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Dietary Intakes of Urban Adolescents of Sialkot, Pakistan Do Not Meet the Standards of Adequacy

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Abstract: There is paucity of national data on dietary intakes of adolescents in Pakistan presently. Therefore, this study was conducted to investigate the dietary intake and nutritional status of urban adolescents in a cross-sectional descriptive survey. A convenience sample of 328 high school students (46.67% female and 53.33% male; mean age, 14.3 years) in Sialkot, Pakistan was analyzed by a demographic questionnaire with lifestyle and health-related questions and kept a 3-day food record for evaluation of dietary intake. Anthropometric measurements, including body composition, were performed. Female adolescents had significantly lower total energy intake than male adolescents ($P \leq 0.001$); however, percentage of killocalorie distribution of protein (12.5%), carbohydrate (51.5%) and fat (36.3%) was similar between male and female adolescents. Male participants had significantly higher micronutrient intakes than female adolescents while female consumed more caffeine than male participants. Both male and female did not meet the estimated average requirements and/or adequate intakes for vitamins A, C, D and E, calcium, potassium and magnesium, whereas more than 70% of female adolescents did not meet the recommendations for vitamin A, D, E, folic acid, phosphorus, zinc and approximately 44% of them did not meet the estimated average requirements for vitamin C, sodium, potassium, iron and manganese. Dietary intake among Pakistani high schools student population intakes in many macro- and micro-minerals, especially in female adolescents, do not meet the standards of adequacy and it reflects the inadequate dietary intake and eating patterns compared with adolescents in other countries.

Key words: Food intake, diet, nutrition, obesity, adolescents

INTRODUCTION

Dietary intake during adolescence is crucial for the growth and development of adolescents, who gain 50% of their adult body weight and skeletal mass and 20% of their adult height with in next few years, while they develop secondary sexual characteristics (Klimis-Zacas, *et al*., 2007). Poor food selections and inadequate dietary intake lead to common nutrition-related disorders which often increase the risk for a wide range of diseases (Klimis-Zacas *et al*., 2007; Abudayya *et al*., 2009). Both male and female are vulnerable to nutritional deficiencies and to imbalanced or unorganized eating behaviors (Abudayya *et al*., 2009) which can lead to developmental disorders like loss of height, osteoporosis and delayed sexual maturation. Evidence from many countries of the world indicates that intakes of several essential nutrients, particularly iron, calcium and zinc (da-Silva *et al*., 2009), do not meet the recommendations particularly in adolescent (Gharib and Rasheed, 2011).

During the last many decades, Pakistani society has undergone extensive urbanization which influences multiple facets of life, including diet and health; a reflection of nutritional transition (Moreno *et al*., 2010; Weker *et al*., 2011). Pakistani are rapidly changing their diet pattern which is now included by an increased consumption of animal food sources and saturated fat, while experiencing noteworthy overall increases in chronic diseases (Abudayya *et al*., 2009; Moreno *et al*., 2010; Popkin, 2004). In addition, the prevalence of overweight/obesity and hypercholesterolemia in adolescents has increased during the last 2 decades (Netto *et al*., 2007). There is paucity of national data on dietary intakes of adolescents in Pakistan presently. Thus, there is an urgent need for comprehensive nutritional assessment studies that will aid public health professionals in the development of nutrition education programs in schools and/or in the community to ensure nutrient adequacy and disease prevention. In addition, it may assist in the development of a dietary database for Pakistani adolescents that will aid not only Pakistan but also the WHO in its goal of establishing unified dietary standards. In the present study the dietary intake and nutritional status of a Pakistani high school students was carried. The assessed nutrient adequacy was compared with findings of similar studies conducted in adolescent populations of different cultural and genetic backgrounds.

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MATERIALS AND METHODS

Study population: Principals/Heads of high schools in Model town (urban middle-class area) of Sialkot, Pakistan, were contacted to assess interest in participating in a comprehensive, cross-sectional nutrition assessment survey. Students and parents/legal guardians who expressed an interest were further informed on the purpose and procedures of the study and signed an informed consent before being included in the study. Among 485 registered students, 328 were recruited (response rate, 67.63%). All participants were asked to complete a demographic questionnaire and keep a 3-consecutive-day food record (2 weekdays and 1 weekend day) for the evaluation of their dietary intake. Anthropometric and body composition measurements were performed in all subjects according to standard procedures (Netto *et al*., 2007; Suzana *et al*., 2012). Approval to implement the study protocol was obtained from the Ethics Committee of Gandhara College of Pharmacy, Gandhara University, Peshawar, KPK, Pakistan.

Anthropometry and body composition: Anthropometric and body composition measurements were performed in the morning before breakfast; participants wearing light clothing, without shoes. Body weight and height were measured using a portable weighing balance and a wall-mounted stadiometer to the nearest 0.5 kg and 0.5 cm, respectively. Waist and hip circumferences were measured to a precision of 0.1 cm and the waist-to-hip ratio was calculated as waist/hip circumferences. Body mass index (BMI) was calculated as body weight/height^2 (kilogram per meter square).

Triceps measurements were performed on the right side of the body, to a precision of 0.2 mm (Klimis-Zacas *et al*., 2007). Body composition was evaluated by bioelectrical impedance analysis (Klimis-Zacas *et al*., 2007; Tzotzas *et al*., 2008). Resistance (R) and reactance (Xc) were measured with a single frequency (50 kHz), 4-terminal impedance Plethysmograph (Suzana *et al*., 2012; Tzotzas *et al*., 2008), with the subject lying in a supine position. Fat-free mass and percentage of fat mass was estimated by the sex- and age-specific prediction formulas (Deurenberg *et al*., 1991), using anthropometric and body composition standards. Anthropometric measurements were obtained in all study participants. Participants were classified as being of normal weight, overweight, or obese according to the proposed cutoff points for BMI (Cole *et al*., 2000), based on international data and linked to the widely accepted adult cutoff points of a BMI of 25 and 30 kg/m^2 for overweight and obesity, respectively (Klimis-Zacas *et al*., 2007; WHO, 1988).

Demographic and physical activity: Subjects were asked to complete an extensive, self-administered questionnaire on demographic, general health and lifestyle characteristics. Sets of questions included physical activity, duration and frequency of smoking. Students were then classified according to their responses to the physical activity questions as sedentary, light, moderate and vigorous exercisers; light, moderate, heavy and nonsmokers (CDC, 1998; Klimis-Zacas *et al*., 2007).

Dietary intake: Dietary intake was assessed using 3-consecutive-day food records (Klimis-Zacas *et al*., 2007). The type and amount of food and beverages consumed by students for 3 consecutive days (2 weekdays and 1 weekend day) using standard household measures (cups, tablespoons, etc.) was recorded. Student's record was reviewed to clarify food entries, servings, recipes and missed foods (Aeberli *et al*., 2009; Khattak and Ullah, 2006).

Statistical methods: Descriptive statistics are presented as mean values and standard errors (mean±SEM). Comparisons of variables between male and female adolescents were conducted using Student t test for independent samples and Chi^2 test of proportion was used to determine the percentage of adolescents with intakes at or below the estimated average requirements and adequate intakes. The level of significance was set at $P \leq 0.05$ unless otherwise stated (Klimis-Zacas *et al*., 2007).

RESULTS

Physical characteristics: Table 1 shows physical characteristics of the study participants. Male adolescents were heavier, taller and with higher BMI and waist-to-hip ratio than female adolescents while triceps skinfold measurements and percentage of fat mass of female adolescents was significantly higher ($P \leq 0.001$) when compared with male adolescents. The percentage of overweight and obese students was found greater among male than female. The internationally documented cutoff points were used for classification of participants as overweight and obese (Institute of Medicine Food and Nutrition Board, 2001). Vigorous physical activity and heavy smoking was observed more often in male than female students based on the standards developed by the US Department of Health and Human Services (WHO, 1988).

Dietary intake: Daily macronutrient and energy intake of the adolescents is presented in Table 2. Female participants had lower total energy intake and lower energy intake per kilogram of body weight. The consumption of carbohydrate and sugar was significantly higher in male than female students but, percentage of energy intake derived from carbohydrates was similar between both sexes. Dietary fiber intake

Table 1: Demographic, anthropometric and lifestyle characteristics of the adolescent population

	Total sample	Male	Female
Characteristics	N = 328	n_m = 175	n_f = 153
Age (years)[a]	14.3±1.52	14.5±1.61	14.1±1.43
Body weight (kg)[a]	42.65±7.35	51.72±6.33	31.70±4.74*
Height (m)[a]	1.56±0.34	1.61±0.28	1.57±0.25
BMI (kg/m^2)[a]	22.9±2.71	26.8±2.73	17.1±2.64*
Overweight (%)	62 (18.90)	34 (19.43)	28 (18.30)
Obese (%)	13 (3.96)	08 (4.57)	05 (3.27)
Waist-to-hip ratio[a]	7.0±0.06	7.8±0.062	6.2±0.043**
Skin folds[a]			
Triceps (mm)[a]	12.4±1.6	10.5±1.70	14.3±1.2*
Body composition[a]			
Free fat mass (%)	22.5±2.6	16.6±2.1	28.4±2.3**
Physical activity (%)			
Sedentary	137 (41.77)	67 (38.29)	70 (45.75)
Light	156 (47.56)	79 (45.14)	77 (50.33)
Moderate	32 (9.76)	27 (15.43)	05 (3.27)
Vigorous	03 (0.91)	02 (1.14)	01 (0.65)
Smoking status (%)			
None	288 (87.80)	146 (83.43)	142 (92.81)
Light	31 (9.45)	22 (12.57)	09 (05.88)
Moderate	08 (02.44)	06 (03.43)	02 (1.31)
Heavy	01 (0.30)	01 (00.57)	00 (0.0)

[a]Mean±SEM (Standard error of means). *P≤0.05 significantly different, **P≤0.001 highly significant difference from male adolescents as determined by Student t test for independent samples.

Table 2: Daily macronutrient and energy intake of the adolescents

	Total sample	Male	Female
Nutrients	N = 328	n_m = 175	n_f = 153
Energy (kcal)	1925±634	2226±742	1226±458
Energy/body weight (kcal/kg)	46.3±8.0	42.3±9.0	40.8±6.2
Protein (g)	68.5±12.1	81.9±12.3	46.5±10.1*
Protein/body weight (g/kg)	1.64±0.35	1.56±0.54	1.54±0.50
Carbohydrate	368.4±75.4	418.2±50.3	271.0±31.0*
Sugars (g)	107.4±12.5	121.7±12.2	77.4±10.3*
Fat (g)	106.3±12.0	130.2±13.2	82.4±12.3*
Dietary fiber (g)	13.7±2.2	19.7±2.1	11.5±1.3*
Cholesterol (mg)	348±20.5	468±25.2	263±16.2**
Energy sources (%kcal)			
Protein	12.5±2.2	13.7±2.4	11.3±2.5
Carbohydrate	51.5±6.4	53.7±4.4	49.3±4.1
Fat	36.3±3.5	38.2±3.2	34.1±3.2
Caffeine (mg)	62.2±3.5	52.6±2.4	67.4±3.5*

Values are mean±SEM (standard error of means). *P≤0.05 significantly and **P≤0.001 high significantly different from male adolescents as determined by Student t test for independent samples.

was higher among male students (P≤0.001). Both sexes derived an equal percentage of their total energy from protein; whereas, the ratio of protein to body weight (grams per kilogram) was significantly higher in male than in female adolescents (P≤0.05). Male adolescents consumed significantly more cholesterol than females (P≤0.05) while females intake of caffeine was higher than male.

With the exception of copper, male adolescents had higher micronutrient intakes than female adolescents. The consumption of Vitamin D, Vitamin E, Folic acid and Manganese was similar in both male and female participants (Table 3).

The percentage of male and female adolescents whose intake is below the dietary reference intakes (DRIs) (EARs and AIs) are presented in Table 4. EAR was used to evaluate the adequacy of nutrient intakes in population groups and the prevalence of inadequate intakes was estimated by the proportion of the population with intakes that fall below the EAR. For nutrients for which the EAR has not been established yet, the Ais were used to assess adequacy of intake. Population tested did not meet the intake recommendations of vitamins and mineral. Female adolescents were found more deficient of vitamin and mineral intakes than male (Table 3, 4).

Table 3: Daily micronutrient intake of the adolescent students

Nutrients	Total sample N = 328	Male n_m = 175	Female n_f = 153
Vitamins			
Vitamin A (mg RE)	471.54±11.73	582±12.65	318±7.54**
Vitamin D (µg)	4.70±0.69	4.72±0.92	4.68±0.77
Vitamin E (mg)	9.63±1.25	9.67±1.02	9.57±0.85
Folic acid (µg)	221±4.63	139±5.83	90.1±4.68**
Vitamin C (mg)	46.4±2.82	51.47±2.53	41.33±1.55*
Minerals			
Calcium (mg)	971.6±32.5	1102.3±34.6	840.7±30.4**
Sodium (mg)	1173.5±46.3	1224.6±50.6	1058.4±44.5*
Potassium (mg)	1903.9±54.6	1968.9±54.8	1810.6±50.3*
Phosphorus (mg)	3150.9±92.4	3351.5±89.2	2885.4±83.4*
Magnesium (mg)	871.3±45.5	919.2±45.8	828.4±41.6
Zinc (mg)	211.4±18.7	225.8±23.4	191.6±17.2
Iron (mg)	6.7±0.82	8.0±0.67	5.2±0.52*
Copper (mg)	6.4±0.81	6.2±0.57	6.6±0.78
Manganese (mg)	571.0±32.1	575.5±29.3	566.5±28.3

Values are mean±SEM (standard error of means). *P≤0.05 significantly and **P≤0.001 high significantly different from male adolescents as determined by Student t test for independent samples. RE indicates retinol equivalents.

Table 4: Percentages of adolescent males and females not meeting the DRIs

Nutrients	Male adolescents (%) with daily intake less than DRIs	DRIs for male adolescents	Female adolescents (%) with daily intake less than DRIs	DRIs for female adolescents
Vitamins				
Vitamin A (mg RE)	70.8	630	78.9	485
Vitamin D (µg)	85.8	5	89.6	5
Vitamin E (mg)	77.2	12	79.7	12
Folic acid (µg)	44.1	330	85.4	330
Vitamin C (mg)	35.2	63	67	56
Minerals				
Calcium (mg)	77.2	1300	77.3	1300
Sodium (mg)	30.4	1500	45.5	1500
Potassium (mg)	44.6	2300	51	2300
Phosphorus (mg)	70.2	4700	86.5	4700
Magnesium (mg)	25.3	1055	38.4	1055
Zinc (mg)	78	340	88.3	300
Iron (mg)	32.7	8.5	49.9	7.3
Copper (mg)	18.3	7.7	44.9	7.9
Manganese (mg)	35.8	685	46.9	685

RE indicates retinol equivalents. DRIs: dietary reference intakes (Institute of Medicine Food and Nutrition Board, 1997, 1998, 2000, 2001, 2005)

DISCUSSION

The present cross-sectional descriptive study provides data on the dietary intake of adolescents residing in an urban middle-class population of Sialkot-Pakistan. The dietary intakes of adolescents were compared between male and female, assessed adequacy of their diet using the DRIs (EARs or AIs) as a standard and compared their dietary intake with that of adolescents from other countries (Hanley *et al*., 2000; Klimis-Zacas *et al*., 2007). Male adolescents had a significantly higher BMI and significantly lower percentage of fat mass than female adolescents (Table 1). Finding is in agreement with normal physiological differences in male versus female (Klimis-Zacas *et al*., 2007). Overweight and obesity are commonly classified according to the cutoff points for BMI (WHO, 1988). Using these standards, 26.8% of male adolescents and 17.1% of female adolescents were classified as overweight/obese in the population tested. It has been found (da-Silva *et al*., 2009) that the prevalence of overweight/obesity among adolescents from South Mediterranean countries is high, around 15% to 25%, even higher than that of the Nordic countries but lower than that of the United States. In Cyprus, 16.9% of male adolescents and 13% of female adolescents were found overweight, with obesity rates of 10.3% for male and 9% for female adolescents. The data from our adolescent population is comparable with the overweight and obesity trends in the United States, where approximately 25% of male and female adolescents are overweight and 30% of male and female adolescents are obese (Amorim-Cruz, 2000; Ghosh, 2011).

Table 5: Comparison of selected macronutrients intake in different countries among adolescents

Parameters	Present study	Canada (Native Canadians)	France	Greece	Portugal	Turkey	USA
No. of participants	328	445	92	114	78	300	8604
Age (years)	14.3	2-19	14	18	13-18	12-19	12-19
Percentage (%) of energy intake from:							
Protein	12.5	14.4	15	14	17.7	13.4	13.7
Carbohydrates	52.5	35	46	44	48.7	51.7	54.8
Fat	36.3	48	38	40	33.25	34.8	32
Dietary fiber (g/1000 kcal)	13.7	4.84	6.3	6.4	NA	8	NA

NA indicates not available. Canada (Hanley *et al*., 2000), Turkey (Bas *et al*., 2005), France (Rolland-Cachera *et al*., 2000), Greece (Klimis-Zacas *et al*., 2007), Portugal (Amorim-Cruz, 2000), USA (Wright *et al*., 2003)

Along with inadequate diet, lifestyle characteristics such as inactivity and smoking promote unhealthy behaviors and are important risk factors for poor growth and disease conditions in later life (Freedman *et al*., 2009). Data of physical activity of male and female adolescents (Table 1) is comparable with the earlier studies (Popkin *et al*., 2006). More than 12% of adolescent population reported cigarette smoking (Table 1) which is significantly lesser than the 35% of adolescents smoking cigarettes in the United States (female adolescents only). Smoking has been related to poor eating habits, such as low consumption of fruits, vegetables and milk (Nieves *et al*., 2010). In addition, smoking has been reported as a weight control practice by adolescents (Nieves *et al*., 2010; Patrick *et al*., 2004). Protein, fat, carbohydrate, fiber and sugar consumption was found higher in male population than female (Table 2) which indicate their higher energy intake but percentage of energy derived from the above macronutrients, as well as the amount of fiber per 1000 kcal, was similar between both sexes. Total sugar consumption was lower than the one reported for Dutch (24.9%) and Native Canadian (23.5-26.4%) teens (Nieves *et al*., 2010; Patrick *et al*., 2004). Our data agree with the suggested trend of lower sugar consumption of children and adolescents in Southern European countries (Patrick *et al*., 2004). The significantly higher fiber intake in male adolescents (Table 2) is attributed to the higher energy intake because the average consumption per 1000 kcal was similar in both sexes. Fiber intake seems to be inadequate when compared with recommendations both for male (19.7±2.1 vs. AIs: 38 g/d) and female adolescents (11.5±1.3 vs. AIs: 26 g/d). Similar findings have been reported for fiber intake of Turkish (Bas *et al*., 2005) and younger US adolescents (Patrick *et al*., 2004) (Table 5).

The population met the recommendations for protein (52 g/d for male and 46 g/d for female adolescents), carbohydrates (130 g/d) and sugar intake (<25% of total energy). Fat consumption was higher in both sexes than the suggested acceptable macronutrient distribution range (25%-35% of total energy for ages 4-18 years) (Bas *et al*., 2005; Rolland-Cachera, 2000) (Table 2). This finding was comparable with total fat intake of British, French, Spanish and Chinese adolescents (Abudayya *et al*., 2009; da-Silva *et al*., 2009; Gharib and Rasheed, 2011; Klimis-Zacas *et al*., 2007) (Table 5).

Both in male and female adolescents reported vitamin D intake were lower than the AIs (Table 3 and 4). Inadequate consumption of vitamin D during adolescence can decrease calcium absorption and consequent its lesser availability for bone mineralization during a stage where 50% of adult bone mass is being acquired (Klimis-Zacas *et al*., 2007). Intake of vitamin D in European countries does not meet the recommendations and there is no specific strategy yet for food fortification with vitamin D, in Pakistan (Anwar *et al*., 2010). In the Mediterranean, casual exposure to sunlight is thought to provide most of the vitamin D requirement of the human population (Klimis-Zacas *et al*., 2007).

The mean intake of vitamin E did not meet the EARs in both sexes. Further water-soluble vitamins intakes were found less than recommendations in both sexes (Table 3 and 4). It has been suggested that the increased vitamin E intake of adolescents from Central and Eastern European countries when compared with Mediterranean adolescents may reflect their higher consumption of PUFAs (Lutfiyya *et al*., 2008). It is reported for the first time that 85.4% of female adolescents tested did not meet the recommendations for folic acid (Table 3 and 4). Low folic acid intake has been reported in adolescent populations across Europe (Lutfiyya *et al*., 2008). Insufficient folic acid status during the periconceptual period has been related to increased risk for neural tube defects in the fetus. Although mandatory folic acid fortification of flour has been discussed in many European countries, none has been introduced (Lutfiyya *et al*., 2008).

A lower calcium intake than AIs standard was observed in both sexes, with more than 77% of male and female adolescents consumed less calcium. The finding is in accordance with the previous reports (Klimis-Zacas *et al*., 2007; Lutfiyya *et al*., 2008). Inadequate calcium intake in adolescence has been related to increased risk for osteoporosis (Abudayya *et al*., 2009), delayed pubertal development, lower circulating adrenal

androgens and significantly higher parathyroid hormone levels (Annweiler *et al*., 2009), indicating a link between calcium intake, the hormonal milieu and skeletal maturation. Calcium fortification in food products is not widespread in Pakistan. Increased sodium intake especially documented in our male population might be a result of increased energy consumption and increased consumption of protein-rich and processed foods (Annweiler *et al*., 2009). A reduced consumption of fruits, vegetables and whole grains in the population is the reflection of insufficient potassium and magnesium intake in most adolescents. Similar mineral inadequacies have been reported in studies on US adolescents (Rolland-Cachera *et al*., 2000) and have been attributed to a shift in dietary patterns (Popkin, 2006). In our female participants, we have also observed insufficient iron intake which has been reported for adolescent populations with similar (Lee and Jiang, 2008) or different ethnic backgrounds (Klimis-Zacas *et al*., 2007; Lee and Jiang, 2008). Iron deficiency in female adolescents is very common and appears soon after they enter menarche and during growth spurt in males (Alizadeh *et al*., 2012). Iron-deficiency anemia can be caused by chronic lesser iron consumption in adolescents may lead to pallor, headache, fatigue and problems with concentration which might affect school and physical performance. Iron fortification of selected foods and educational programs focused on high iron food intakes and on changes in eating behavior may be beneficial in preventing iron deficiency (Ansari *et al*., 2009).

The findings agree with data from different countries suggesting that the adolescents tested were consumed lower than recommended intakes of essential nutrients, vitamins and minerals, especially calcium and iron in population (Alizadeh *et al*., 2012) (Table 5). Such observations of present study are comparable with previous studies on adolescents in Southern Mediterranean countries (da-Silva *et al*., 2009). Sex differences found in this study have also been reported earlier (Fraser *et al*., 2000) and are mainly attributed to sex differences in the level of nutrition knowledge, weight concerns and slimming diets (Abudayya *et al*., 2009). Although, we evaluated a small group of adolescents which by no means representative of the entire Pakistani adolescent population. However, it sufficiently indicates a need for a comprehensive survey of the dietary intake of adolescents in an urban, middle-class setting of Pakistan. Further findings from this study may be used as a tool to assist public health professionals to develop and implement health and nutrition education curricula and design interventions targeting adolescents. This effort may be useful in promoting healthy lifestyles and thus preventing nutrition-related diseases in later part of life. In addition, the paucity of data in this population necessitates the need for more studies in different province of Pakistan to develop a database of dietary intake representative of Pakistani adolescents with the eventual goal of establishing population reference intakes specifically targeted to Pakistani adolescents. We hope that this study, although small, will certainly add to this endeavor.

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Conclusion: Dietary intake among Pakistani high school students population intakes in many macro- and micro-minerals, especially in female adolescents, do not meet the standards of adequacy and it reflects the inadequate dietary intake and eating patterns compared with adolescents in other countries.

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