathne P. Nutritional status of school children in an urban area of Sri Lanka. *Ceylon Med J* 2004; **49**:114-8.
5. Florentino RF, Villavieja GM, Lana RD. Dietary and physical activity patterns of 8-10 years old urban school children in Manila, Philippines. *Food Nutr Bull* 2002; **23**:267-73
6. Wojcicki JM, Heyman MB. Healthier choices and increased participation in an middle school lunch program: effects of nutrition policy changes in San Francisco. *Am J Public Health* 2006; **96**:1542-7. Epub 2006 Jul 27.
7. Srihari G, Eilander A, Muthayya S, Kurpad AV, Seshadri S. Nutritional status of affluent Indian school children: what and how much do we know? *Indian Pediatr* 2007; **44**:204-13.
8. Hakeem R, Thomas J, Badruddin SH. Rural-urban differences in food and nutrient intake of Pakistani children. *J Pak Med Assoc* 1999; **49**:288-94.
9. United States Department of Agriculture's Food Guide Pyramid Booklet, Food and Nutrition, 1996. [Internet]. [updated 2009 Dec 2]. Available from: www.nal.usda.gov/fnic/fpyr/pyramid.html
10. Food composition table for Pakistan (revised 2001). [Internet]. [cited 2002]. Available from: www.aiou.edu.pk/foodsite/fctviewonline.html
11. Centres for Disease Control and Prevention: growth charts. [Internet]. [updated 2009 Aug 4]. Available from: http://www.cdc.gov/growthcharts/
12. Hakeem R. Socioeconomic differences in height and body mass index of children and adult living in urban areas of Karachi, Pakistan. *Eur J Clin Nutr* 2001; **55**:400-6.
13. Jafar TH, Qadir Z, Islam M, Hatcher J, Bhutta ZA, Chaturvedi N. Rise in childhood obesity with persistently high rates of under nutrition among urban school-aged Indo-Asian children. *Arch Dis Child* 2008; **93**:373-8. Epub 2007 Oct 17. Comment in: p. 361-2.
14. Aziz S, Noorulain W, Zaidi UE, Hossain K, Siddiqui IA. Prevalence of overweight and obesity among children and adolescents of affluent schools in Karachi. *J Pak Med Assoc* 2009; **59**:35-8.
15. Casagrande SS, Wang Y, Anderson C, Gary TL. Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002. *Am J Prev Med* 2007; **32**:257-63.
16. Khor GL. Update on the prevalence of malnutrition among children in Asia. *Nepal Med Coll J* 2003; **5**:113-22.
17. Chatterjee P. India sees parallel rise in malnutrition and obesity. *Lancet* 2002; **360**:1948.
18. Pobocik RS, Richer JJ. Estimated intake and food sources of vitamin A, folate, vitamin C, vitamin E, calcium, iron, and zinc for Guamanian children aged 9-12. *Pac Health Dialog* 2002; **9**: 193-202.
19. Siekmann JH, Allen LH, Bwibo NO, Demment MW, Murphy SP, Neumann CG. Kenyan school children have multiple micronutrient deficiencies, but increased plasma vitamin $B_{12}$ is the only detectable micronutrient response to meat or milk supplementation. *J Nutr* 2003; **133**:3972S-3980S.
20. Rao BS. Approaches to intervention among children and adolescents. *Nutr Rev* 2002; **60**:S118-25.
21. Aziz S, Puri DA, Hossain K, Hussain F, Naqvi SA, Rizvi SA. Anthropomatric indices of middle socioeconomic class school

children in Karachi compared with NCHS standards: a pilot study. *J Pak Med Assoc* 2006: **56**:264-7.

22. Goran MI, Sun M. Total energy expenditure and physical activity in pre-pubertal children: recent advances based on the application of the doubly labeled water method. *Am JClin Nutr* 1998; **68**:944S-949S.
23. Salmeron J, Hu FB, Manson JE, Stampfer MJ, Colditz GA, Rimon FB, *et al.* Dietary fat intake and risk of type-2 diabetes in women. *Am J Clin Nutr* 2001; **73**:1019-26.
24. Appropriate bodymass index for Asian population and its implications for policy and intervention strategies. *Lancet* 2004; **363**:157-63.
25. Warde-Kamar J, Rogers M, Flancbaum L, Laferrere B. Calorie intake and meal patterns upto 4 years after Roux-en-Y gastric bypass surgery. *Obesit Surg* **14**:1070-9.
26. Akram DS, Agboatwala M. Growth parameters of Pakistani children. *Indian J Pediatr* 1991; **58**:825-32.