



## **Association between Frequency of Breakfast Eating and Obesity in Korean Adolescents**

*Jong-Hyuck Kim<sup>1</sup>, \*Wi-Young So<sup>2</sup>*

1. *Dept. of Sport Education in Living, Bucheon University, Bucheon, Korea*
2. *Dept. of Human Movement Science, Seoul Women's University, Seoul, Korea*

**(Received 14 Dec 2011; accepted 10 Apr 2012)**

### **Abstract**

**Background:** The purpose of this study was to examine whether the frequency of breakfast eating was related with overweight/obesity in Korean adolescents.

**Method:** We analyzed the data collected in the 5<sup>th</sup> KYRBWS, in which 72,399 adolescents participated in 2009. We assessed the association between frequency of breakfast eating and body mass index by using multivariate logistic regression analysis.

**Results:** A total of 20,962(54.9%) boys and 18,479(54.0%) girls skipped breakfast 7 days(all days) per week at baseline. For boys, the odds ratios(ORs) between being overweight and frequency of breakfast eating were 1.040 for 3–5 times per week, 1.092 for 1–2 time(s) per week, 1.059 for no breakfast per week, compared to 6–7 times per week( $p>0.05$ ). The ORs between being obese and frequency of breakfast eating were 1.011 for 3–5 times per week, 0.968 for 1–2 time(s) per week, and 0.932 for no breakfast per week, compared to 6–7 times per week( $p>0.05$ ). For girls, the ORs between being overweight and frequency of breakfast eating were 0.990 for 3–5 times per week, 0.992 for 1–2 time(s) per week, 1.019 for no breakfast per week, compared to 6–7 times per week( $p>0.05$ ). The ORs between being obese and frequency of breakfast eating were 1.075 for 3–5 times per week, 0.946 for 1–2 time(s) per week, and 0.941 for no breakfast per week, compared to 6–7 times per week( $p>0.05$ ).

**Conclusion:** The frequency of breakfast eating has no correlation with overweight/obesity in Korean adolescents.

**Keywords:** Adolescent, Breakfast, Korea, Youth, Behavior, Web-based Survey, Obesity

### **Introduction**

Excessive weight gain has become a major social and public health problem throughout Korea. According to the Korea National Health and Nutrition Examination Survey-IV (KNHANES-IV) conducted in 2009, 5.0% and 11.3% of adolescents aged 12–18 years are overweight and obese, respectively, and the prevalence of excessive weight gain is continually increasing year after year (1).

Excessive weight gain is known to cause negative health effects such as type-II diabetes, hyperten-

sion, stroke, cardiovascular disease, musculoskeletal disorders, and some cancers (2). Furthermore, several studies report that approximately 80% of obese adolescents become obese adults, and hence, prevention of obesity during adolescence is important (3-4).

A sedentary lifestyle and physical inactivity contributes to the increasing prevalence of overweight and obesity in adolescents (5-7). Moreover, excessive energy intake is also an independent risk factor for excessive weight gain (8-9). For this reason,

---

\*Corresponding Author: Tel: 82-10-8998-4642, E-mail address: [wowso@swu.ac.kr](mailto:wowso@swu.ac.kr)

many obese people try to reduce energy intake by diet control and program.

Skipping breakfast is a common method for diet control. However, interestingly, even though skipping breakfast reduces energy intake in the morning, it is also related to a high prevalence of overweight and obesity (10-11). A large number of studies have been carried out to determine whether skipping breakfast is associated with obesity and related to variables in western countries (12-14). Moreover, longitudinal cohort studies have confirmed that regularly skipping breakfast is connected with an increased body mass index (BMI) in all age groups (15-18).

On the other hand, in Korea, no study has examined the relationship between skipping breakfast and obesity among adolescents, as well as no nationwide study has focused on this issue. Hence, the purpose of this study was to determine whether the frequency of breakfast eating was related with obesity in Korean adolescents throughout the country.

## Materials and Methods

### Subject

The 5<sup>th</sup> Korea Youth Risk Behavior Web-based Survey (KYRBWS-V) is a retrospective *cohort study* that was conducted using a complex sample design, which involved stratification, clustering, and multistage sampling. This nationwide school-based survey was conducted by the Korea Centers for Disease Control and Prevention in order to evaluate the prevalence of health-risk behavior among Korean adolescent students (19). The present study drew on the data from KYRBWS-V for students from 400 middle and 400 high schools to evaluate the association of frequency of breakfast eating with obesity, taking into account potential covariate variables such as age, frequency of smoking, frequency of drinking, the parents' education level, economic status, frequency of vigorous physical activity (PA), frequency of moderate PA, frequency of muscular strength exercises, mental stress, and sleep duration.

For the survey, classroom teachers assigned each participating student a unique identification number, with the help of which the students could access the survey web page. On this web page, the students were first asked about their willingness to participate in the survey. Those willing were given access to a self-administered questionnaire, which they completed anonymously at the school, while those unwilling, could not proceed further. The KYRBWS-V was administered to a nationally representative group, and ethical approval was not required since it did not collect private information. This survey was valid and reliable (20-21).

Students who were absent for long periods and students with dyslexia or dysgraphia were excluded from this study; the response rate was 97.6% (N = 75,066). The study sample comprised 72,399 students after excluding 2,667 students who did not meet the sample requirements or were absent. Table 1 shows the characteristics of subjects.

### Dependent variables

The adolescent students were asked to self-record their height and weight and then the BMI ( $\text{kg}/\text{m}^2$ ) was calculated for each student. According to the World Health Organization (WHO) Asia-Pacific standard of obesity, people with BMIs of  $<23$ ,  $\geq 23$ – $<25$ , and  $\geq 25$   $\text{kg}/\text{m}^2$  were classified into normal, overweight, and obesity groups, respectively (22).

### Independent variables

Frequency of breakfast eating was evaluated for each adolescent student by asking one question: (Q1) "Usually, how many days did you have breakfast per week?" The available responses were [1] 1–2 day (s), [2] 3–5 days, [3] 6–7 days, and [4] no breakfast. Then, these responses were classified into the following 4 groups: First group, 6–7 times per week (reference group); second group, 3–5 times per week; third group, 1–2 time (s) per week; and fourth group, no breakfast per week (worst condition group).



Table 1: The characteristics of subjects (Mean  $\pm$  SD)

Variables	Boys (n = 38,152)	Girls (n = 34,247)	t (P) or F (P)	Total (n = 72,399)
Age (years)	15.00 $\pm$ 1.73	15.12 $\pm$ 1.77	-9.425 (***)	15.06 $\pm$ 1.75
Height (cm)	169.58 $\pm$ 8.19	160.08 $\pm$ 5.39	185.053 (***)	165.09 $\pm$ 8.46
Weight (kg)	60.14 $\pm$ 11.72	51.47 $\pm$ 7.67	118.834 (***)	56.04 $\pm$ 10.91
Body mass index (kg/m <sup>2</sup> )	20.80 $\pm$ 3.21	20.05 $\pm$ 2.58	35.002 (***)	20.45 $\pm$ 2.95
Weight state N (%)	Normal weight (BMI < 23)	29,404 (77.1)		59,078 (81.6)
	Over weight (23 $\leq$ BMI < 25)	4,385 (11.5)	1337.15 (***)	7,346 (10.2)
	Obese (25 $\leq$ BMI)	4,363 (11.4)		5,975 (8.3)
City size N (%)	Large cities	20,252 (53.1)		37,960 (52.4)
	Middle-sized cities	13,303 (34.9)	16.826 (***)	25,456 (35.2)
	Small-sized cities	4,597 (12.0)		8,983 (12.4)
Frequency of break- fast eating	6 -7 days per week	6,616 (17.3)		13,582 (18.8)
	3 - 5 days per week	6,627 (17.4)		12,087 (16.7)
	1 - 2 days per week	3,947 (10.3)	117.944 (***)	7,289 (10.1)
Economic status N (%)	No breakfast per week	20,962 (54.9)		39,441 (54.5)
	Very rich	2,691 (7.1)		4,028 (5.6)
	Rich	8,768 (23.0)		15,487 (21.4)
	Average	17,229 (45.2)	564.176 (***)	34,488 (47.6)
	Poor	6,890 (18.1)		13,715 (18.9)
Grade N (%)	Very poor	2,574 (6.7)		4,681 (6.5)
	1 <sup>st</sup> grade middle-school	6,711 (17.6)		12,326 (17.0)
	2 <sup>nd</sup> grade middle-school	6,722 (17.6)		12,449 (17.2)
	3 <sup>rd</sup> grade middle-school	6,767 (17.7)		12,382 (17.1)
	1 <sup>st</sup> grade high-school	6,626 (17.4)	222.657 (***)	11,995 (16.6)
	2 <sup>nd</sup> grade high-school	5,889 (15.4)		11,991 (16.6)
	3 <sup>rd</sup> grade high-school	5,437 (14.3)		11,256 (15.5)

\* $P < 0.05$  \*\* $P < 0.01$  \*\*\* $P < 0.001$ , tested by independent t-test or Chi-square analysis

### Covariate variables

**Age:** the adolescents' ages defined by the KYRBWS-V data were used without any alteration.

**Frequency of smoking:** This parameter was evaluated by asking the question "In the last month, how often have you smoked more than 1 cigarette per week?" for which the response options ranged from [1] no to [7] every day.

**Frequency of drinking:** This parameter was evaluated by asking the question "In the last month, how often did you consume more than 1 glass of

alcohol per week?" for which the response options ranged from [1] no to [7] every day.

**Parents' education level:** This parameter was evaluated by asking 2 questions, that is, "What is your mother's education level?" and "What is your father's education level?"; the response options ranged from [1] middle school or lower to [3] college or higher.

**Economic status:** This parameter was evaluated by asking the question "What is your parents' economic status?" for which the response options ranged from [1] very rich to [5] very poor.

**Frequency of vigorous PA, such as digging, aerobics, heavy lifting, or fast cycling during the week:** the response options ranged from [1] no to [6] over 5 days.

**Frequency of moderate PA, such as bicycling at a regular pace, carrying light loads, or playing doubles tennis during the week:** the response options ranged from [1] no to [6] over 5 days.

**Frequency of muscular strength exercises, such as sit-ups, push-ups, and weight lifting or weight training, during the week:** the response options ranged from [1] no to [6] over 5 days.

**Mental stress:** This parameter was evaluated by asking the question “What is the degree of mental stress that you experienced in the last month?” for which the response options ranged from [1] very high to [5] none.

**Sleep duration:** This parameter was evaluated by asking the question “What was the daily sleep duration during the last month?” for which the response options ranged from [1]  $\leq 4$  h/day to [6]  $\geq 8$  h/day.

### *Statistical analysis*

All results from this study are presented in terms of mean and standard deviation. Multivariate logistic regression analyses were conducted to determine whether frequency of breakfast eating was related to overweight/obesity after adjusting for covariate variables. Statistical significance was set at  $P < 0.05$ , and all analyses were performed using SPSS Complex Sample™ version 18.0 (SPSS, Chicago, IL, USA).

## **Results**

### *The multivariate logistic regression analyses*

The multivariate logistic regression analyses of frequency of breakfast eating for overweight and normal-weight groups and for obese and normal-weight, groups of Korean adolescents are shown in Table 2 and 3, respectively. The results presented in the tables show the prevalence of overweight and obesity in Korean adolescents after

adjusting for covariate variables such as age, frequency of smoking, frequency of drinking, parents' education level, economic status, frequency of vigorous PA, frequency of moderate PA, frequency of muscular strength exercises, mental stress, and sleep duration, and spanning a range of frequency per week from “6–7 times per week” to “no breakfast per week”. A total of 20,962 (54.9%) boys and 18,479 (54.0%) girls skipped breakfast 7 days (all days) per week at the baseline (ORs between normal-weight and overweight individuals, 18,625 boys and 17,667 girls; ORs between normal-weight and overweight individuals, 18,506 boys and 16,885 girls).

For boys, the odds ratios (ORs) [confidence interval (CI) 95%] between being overweight and frequency of breakfast eating were 1.040 (range, 0.951–1.162;  $P = 0.482$ ) for 3–5 times per week, 1.092 (range, 0.963–1.239;  $P = 0.170$ ) for 1–2 time (s) per week, 1.059 (range, 0.968–1.159;  $P = 0.208$ ) for no breakfast per week, compared to 6–7 times per week (Table 2). The ORs (CI 95%) between being obese and frequency of breakfast eating were 1.011 (range, 0.908–1.126;  $P = 0.843$ ) for 3–5 times per week, 0.968 (range, 0.854–1.097;  $P = 0.611$ ) for 1–2 time (s) per week, and 0.932 (range, 0.854–1.018;  $P = 0.120$ ) for no breakfast per week, compared to 6–7 times per week (Table 3).

For girls, the ORs (CI 95%) between being overweight and frequency of breakfast eating were 0.990 (range, 0.872–1.123;  $P = 0.871$ ) for 3–5 times per week, 0.992 (range, 0.794–1.071;  $P = 0.286$ ) for 1–2 time (s) per week, 1.019 (range, 0.992–1.125;  $P = 0.714$ ) for no breakfast per week, compared to 6–7 times per week (Table 2). The ORs (CI 95%) between being obese and frequency of breakfast eating were 1.075 (range, 0.914–1.264;  $P = 0.382$ ) for 3–5 times per week, 0.946 (range, 0.780–1.148;  $P = 0.575$ ) for 1–2 time (s) per week, and 0.941 (range, 0.824–1.073;  $P = 0.363$ ) for no breakfast per week, compared to 6–7 times per week (Table 3).

**Table 2:** The multivariable logistic regression analyses of frequency of breakfast eating for the overweight and normal-weight groups in Korean adolescents

Frequency of breakfast eating		Overweight Vs. normal-weight			
		Case	OR	95% CI	P-value
Boys	6-7 times per week	5,835	Ref		
	3-5 times per week	5,850	1.040	0.931-1.162	0.482
	1-2 time(s) per week	3,481	1.092	0.963-1.239	0.170
	No breakfast per week	18,625	1.059	0.968-1.159	0.208
Girls	6-7 times per week	6,624	Ref		
	3-5 times per week	5,167	0.990	0.872-1.123	0.871
	1-2 time(s) per week	3,177	0.992	0.794-1.071	0.286
	No breakfast per week	17,667	1.019	0.992-1.125	0.714

S.E; Standard Error, OR; Odd Ratio, CI; Confidence Interval

Tested by multivariable logistic regression analysis (adjusting for covariate variables such as age, frequency of smoking, frequency of drinking, the parents' education level, economic status, frequency of vigorous physical activity (PA), frequency of moderate PA, frequency of muscular strength exercises, mental stress, and sleep duration)

**Table 3:** The multivariable logistic regression analyses of frequency of breakfast eating for the obese and normal-weight groups in Korean adolescents

Category		Obese Vs. normal-weight			
		Case	OR	95% CI	P-value
Boys	6-7 times per week	5,892	Ref		
	3-5 times per week	5,893	1.011	0.908-1.126	0.843
	1-2 time(s) per week	3,476	0.968	0.854-1.097	0.611
	No breakfast per week	18,506	0.932	0.854-1.018	0.120
Girls	6-7 times per week	6,356	Ref		
	3-5 times per week	4,984	1.075	0.914-1.264	0.382
	1-2 time(s) per week	3,061	0.946	0.780-1.148	0.575
	No breakfast per week	16,885	0.941	0.824-1.073	0.363

S.E; Standard Error, OR; Odd Ratio, CI; Confidence Interval

Tested by multivariable logistic regression analysis (adjusting for covariate variables such as age, frequency of smoking, frequency of drinking, the parents' education level, economic status, frequency of vigorous physical activity (PA), frequency of moderate PA, frequency of muscular strength exercises, mental stress, and sleep duration)

## Discussion

Skipping breakfast is closely associated with weight gain, overeating in the evenings, and increased appetite during the entire day (23-24). Therefore, we might expect to find a positive association between increasing frequency of skipping breakfast and overweight/obesity in Korean adolescents. This study indicated that an increas-

ing frequency of skipping breakfast had no correlation with overweight/obesity adolescents even after controlling for covariate variables related to overweight/obesity.

Many studies have found an association between breakfast skipping and increased BMI or overweight/obesity (12-18), while several other studies have found no association between breakfast skipping and BMI (25-27) or overweight/obesity (28-

29). In our study, no association was found between breakfast skipping and obesity in Korean adolescents.

The adolescent period is a phase of rapid physical growth, culminating in sexual maturity, increased hormone levels, and psychological change (30-31). We believe that no association was found between increased skipping breakfast frequency and weight status in adolescent students because the rates of basal metabolic rate, fat metabolism, fat oxidation, and substrate oxidation during adolescence are higher than those during adulthood (32-34). Therefore, we think that even though adolescents have an increased skipping breakfast frequency (increased overeating and appetite during the day), there is no effect to their weight status because of the rates of metabolism, fat oxidation, substrate oxidation, and increased hormone levels that are the highest during their adolescent phase compared to the rest of their life (32-34). Nevertheless, further well-designed studies should be performed in the future to determine the effects of skipping breakfast on Korean adolescents.

This study has several limitations. First, it did not include the amount and quality of food eaten and the variety of food eaten. Second, the study did not examine the effects of skipping breakfast frequency on overeating and appetite. For this reason, we did not have any information on how skipping breakfast affected overeating and appetite. Third, the adolescents reported their height and weight via online methods; these variables were not directly measured. The prevalence of obesity might be lower because during this growth phase adolescents tend to increase in height and decrease in weight (21). Fourth, information regarding the economic status was obtained from the adolescent students, not from their parents, and thus their perceptions could have been inaccurate. Fifth, because the survey was a retrospective *cohort study*, we did not provide the cause and effect but only assessed the interrelationship between increased skipping breakfast frequency and overweight/obesity. However, we studied 72,399 adolescents from all over Korea. Therefore, our study has an enormous strength that is representa-

tive of the relationship between frequency of breakfast eating and obesity in Korean adolescents. In conclusion, the frequency of breakfast eating has no correlation with overweight/obesity in Korean adolescents.

## Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

## Acknowledgements

This work was supported by a special research grant from Seoul Women's University (2012). The authors declare that there is no conflict of interests.

## References

1. Korea Centers for Disease Control and Prevention (2010). *Korea Health Statistics 2009: Korea National Health and Nutrition Examination Survey-IV (KNHANESIV-IV)*. Korea Centers for Disease Control and Prevention.
2. World Health Organization (2011). *Obesity and Overweight. Global Strategy on Diet, Physical Activity and Health*. <http://www.who.int/mediacentre/factsheets/fs311/en/>
3. Kvaavik E, Tell GS, Klepp KI (2003). Predictors and tracking of body mass index from adolescence into adulthood: Follow-up of 18 to 20 years in the Oslo Youth Study. *Archives of Pediatrics & Adolescent Medicine*, 157 (12): 1212-1218.
4. Daniels SR, Arnett DK, Eckel RH, Gidding SS, Hayman LL, Kumanyika S, Robinson TN, Scott BJ (2005). Overweight in children and adolescents pathophysiology, consequences, prevention, and treatment. *Circulation*, 111: 1999-2012.
5. Canoy D, Bundred P (2011). Obesity in children. *Clinical Evidence (Online)*, pii: 0325.

6. Park YS, Lee DH, Choi JM, Kang YJ, Kim CH (2004). Trend of obesity in school age children in Seoul over the past 23 years. *Korean J Pediatr*, 47 (3): 247-257.
7. Swinburn B, Shelly A (2008). Effects of TV time and other sedentary pursuits. *Int J Obes (Lond)*, 32 (7): S132-136.
8. Thomas AW, Albert JS (2002). *Handbook of obesity treatment (3rd ed.)*. New York: Guilford Press. USA.
9. Van den Bulck J, Van Mierlo J (2004). Energy intake associated with television viewing in adolescents, a cross sectional study. *Appetite*, 43: 181-184.
10. Horikawa C, Kodama S, Yachi Y, Heianza Y, Hirasawa R, Ibe Y, Saito K, Shimano H, Yamada N, Sone H (2011). Skipping breakfast and prevalence of overweight and obesity in Asian and Pacific regions: A meta-analysis. *Preventive Medicine*, 53 (4-5): 260-267.
11. Thompson-McCormick JJ, Thomas JJ, Bainivualiku A, Khan AN, Becker AE (2010). Breakfast skipping as a risk correlate of overweight and obesity in school-going ethnic Fijian adolescent girls. *Asia Pac J Clin Nutr*, 19 (3): 372-382.
12. Delva J, O'Maley PM, Johnston LD (2006). Racial/ethnic and socioeconomic status differences in overweight and health related behaviours among American students: national trends 1986-2003. *J Adolesc Health*, 39: 536-545.
13. Siega-Riz AM, Popkin BA, Carson T (1998). Trends in breakfast consumption for children in the United States from 1965 to 1991. *Am J Clin Nutr*, 67: 748S-756S.
14. Utter J, Scragg R, Mhurchu CN, Schaaf D (2007). At-home breakfast consumption among New Zealand children: associations with body mass index and related nutrition behaviors. *J Am Diet Assoc*, 107: 570-576.
15. Ma Y, Bertone ER, Stanek EJ 3rd, Reed GW, Hebert JR, Cohen NL, Merriam PA, Ockene IS (2003). Association between eating patterns and obesity in a free-living US adult population. *Am J Epidemiol*, 158: 85-92.
16. Cho S, Dietrich M, Brown CJ, Clark CA, Block G (2003). The effect of breakfast type on total daily energy intake and body mass index: results from the Third National Health and Nutrition Examination Survey (NHANES III). *J Am Coll Nutr*, 22: 296-302.
17. Sjöberg A, Hallberg L, Höglund D, Hulthén L (2003). Meal pattern, food choice, nutrient intake and lifestyle factors in the Göteborg Adolescence Study. *Eur J Clin Nutr*, 57: 1569-1578.
18. Berkey CS, Rockett HR, Gillman MW, Field AE, Colditz GA (2003). Longitudinal study of skipping breakfast and weight change in adolescents. *Int J Obes Relat Metab Disord*, 27: 1258-1266.
19. Korea Centers for Disease Control and Prevention (2010). *The Statistics of 5th Korea Youth Risk Behavior Web-based Survey (KYRBWS) in 2009*. Korea Centers for Disease Control and Prevention.
20. Bae J, Joung H, Kim JY, Kwon KN, Kim YT, Park SW (2010). Test-retest reliability of a questionnaire for the Korea Youth Risk Behavior Web-based Survey. *J Prev Med Public Health*, 43 (5): 403-410.
21. Bae J, Joung H, Kim JY, Kwon KN, Kim Y, Park SW (2010). Validity of self-reported height, weight, and body mass index of the Korea Youth Risk Behavior Web-based Survey questionnaire. *J Prev Med Public Health*, 43 (5): 396-402.
22. WHO/IASO/IOTF (2000). *The Asia-Pacific perspective: redefining obesity and its treatment*. Health Communications Australia: Melbourne.
23. Leidy HJ, Racki EM (2010). The addition of a protein-rich breakfast and its effects on acute appetite control and food intake in 'breakfast-skipping' adolescents. *Int J Obes (Lond)*, 34 (7): 1125-1133.
24. Pereira MA, Erickson E, McKee P, Schrankler K, Raatz SK, Lytle LA, Pellegrini AD (2011). Breakfast frequency and quality may affect glycemia and appetite in adults and children. *J Nutr*, 141 (1): 163-168.
25. Abalkhail B, Shawky S (2002). Prevalence of daily breakfast intake, iron deficiency anaemia and awareness of being anaemic among Saudi school students. *Int J Food Sci Nutr*, 53: 519-528.



26. Fujiwara T (2003). Skipping breakfast is associated with dysmenorrhea in young women in Japan. *Int J Food Sci Nutr*, 54: 505-509.
27. Williams P (2007). Breakfast and the diets of Australian children and adolescents: An analysis of data from the 1995 National Nutrition Survey. *Int J Food Sci Nutr*, 58: 201-216.
28. Nicklas TA, Morales M, Linares A, Yang S-J, Baranowski T, de Moor C, Berenson G (2004). Children's meal patterns have changed over a 21-year period: The Bogalusa Heart Study. *J Am Diet Assoc*, 104: 753-761.
29. Forslund HB, Lindroos AK, Sjöström L, Lissner L (2002). Meal patterns and obesity in Swedish women—A simple instrument describing usual meal types, frequency and temporal distribution. *Eur J Clin Nutr*, 56: 740-747.
30. Christie D, Viner R (2005). Adolescent development. *BMJ*. 330(7486): 301-304.
31. Sisk CL, Zehr JL (2005). Pubertal hormones organize the adolescent brain and behavior. *Front Neuroendocrinol*, 26(3-4): 163-174.
32. Kostyak JC, Kris-Etherton P, Bagshaw D, DeLany JP, Farrell PA (2007). Relative fat oxidation is higher in children than adults. *Nutr J*, 6: 19.
33. DeLany JP, Bray GA, Harsha DW, Volaufova J (2006). Energy expenditure and substrate oxidation predict changes in body fat in children. *Am J Clin Nutr*, 84 (4): 862-870.
34. Wolman BB (1998). *Adolescence: biological and psychosocial perspectives*. Greenwood press. USA.