Asian Journal of Clinical Nutrition

ISSN 1992-1470

Asian Journal of Clinical Nutrition 4 (3): 88-97, 2012
ISSN 1992-1470 / DOI: 10.3923/ajcn.2012.88.97

Cardiovascular Fitness and Caloric Intake in Filipino Obese Children: An Observational Study

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ABSTRACT

There is an alarming increase in the prevalence of childhood obesity. This study examines the joint association of cardiovascular fitness and nutritional intake with obesity in Filipino pre-adolescents. Grade four to six students from an elementary school in Manila were included. Data were obtained from August 2009 to March 2010. Outcome measures were body mass index, cardiovascular fitness using 20 m multistage shuttle run and 24 h dietary food recall utilizing a face to face interview. For males, the odds of being overweight compared to having normal weight were significantly elevated in those who had low cardiovascular fitness and high caloric intake. Comparing those who were obese with those with normal body mass index, the odds of being obese were very high for those who had low cardiovascular fitness and low caloric intake. However, the odds of being obese increased even more when males had low cardiovascular fitness and high total caloric intake. For females, the odds of being overweight and obese was significantly higher for those with high caloric intake and low physical fitness compared to those with high physical fitness, low total caloric intake. The findings emphasize the importance of increasing cardiovascular fitness through involvement in moderate to vigorous physical activity and improving dietary patterns in order to reduce the increasing prevalence of childhood obesity.

Key words: Cardiovascular fitness, caloric intake, childhood obesity, Anthropometric measurement

INTRODUCTION

Childhood obesity is a growing epidemic not only in developed countries but also in developing countries (Deckelbaum and Williams, 2001; Gholamreza and Mohsen, 2007; Veghari, 2011; Chadarat *et al.*, 2006) and its prevalence has been reported to increase with age (Braddon *et al.*, 1986; Serdula *et al.*, 1993). It is a risk factor for adult development of hypertension, diabetes mellitus, hypercholesterolemia and metabolic syndrome at a younger age (Eisenmann, 2007). The likelihood of being obese as adults increases in those who have been obese as children (Guo *et al.*, 1994; Clarke and Lauer, 1993; Srinivasan *et al.*, 1996; Gasser *et al.*, 1995). There is also emerging evidence that links childhood and adolescent obesity to adult mortality and morbidity and to diseases such as coronary heart disease, non alcoholic fatty liver disease, diabetes mellitus, atherosclerosis, asthma and colorectal cancer (Must *et al.*, 1992; Nieto *et al.*, 1992; Ramzan *et al.*, 2009; Khositseth *et al.*, 2009; El-Helaly *et al.*, 2009; Hydrie *et al.*, 2004).

It has been postulated that obesity is due to an energy imbalance where there is an increase in caloric consumption and a decrease in caloric expenditure. This has been frequently observed in adults (Curioni and Lourenco, 2005) but is not consistently seen in children (Parsons *et al.*, 1999). A review of papers from 1970 to 1998 on the variables that correlated with involvement in physical activity of children and adolescents concluded an indeterminate relationship of physical activity and adolescents' body weight and adiposity (Sallis *et al.*, 2000). A shortcoming of these studies has been the use of self-reported physical activity questionnaires, with either unknown or acceptable reliability and validity, which could have led to measurement errors. However, more recent studies which utilized either pedometers or accelerometers as objective measures of physical activity have shown a negative correlation between adiposity and involvement in vigorous physical activity, but not with moderate intensity physical activity (Ruiz *et al.*, 2006; Gutin *et al.*, 2005).

Cardiovascular fitness has been consistently negatively correlated with childhood obesity (Tokmakidis *et al.*, 2006; Chen *et al.*, 2006; Deforche *et al.*, 2003). This can be explained by an increase in body fat which acts as an extra inert load that obese children carry during weight-bearing activities such as the tests used in assessing cardiovascular fitness. Obese children tend to avoid weight-bearing activities due to an increase in energy cost in performing these tasks. As a consequence, they perform more poorly in physical fitness tests, which could also be a sequelae of the lack of motor learning in these tests (Deforche *et al.*, 2003). Cardiovascular fitness has been shown to be a marker of cardiovascular disease in adulthood and greater cardiovascular fitness has been associated with a diminution in risk of later cardiovascular disease (Gutin *et al.*, 1990; Despres *et al.*, 1990).

There are still inconsistencies in the literature regarding the contribution of dietary factors to childhood obesity. The review undertaken by Moreno and Rodriguez (2007) showed that an increase in total energy intake in both longitudinal and cross-sectional studies had inconclusive correlations with the development of obesity. Of the different kinds of food, only sweetened beverages have been positively associated with childhood obesity (Dietz, 2006; Moreno and Rodriguez, 2007). Non-healthy eating patterns such as snacking, fast food consumption and bigger food portion sizes have not been associated with childhood obesity in either cross-sectional or longitudinal studies (Moreno and Rodriguez, 2007). However, these studies have correlated childhood obesity to the components of the energy equation separately, either to a decrease in involvement in moderate to vigorous physical activity and cardiovascular fitness, or to an increase in intake of high density and sugary food. In order to have a clearer picture of the development of childhood obesity, the interaction between the two components of the energy balance, i.e., caloric consumption and energy expenditure, requires investigation. This study examines the joint association of cardiovascular fitness and nutritional intake with obesity in Filipino pre-adolescents. This study reports on data collected during Project HOPE (Hit Obesity through Preventive Education), which was implemented in a private elementary school in Metro Manila to promote healthy lifestyles among its students.

MATERIALS AND METHODS

Ethics: Ethical approval was provided by the bioethics committee of our institution. Informed consent was obtained from the participating children and their parents.

Participants: All male and female students from grades four to six of a private elementary school in Metro Manila were invited to participate in the study. The school has implemented the Project

HOPE (Hit Obesity through Preventive Education) which aims to decrease the prevalence of overweight and obesity by adopting a healthy school environment. Students aged ten years and below were excluded, because they have a different total caloric intake requirement compared to children aged ten to twelve years (Barba and Cabrera, 2008). Students who had orthopedic and cardiopulmonary problems and who were unable to perform any of the physical fitness tests were excluded from the study. One of the authors who is a rehabilitation physician performed all physical screening examinations.

Outcome measures

Anthropometric measures and cardiovascular fitness assessment: The participants were asked to wear light clothing and rubber shoes on the day of assessment, for anthropometric measurement and cardiovascular fitness. Height was measured to the nearest 0.1 cm using a stadiometer (Detecto). Weight was measured to the nearest 0.1 kg using a Detecto scale. For these measures, students were asked to remove their shoes and their socks. Body mass index was computed by dividing weight in kilograms by height in meters squared. Children were classified to have normal Body Mass Index (BMI), overweight or obese using the International Obesity Task Force (IOTF) gender and age cut-off points (Cole *et al*., 2000) (Table 1).

Cardiovascular fitness was assessed using the multistage shuttle run, where predicted maximum oxygen consumption (predicted VO_2 max) could be calculated using the formula developed by Leger *et al*. (1988). The maximum possible stage and laps were recorded for each child Leger *et al*. (1988) reported a correlation (r) of 0.71 with a SEE of 55.9 among children aged 8-19 years, with the measured maximum aerobic capacity and reliability testing having a test retest correlation (r) of 0.89.

Dietary intake: A 24 h food recall using face-to-face interview was conducted for the participants to determine the type and number of servings of food consumed per meal and snack time. The number of servings included predetermined types of food (vegetable, fruit, rice, bread, meat and fish, milk and milk products, sweetened beverages and junk food). Composite food items such as meat pie and servings per food intake were based on the Philippine Food Exchange List provided by the Food and Nutrition Research Institute (FNRI).

One nutritionist computed the nutritional data, including the number of servings per food group (fruit, vegetable, milk and milk products, fish and meat, bread and rice, sweetened beverages and junk food), the total grams and caloric intake of carbohydrate, protein and fat and total caloric intake per day. The computations were based on the Filipino dietary intake by the Food and Nutrition Research Institute of the Philippines.

Table 1: International obesity task force gender and age-specific body mass index (BMI) cut-off points for overweight and obese

	Overweight (kg m^{-2})		Obese (kg m^{-2})	
Age (year)	Males	Females	Males	Females
10	19.84	19.86	24.00	24.11
11	20.55	20.74	25.10	25.42
12	21.22	21.68	26.02	26.67

Researcher training: Prior to data gathering, there was an orientation training program regarding measurement protocols for the research team which comprised graduating students and faculty members of the institution. Anthropometric data was collected using standard equipment and landmarks (Norton and Olds, 1996). Nutritional information was collected via interviews with children using standard protocols (including a questionnaire, food models and standard interviewing and recording techniques). To quantify food intake, common household or other measures (computer mouse, rulers, pack of playing cards, matchboxes) were utilized. The research team's performance was confirmed to be reliable prior to commencing the study. Data was obtained from August 2009 to March 2010.

Statistical analysis: Data was gathered and entered into a purpose-built MSExcel sheet. SAS 9.2 software was used for statistical analysis. Means and standard deviations were used to describe the data. Student T tests were employed to test differences in measures between males and females. Analysis of Variance models tested differences in anthropometric measurements, cardiovascular endurance and caloric intake between the different BMI categories (normal, overweight, obese).

Multivariate logistic regression models were employed to determine whether cardiovascular endurance and total caloric intake were associated with being overweight and obese. The findings were reported as Odds Ratios (OR), with 95% Confidence Intervals (CI). The cut-off point for total caloric intake was based on the study of Barba and Cabrera, 2008 where the recommended energy intake was 1,920 and 2,140 calories/day for females and males aged 10 to 12 years, respectively. For predicted VO_2 max, the median result of males (42.2 mL of oxygen/kg/min) was used. Using the males' median value as the standard cut-off point in the females' aerobic data allowed a consistent comparison of 'high' physical fitness and potentially addressed the issue that we found in our data, that most girls during the multistage shuttle run did not exert maximum effort. By using the boy's median value, fewer girls were identified to have high aerobic capacity (as only 20% fell above the boys' median). However, it supported testing for comparability.

Four data classifications were compared in this study:

- Group 1 : High physical fitness, low total caloric intake
- Group 2 : High physical fitness, high total caloric intake
- Group 3 : Low physical fitness, low total caloric intake
- Group 4 : Low physical fitness, high total caloric intake

For males, the odds ratios were computed separately comparing overweight and obese boys with normal BMI boys. For females, the girls who were obese and overweight were considered as one group and compared to those with normal BMI. This was because there were few female participants who were obese.

RESULTS

Subject profile: Three hundred sixty-six (90.6%) of 404 students from Grades 4 to 6 were included in the study. Thirty-four students were excluded because they were younger than 10 years old, two students were absent during the interview for the 24 h food recall and two other students were absent during anthropometric measures data collection. The males were heavier, had significantly higher body mass index and aerobic capacity, compared with females. There was no difference in the carbohydrate, fat and protein intake and total caloric intake between the genders (Table 2).

Comparing the predicted VO_2 max and caloric intake in the three BMI categories, the obese children had lower aerobic capacity compared to the overweight and normal BMI children, considering the total population and females and males separately. There was no difference in intake of carbohydrate, fats, protein and total caloric intake comparing the different BMI categories (Table 3). Although not significant, the obese children had a smaller intake of macronutrients and total caloric intake, compared to the overweight children in the total population and when considering males and females separately. Obese males and females had a smaller total caloric intake compared to the recommended energy requirement of 1,920 and 2,140 calories/day for females and males respectively (Barba and Cabrera, 2008).

The association between caloric intake and cardiorespiratory fitness and overweight and obesity, is reported in Table 4. For males, the odds of being overweight compared to having normal weight

Table 2: Subject profile

Parameters	Male (n = 171)	Female (n = 195)	p-value
Age (year)	11.47±0.79	11.40±0.84	NS
Weight (kg)	43.85±12.08	40.72 ±16.68	0.009
Height (m)	1.46±0.08	1.46±0.09	NS
BMI (kg m^{-2})	20.25±4.31	18.98±3.94	0.003
BMI categories			
Normal	98 (57.3%)	140 (71.8%)	
Overweight	49 (28.7%)	43 (22.1%)	
Obese	24 (14.0%)	12 (6.1%)	
Predicted VO_2 max (mL O_2/ kg b.wt./min)	42.12±3.32	40.61±2.15	< 0.0001
Carbohydrates (g)	295.55±140.29	279.34±105.35	NS
Protein (g)	74.58±34.21	69.43 ±25.40	NS
Fat (g)	58.38 ±57.11	52.33±1.70	NS
Total calories	1966.84±840.16	1863.82±689.34	NS

NS: Non significant differences, VO_2 max: Maximum oxygen consumption

Table 3: Aerobic capacity and intake of food groups, total calories per body mass index categories

Groups	Normal body mass index	Overweight	Obese	p-value
Both boys and girls				
Predicted VO_2 max (mL O_2/kg b.wt./ min)	41.76±3.14	40.91±1.95	39.30±1.75	<0.0001
Carbohydrates (g)	281.68±104.68	306.97±162.69	270.09±113.73	NS
Protein (g)	70.23±25.92	76.02 ±36.85	71.64±34.12	NS
Fat (g)	54.11±50.19	59.59±38.19	50.72±32.88	NS
Total calories	1865.97 ±675.53	2066.8±934.63	1817.72 ±794.12	NS
Boys				
Predicted VO_2 max (mL O_2/kg b.wt./min)	43.13±3.64	41.38 ±2.07	39.39±1.89	<0.0001
Carbohydrates (g)	285.47±111.91	329.92±188.76	267.51±121.21	NS
Protein (g)	71.15±27.9	82.10±42.65	73.27±37.32	NS
Fat (g)	57.57±68.23	61.72±40.16	54.94±33.41	NS
Total calories	1877.05±702.83	2205.12±1038.67	1849.47±844.89	NS
Girls				
Predicted VO_2 max (mL O_2/kg b.wt./min)	40.78±2.29	40.40±1.67	39.10±1.44	<0.045
Carbohydrates (g)	278.99±99.55	281.56±124.88	275.24±101.93	NS
Protein (g)	69.59±24.50	69.23±28.01	68.39±27.8	NS
Fat (g)	51.66±31.76	57.22±36.18	42.27±31.44	NS
Total calories	1858.09 ±657.97	1912±786.33	1754.22±712.30	NS

NS: Non significant differences, VO_2 max: Maximum oxygen consumption

Table 4: Odds ratio of being overweight and obese for males and females

	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value
Males	**Overweight vs. normal**		**Obese vs. normal**	
Group 2*	0.49 (0.34, 2.90)	NS	1.85 (0.11,31.18)	NS
Group 3*	1.29 (0.54, 3.11)	NS	17.94 (2.25, 142.75)	0.006
Group 4*	4.98 (1.70,14.58)	0.003	27.75 (2.92, 263.47)	0.004
Females	**Overweight, obese vs. normal**			
Group 2*	0.56 (0.99, 3.18)	NS		
Group 3*	2.69 (0.91,7.47)	NS		
Group 4*	3.54 (1.17, 10.78)	0.025		

NB: All three categories of interest reported in this table were compared with the reference category (1 = High physical fitness, low total caloric intake), *Group 1: High physical fitness, low total caloric intake, Group 2: High physical fitness, high total caloric intake Group 3: Low physical fitness, low total caloric intake, Group 4: Low physical fitness, high total caloric intake, NS: Non-significant, CI: Confidence interval

was significantly elevated (OR 4.98 (95% CI 1.70, 14.58)) in those who had low cardiovascular fitness and high caloric intake. Comparing those who were obese with those with normal BMI, the odds of being obese was very high (OR 17.94 (95% CI: 2.25, 142.75)) for those who had low cardiovascular fitness and low caloric intake. However, the odds of being obese increased even more to 27.75 (95% CI: 2.92, 263.47)) when males had low cardiovascular fitness and high total caloric intake. For females, the odds of being overweight and obese was significantly higher for those with high caloric intake and low physical fitness (OR: 3.54 (95% CI: 1.17, 10.78), compared to those with high physical fitness, low total caloric intake.

DISCUSSION

This is one of few studies, to the authors' knowledge, which has examined the interaction between physical fitness and caloric intake, related to childhood obesity. We have shown a consistent negative correlation between obesity and cardiovascular fitness and no correlation between obesity and the intake of different macronutrients and total caloric intake, when analyzed separately. However, we demonstrated that regardless of total caloric intake, low physical fitness was associated with obesity for males, while being overweight for males was significantly associated with low physical fitness and high caloric intake. This was a similar finding for females, where being overweight and obese was strongly associated with low physical fitness and high caloric intake.

Most researchers have studied the association of physical activity and food intake with obesity and found no correlation with childhood obesity (Yannakoulia *et al*., 2010; Muecke *et al*., 1992; Zalilah *et al*., 2006). Zalilah *et al*. (2006) compared the nutrients ingested and energy expenditure, among male and female adolescents according to various BMI categories and concluded that overweight males and females had the lowest energy expenditure, while the overweight females had the highest intake of total macronutrients. However, this study did not establish the relationship of physical activity and total caloric intake with obesity. Muecke *et al*. (1992) did not demonstrate an association between low physical activity, high fat intake and obesity. One of the reported limitations of this study was the use of self-reported questionnaires of physical activity and dietary recall, which may be insensitive to adequately measure the two domains. Yannakoulia *et al*. (2010) identified five diet and physical activity behavioral patterns of which only "dinner, cooked meals and vegetables pattern" was negatively associated with obesity indices, i.e., BMI, waist circumference and triceps skinfold. The "high fiber pattern" which had high consumption of whole grain cereals and legumes with low intake of sweetened beverages was negatively correlated with the obesity indices. However, the association was not significant, except for triceps skinfold, when analysis included only acceptable energy reporters (the ratio of the reported energy intake/basal metabolic rate of more than 1). Only, Kamtsios (2008) examined the difference in physical fitness parameters and nutritional habits within BMI categories. Obese children had significantly lower results in the standing long jump, 30-meter sprint and multistage shuttle run and they consumed more fruits, hamburgers and soda. This study did not investigate the interaction between physical fitness and food intake.

Most studies have used physical activity instead of physical fitness in determining putative causes in the development of childhood obesity. This may be due to a weak correlation of the physical activity and cardiorespiratory fitness. A systematic review of Morrow and Freedson (1994) which appraised papers that tested the relationship between physical activity and cardiorespiratory fitness showed a small to moderate relationship between the two, with Pearson r values ranging from 0.16 -0.17. However, not all the studies showed a positive relationship. The results were attributed to poor measurement of physical activity in this age group, a generally acceptable level of aerobic fitness or a true lack of relation between the two domains. However, most of the studies included in this review used self-reported physical activity or questionnaires which did not quantify engagement in the different levels of physical activity. Studies that have used objective measures of physical activity such as accelerometers or pedometers (Ruiz *et al*., 2006; Gutin *et al*., 2005; Rowlands *et al*., 1999) demonstrated a stronger correlation of cardiorespiratory fitness with either vigorous or moderate to vigorous physical activity and this was negatively associated with obesity. A longitudinal study by Johnson *et al*. (2000), which explored whether resting energy expenditure or cardiovascular fitness predicted the rate of adiposity in pre-pubescent children, showed that there was a significant negative relationship between baseline maximum oxygen consumption (VO_2 max) and increasing adiposity. These researchers predicted that an increase in VO_2 max of 0.1 L min^{-1} would result in a decrease of 0.081 kg of fat per kg of lean mass. Energy expenditure did not significantly predict increasing adiposity in children.

Our study showed that low cardiorespiratory fitness was associated with obesity in males regardless of the total caloric intake, while for females, high total caloric intake and low cardiorespiratory fitness was associated with overweight and obesity. Pre-adolescent obese males have been shown to have higher basal metabolic rates compared to their female counterparts (Van Mil *et al*., 2001). Males also had a higher mean lean mass associated with a higher capacity for carbohydrate oxidation. There is also sexual dimorphism in the levels of hormones that could influence metabolism and obesity. The circulating concentrations of norepinephrine and epinephrine are higher in males during exercise. Epinephrine stimulates muscle glycogenolysis, which leads to a greater glycogen utilization (Febbraio *et al*., 1998). The increased level of androgens in pre-adolescent males is a main determinant in the increase in muscle mass in males. Aside from this, it has a thermogenic effect which stimulates substrate utilization (Mooradian *et al*., 1987). On the other hand, testosterone suppresses leptin production which is an important satiety signal in humans. This allows an increased caloric intake to compensate for the increased energy expenditure in males (Wabitsch *et al*., 1997). These gender differences provide a plausible explanation why physical fitness is a more important variable associated with obesity in males as compared to total caloric intake and why both cardiovascular fitness and total caloric intake are associated with obesity in females.

An important observation in this study was that obese children had a lower intake of the different macronutrients and total caloric intake, although not significant, compared with overweight children. In fact, the obese participants did not meet the Filipino nutritional requirement for this age group. This finding is consistent with other studies which reported a lower food intake of obese children compared to overweight children (Gonzalez-Suarez *et al*., 2009; Magarey and Boulton, 1994). These may be due to underreporting of obese children of their food intake.

These findings emphasize the importance for every child, of increasing cardiovascular fitness through involvement in moderate to vigorous physical activity and improving dietary patterns, in order to reduce the increasing prevalence of childhood obesity (Saygin *et al*., 2007). However, a challenge posed by this finding is how to encourage obese children to participate in moderate to vigorous physical activity, since they are less likely to experience success in sports and physical education in school. Physical education classes should be reviewed so that the physical activities included in them should be enjoyable and at the same time, developmentally appropriate to different age groups and different body shapes and weights of children. Nutrition education should also be included in the school curriculum in order for children to have adequate knowledge on healthy eating habits (Bhat and Bhat, 2011) and the detrimental effects of eating energy-dense food. Preventing the increase in the prevalence of childhood obesity will better safeguard adult health by averting adult obesity and the lifestyle-related diseases that are associated with it.

ACKNOWLEDGMENT

The authors would like to extend their gratitude to Ms. Nenita Caralipio, MA, for her support in implementing the Project HOPE.

REFERENCES

Barba, C. and M.I. Cabrera, 2008. Recommended energy and nutrient intakes for Filipinos 2002. Asia Pac. J. Clin. Nutr., 17: 399-404.

Bhat, Z.F. and H. Bhat, 2011. Milk and dairy products as functional foods: A review. Int. J. Dairy Sci., 6: 1-12.

Braddon, F.E., B. Rodgers, M.E. Wadsworth and J.M. Davies, 1986. Onset of obesity in a 36 year birth cohort study. Br. Med. J., 293: 299-303.

Chadarat, M., T. Phattrawan and T. Sunan, 2006. Factors affecting high school overweight students in Pattani province of Thailand. Pak. J. Nutr., 5: 125-129.

Chen, L.J., K.R. Fox, A. Haase and J.M. Wang, 2006. Obesity, fitness and health in Taiwanese children and adolescents. Eur. J. Clin. Nutr., 60: 1367-1375.

Clarke, W.R. and R.M. Lauer, 1993. Does childhood obesity track into adulthood? Critical Rev. Food Sci. Nutr., 33: 423-430.

Cole, T.J., M.C. Bellizzi, K.M. Flegal and W.H. Dietz, 2000. Establishing a standard definition for child overweight and obesity worldwide: International survey. Br. Med. J., 320: 1240-1243.

Curioni, C.C. and P.M. Lourenco, 2005. Long-term weight loss after diet and exercise: A systematic review. Int. J. Obesity, 29: 1168-1174.

Deckelbaum, R.J. and C.L. Williams, 2001. Childhood obesity: The health issue. Obesity Res., 9: S239-S243.

Deforche, B., J. Lefevre, I. De Bourdeaudhui, A. Hills, W. Duquet and J. Bouckaert, 2003. Physical fitness and physical activity in obese and nonobese flemish youth. Obes. Res., 11: 434-441.

Despres, J.P., C. Bouchard and R.M. Malina, 1990. Physical activity and coronary heart disease risk factors during childhood and adolescence. Exerc. Sports Sci. Rev., 18: 243-260.

Dietz, W.H., 2006. Sugar-sweetened beverages, milk intake and obesity in children and adolescents. J. Pediatr., 148: 152-154.

Eisenmann, J., 2007. Aerobic fitness, fatness and the metabolic syndrome in children and Adolescents. Acta Paediatrica, 96: 1723-1729.

El-Helaly, N., Y. Kamel, E. Abd-Elaziz, A. Elwan and M. Nabih, 2009. Childhood obesity and asthma severity: Is there a link? J. Biol. Sci., 9: 259-263.

Febbraio, M.A., D.L. Lambert and R.L. Starkie, 1998. Effect of epinephrine on muscle glycogenolysis during exercise in trained men. J. Applied Physiol., 84: 465-470.

Gasser, T., P. Ziegler, L. Molinari, R.H. Largo and A. Prader, 1995. Prediction of adult skinfolds and body mass from infancy through adolescence. Ann. Hum. Biol., 22: 217-233.

Gholamreza, V. and S. Mohsen, 2007. The comparative study of body mass index distribution among preschool children in a 7 years period in North of Iran. J. Applied Sci., 7: 2681-2685.

Gonzalez-Suarez, C., K. Grimmer-Somers and A. Worley, 2009. Is food intake associated with pre-adolescent obesity? An observational study in Metro Manila, Philippines. Asian J. Clin. Nutr., 1: 107-119.

Guo, S.S., A.F. Roche, W.C. Chumlea, J.D. Gardner and R.M. Siervogel, 1994. The predictive value of childhood body mass index values for overweight at age 35 years. Am. J. Clin. Nutr., 59: 810-819.

Gutin, B., C. Basch, S. Shea, I. Contento and M. DeLozier *et al*., 1990. Blood pressure, fitness and fatness in 5-and 6-year old children. J. Am. Med. Associ., 264: 1123-1127.

Gutin, B., Z. Yin, M. Humphries and P. Barbeau, 2005. Relations of moderate and vigorous physical activity to fitness and fatness in adolescents. Am. J. Clin. Nutr., 81: 746-750.

Hydrie, M.Z.I., A. Basit, N. Badruddin and M.Y. Ahmedani, 2004. Diabetes risk factors in middle income Pakistani school children. Pak. J. Nutr., 3: 43-49.

Johnson, M.S., R. Figueroa-Colon, S. Herd, S.L. Herd and D.A. Fields *et al*., 2000. Aerobic fitness, not energy expenditure, influences subsequent increase in adiposity in black and white children. Pediatrics, 106: 1-6.

Kamtsios, S., 2008. Physical fitness, nutritional habits and daily locomotive action of 12-year-old children with different body mass index. SAJSM, 20: 32-35.

Khositseth, A., U. Suthutvoravut and N. Chongviriyaphan, 2009. Left ventricular mass and geometry in obese children. Asian J. Clin. Nutr., 1: 58-64.

Leger, L.A., D. Mercier, C. Gadoury and J. Lambert, 1988. The multistage 20 m shuttle run test for aerobic fitness. J. Sports Sci., 6: 93-101.

Magarey, A. and J. Boulton, 1994. The Adelaide nutrition study. 1. Food energy intake through adolescence: including an evaluation of the problem of underrecording, age and sex differences Aust. J. Nutr. Diet., 51: 104-110.

Mooradian, A.D., J.E. Morley and S.G. Korenman, 1987. Biological actions of androgens. Endocrine Rev., 8: 1-28.

Moreno, L. and G. Rodriguez, 2007. Dietary risk factors for development of childhood obesity. Curr. Opin. Clin. Nutr. Metab. Care, 10: 336-341.

Morrow, J. and P. Freedson, 1994. Relationship between habitual physical activity and aerobic fitness in adolescents. Pediatric. Exercise Sci., 6: 315-329.

Muecke, L., B. Simons-Morton, I. Weing Huang and G. Parcel, 1992. Is childhood obesity associated with high-fat foods and low physical activity? J. Sch. Health, 62: 19-23.

Must, A., P.F. Jacques, G.E. Dallal, C.J. Bajema and W.H. Dietz, 1992. Longterm morbidity and mortality of overweight adolescents: A follow-up of the harvard growth study of 1922 to 1935. N. Engl. J. Med., 327: 1350-1355.

Nieto, F.J., M. Szklo and G.W. Comstock, 1992. Childhood weight and growth rate as predictors of adult mortality. Am. J. Epidemiol., 136: 201-213.

Norton K. and T. Olds, 1996. Anthropometrica. UNSW Press, Sydney, Australia, ISBN-10:0868402230.

Parsons, T.J., C. Power, S. Logan and C.D. Summerbell, 1999. Childhood predictors of adult obesity: A systematic review. Int. J. Obesity, 8: S1-S107.

Ramzan, M., I. Ali and A. Matin, 2009. Sonographic assessment of hepatic steatosis (fatty liver) in< school children of Dera Ismail Khan City (NWFP) Pakistan. Pak. J. Nutr., 8: 797-799.

Rowlands, A.V., R.G. Eston and D.K. Ingledew, 1999. Relationship between activity levels, aerobic fitness and body fat in 8- to 10-yr old children. J. Appl. Physiol., 86: 1428-1435.

Ruiz, J., N. Rizzo, A. Hurtig-Wennlof, F. Ortega, J. Wärnberg and M. Sjostrom, 2006. Relations of total physical activity and intensity to fitness and fatness in children: The European youth heart study. Am. J. Clin. Nutr., 84: 299-303.

Sallis, J.F., J.J. Prochaska and W.C. Taylor, 2000. A review of correlates of physical activity of children and adolescents. Med. Sci. Sports Exercise, 32: 963-975.

Saygin, O., E. Zorba, K. Karacabey and S. Mengutay, 2007. Gender and maturation differences in health-related physical fitness and physical activity in Turkish children. Pak. J. Biol. Sci., 10: 1963-1969.

Serdula, M.K., D. Ivery, R.J. Coates, D.S. Freeman, D.F. Williamson and T. Byers, 1993. Do obese children become obese adults? A review of the literature. Prev. Med., 22: 167-177.

Srinivasan, S.R., W. Bao, W.A. Wattigney and G.S. Berenson, 1996. Adolescent overweight is associated with adult overweight and related multiple cardiovascular risk factors: The Bogalusa heart study. Metabolism, 45: 235-240.

Tokmakidis, S., A. Kasambalis and A. Christodoulos, 2006. Fitness levels of Greek primary schoolchildren in relationship to overweight and obesity. Eur. J. Pediatr., 165: 867-874.

Van Mil, E.G., K.R. Westerterp, A.D. Kester and W. Saris, 2001. Energy metabolism in relation to body composition and gender in adolescents. Arch. Dis. Child., 85: 73-78.

Veghari, G., 2011. Prevalence of overweight, obesity and scoio-demographic related factors among Iranian Northern school children. J. Biol. Sci., 11: 487-491.

Wabitsch, M., W. Blum, R. Muche, M. Braun and F. Hube *et al.*, 1997. Contribution of androgens to the Gender differences in leptin production in obese children and adolescents. J. Clin. Invest., 100: 808-813.

Yannakoulia, M., I. Ntalla, C. Papoutsakis, A. Farmaki and G. Dedoussis, 2010. Consumption of vegetables, cooked meals and eating dinner is negatively associated with overweight status in children. J. Pediatr., 157: 815-820.

Zalilah, M.S., G. Khor, K. Mirnalini, A. Norimah and M. Ang, 2006. Dietary intake, physical activity and energy expenditure of Malaysian adolescents. Singapore Med. J., 47: 491-498.