Nutritional assessment and obesity in Down syndrome children and their siblings in Saudi Arabia

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ABSTRACT

الأهداف: تقييم الحالة الغذائية، ونسبة انتشار السمنة بين الأطفال السعوديين المصابين بمتلازمة داون.

الطريقة: أجريت هذه الدراسة في الرياض، المملكة العربية السعودية وذلك خلال الفترة من فبراير إلى مايو 2011م. وشملت مجموعة الدراسة أطفال قبل سن البلوغ ثبتت إصابتهم سريرياً وجينياً بمتلازمة داون. ولقد تم اختيار أشقاء لهم متقاربين في العمر ليكونوا في مجموعة الشاهد. لقد تم أخذ البيانات الخاصة بوزن الجسم، والطول، ومؤشر كتلة الجسم، وسماكة العضلة العضودية ثلاثية الرؤوس، وتناول المغذيات الكبرى والصغرى لكل من مجموعة متلازمة داون ومجموعة الشاهد.

النتائج: أشارت نتائج الدراسة إلى أن أطفال متلازمة داون قد كانوا أقل طولاً من مجموعة الشاهد ولكن لم يوجد أي فروق في الوزن بين المجموعتين. وكان أطفال متلازمة داون أعلى من حيث مؤشر كتلة الجسم وسماكة العضلة العضودية مقارنة بمجموعة الشاهد، بالإضافة إلى ذلك فقد كان انتشار السمنة والبدانة أعلى بين أطفال متلازمة داون مقارنةً بمجموعة الشاهد. كما كان تناول الدهون، والبروتين، وريتنول، وريبوفلافين، والبوتاسيوم أقل لدى مجموعة أطفال متلازمة داون مقارنة بمجموعة الشاهد.

خاتمة: أظهرت هذه الدراسة مدى انتشار السمنة الظاهر والواضح بين الأطفال السعوديين المصابين بمتلازمة داون.

Objectives: To assess the nutritional status and prevalence of obesity among children with Down syndrome (DS).

Methods: The study group comprised pre-pubertal children, with clinically and cytogenetically proven DS. Healthy siblings, closest in age to the DS children, were used as a control group. Body weight, height, body mass index (BMI), triceps skinfold thickness (TSFT), and macro- and micronutrient intakes were measured in both groups. The study was conducted in Riyadh, Kingdom of Saudi Arabia, between February and May 2011.

Results: Children with DS were shorter than their siblings, but had comparable weights. The DS children had higher BMIs and higher TSFTs, compared with their siblings. The prevalence of overweight and obesity differed significantly between the DS and control groups. The DS children had significantly lower intakes of fat, protein, retinol, riboflavin, and potassium compared with their siblings.

Conclusion: Obesity appears to be a prominent feature among Saudi DS children.

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Down syndrome (DS) is characterized by mental and growth retardation associated with genetic anomalies. It affects approximately one in 1,000 live births, and the incidence of DS births in the Kingdom of Saudi Arabia (KSA) is 1.8 for every 1,000 live births,[1] compared with 1.93-3.5/1,000 live births in other Arabian countries.[1] The overall incidence worldwide ranges from 1.25-1.67/1,000 live births.[1,2] Feeding difficulties, and inappropriate nutrition are common problems in children with DS,[3,4] and lower energy intake in these children has been reported in several studies.[5-7] Many studies have suggested that DS children require fewer calories than average children of the same age,[8-10] while a few studies have reported that DS and healthy children require similar calorie intakes.[9,11] Low intakes of dietary fiber, vitamin A, and calcium have also been reported,[6-12] and calcium insufficiency raises concerns regarding bone density later in life.[13,14] The

DS children have a high carbohydrate intake as a result of the consumption of large quantities of easy to chew starches, the use of sweets as a reward for good behavior, and the intake of canned fruit juices.[10] Their intake of vitamin A is also limited because fruit and vegetables may be rejected or not offered.[9]

Obesity is associated with a number of chronic diseases, including hypertension, insulin resistance type-2 diabetes, cardiovascular disease, and stroke.[15-17] Studies indicate a growing incidence of childhood obesity in KSA (1.8 for every 1,000 live births).[13,18] Children with DS are often overweight compared with age-matched non-disabled children,[19-22] and a study on Saudi DS children below the age of 5 years reported mean body mass index (BMI) curves similar to the international cut-off points, indicating a clear tendency for overweight.[23] Other studies found that 50% of DS cases between the ages of one month and 18 years were overweight.[9,24,25]

Although some research has addressed nutritional status and obesity among healthy Saudi children,[2,17,26] nutritional status and obesity in specific subgroups of disabilities (such as children with DS) are ill-defined. However, overweight and obesity among these children are recognized as problems by parents and health professionals.[7] In this study, we assess the nutritional status and the role of diet in the obesity of DS children.

Methods. The Al-Nahda School for Down Syndrome and the Down Syndrome Charitable Association in Riyadh are the only schools for DS children in Saudi Arabia, and were the 2 sites selected for this study. The DS children in these schools were distributed in classrooms according to their chronological ages. The study was conducted in Riyadh, Saudi Arabia, during the period between February and May 2011. We obtained approval to conduct this study from the school board of these 2 schools.

One hundred and eight families were enrolled in the study. Consent was obtained from all the families, and the objectives of the study were fully explained to them. The study group comprised pre-pubertal in the age range of 5-12 years DS children (n=108), with clinically and/or cytogenetically proven DS. Healthy siblings, closest in age to the DS children, were selected as the control group (n=113). Siblings were used as controls to ensure similar environmental backgrounds. All the subjects were living with their parents and had at least one sibling living in the same house. Anthropometric measurements of the siblings were taken following a weekly schedule. Information on the ages and genders of the cases and controls was also collected.

Body weights (to the nearest 0.1 kg) and height (to the nearest 0.1 cm) were measured using a beam balance scale and a meter rule. Two measurements were obtained, and a third was taken if the first 2 differed by >0.3 kg for weight or >0.5 cm for height. Weight measurements were taken with subjects in bare feet, with empty pockets, and wearing light clothes. Height was measured with the subjects in bare feet and standing with their back straight against a vertical mounted scale. The BMI was calculated as weight/height^2 (wt/ht^2) and was classified according to age and gender into overweight (≥85th percentile to <95th percentile), and obese (≥95th percentile).[27,28]

Triceps skinfold thickness (TSFT), which provides an estimate of subcutaneous fat, was measured (by trained research anthropometrists) to the nearest 0.2 mm using Holton calipers. The midpoint of the back of the upper arm, between the tip of the olecranon and the armorial, was determined by measuring the arm flexed at 90°. Two measurements were taken, with a third if the first 2 differed by >0.10 mm. Dietary assessment[29] was made on the basis of 3-day dietary records kept by parents or the primary caregiver to estimate the children's food intake. Because dietary patterns may differ between weekdays and weekends, food intake was recorded for 2 weekdays and one weekend day. The food intake was analyzed, and the nutrient content of the diets was estimated for both DS and control groups using a local validated food composition table. The mean food intake from the 3-day records was used to analyze nutrient intakes.

A validated food frequency questionnaire was used to evaluate dietary habits. The parents or caregivers were interviewed regarding the daily and weekly details of the food consumed by their children and the frequencies of consumption. The questionnaire included a checklist of commonly consumed items. The questionnaire was validated for completeness and consistency. Data entry and analysis were carried out using the EPI Info 6 (Centers of Disease Control (CDC), Atlanta, Georgia, USA) and the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) version 14. The results were presented as number (n), percentage (%), and mean value (M) ± standard deviation (SD). T-tests were used to test for significant differences in quantitative variables that were normally distributed, and Chi-square test was used to determine the significance of differences in categorical variables between DS children and their siblings. Analysis of covariance was used to adjust for age differences. Multivariate analysis of variance (MANOVA) was used to test for differences in macro and micronutrient intake variables. A *p*-value of less

Table 1 - Height, weight, body mass index (BMI), triceps skin fold thickness, and subcutaneous fat in Down syndrome (DS) children and siblings.

Variable	DS children (N=108)		Siblings (N=113)		*P*-value
	n (%)	M ± SD	n (%)	M ± SD	
Boys	62 (57.4)		60 (53.1)		0.41
Girls	46 (42.6)		53 (46.9)		
Age					
Boys		8.2 ± 1.7		8.9 ± 1.4	0.015
Girls		7.9 ± 1.5		8.1 ± 1.6	0.523
BMI (kg/m^2)		17.8 ± 3.6		15.1 ± 2.7	0.03
Triceps skinfold thickness (mm)		9.1 ± 3.2		8.6 ± 2.6	<0.001
Subcutaneous fat (%)					
Normal		90.7		97.3	0.036
Excess fat		9.3		2.7	

than 0.05 was considered statistically significant. The WHO nutrition program in the EPI 2000 statistical package was used to compute growth percentiles and growth parameters.

Results. *Anthropometric measurements.* The DS children were significantly shorter and had a higher BMI than their siblings. The DS children weighed less than their siblings, but the difference did not reach the significant level. The DS children had higher TSFTs than the siblings, and also had a significant excessive subcutaneous fat compared with their siblings (**Table 1**). Using the National Center for Health Statistics (NCHS) growth charts, the mean height-for-age was significantly lower in the DS children (11.4±14.7) compared with the siblings (39.8±18.8) (p=0.0001). However, there was no significant difference in mean weight-for-age between DS cases (38.7±27.8) and siblings (41.7±28.2) (p=0.086). Using the 85th and 95th percentile cut-off points of the Centers for Disease Control and Prevention (NCHS/CDC) growth charts for overweight and obesity, the percentages of DS children classified as overweight and obese were markedly higher than those for the corresponding siblings (p<0.001) (**Table 2**). Children with normal and abnormal weights spent similar lengths of time watching TV, in both the DS and sibling groups (**Table 3**). **Table 4** shows the distribution of BMI in the normal weight (<85th percentile) group and in the overweight and obese group (≥85th percentile) in DS children, by mother's education level and family income. More overweight and obese DS children were noted among mothers with secondary or university-level educations and above. Families with the lowest (less than SR5,000) and highest incomes (more than SR15,000) had the highest percentages of overweight and obese DS children.

Nutritional analysis. The result for the MANOVA test is shown in **Table 5**. Normality test for each group dependent variable (micro and macronutrient intake variables) were not statistically significant using Shapiro-Wilk test (p=0.181), indicating no serious normality violation. This was confirmed with the skewness and kurtosis statistics, all within the range -1 to +1. The homogeneity of the variance-covariance matrices was assessed by Box's M test (p=0.314). Bartlett's test for sphericity was significant (p=0.002) indicating a sufficient correlation between the dependent variables to proceed for analysis. F test using Roy's largest root (p=0.001) is significant. The separate univariate F tests

Table 2 - Overweight and obesity in Down syndrome (DS) children and siblings.

Nutritional status	DS children (N=108)	Siblings (N=113)	*P*-value
	n (%		
Normal	62 (56.5)	99 (87.6)	<0.0001
Overweight	22 (20.4)	8 (7.1)	
Obese	24 (23.1)	6 (5.3)	

Table 3 - Television viewing in Down syndrome children and siblings.

Variable	Normal (h/day)	Overweight and obese (h/day)	*P*-value
DS children	2.3±1.2	2.9±1.8	0.28
Siblings	2.7±1.7	2.8±2.5	0.80

Table 4 - Distribution of body mass index by mother's education and family income for Down syndrome children.

Variable	Normal (<85th percentile)	Overweight or obese (≥ 85th percentile)	*P*-value
	n (%)		
Mother's education			
Illiterate	8 (12.9)	5 (10.9)	0.65
Elementary	20 (32.3)	11 (23.9)	
Intermediate	9 (14.5)	5 (10.9)	
Secondary	9 (14.5)	11 (23.9)	
University or above	16 (25.8)	14 (30.4)	
Family income (SR)			
<5000	19 (30.6)	15 (32.6)	0.029
5,000 - <10,000	22 (35.5)	9 (19.6)	
10,000 - 15,000	14 (22.6)	7 (15.2)	
>15,000	7 (11.3)	15 (32.6)	

SR - Saudi Riyal

Table 5 - Macronutrient and micronutrient intakes in Down syndrome (DS) children and siblings.

Variable	DS children	Sibling	*P*-value
Energy (Kcal/day)	1692±442	1826±562	0.21
Fat (g/day)	53.4±14.8	64.7±29	0.031
Protein (g/day)	55±14	65.6±23	<0.001
Carbohydrates (g/day)	246.5±68.2	245.5±88	0.84
Fiber (g/day)	11.65±4.7	12.45±5.7	0.57
Retinol (ug/day)	543.5±225.4	719±387	0.024
Carotene (ug/day)	894.5±328	841.5±415	0.73
Thiamin (mg/day)	0.7±0.35	0.8±0.3	0.71
Riboflavin (mg/day)	1.5±0.74	1.8±0.85	0.032
Vitamin C (mg/day)	50.2±32.4	56±28	0.72
Sodium (mg/day)	1880±675	2,331±767	<0.001
Potassium (mg/day)	1704±535	1,964±751	0.038
Calcium (mg/day)	515±297	626±277.3	0.017
Phosphorus (mg/day)	911±327.5	1029±277.4	0.21
Iron (mg/day)	25±3	33±4	0.34

for all the dependent variable for between DS children and siblings are shown in **Table 5**. No difference in calorie or energy intake was observed between DS and siblings. The DS children had significantly lower intakes of protein and fat compared with the siblings. The DS children also had significantly lower intakes of retinol, riboflavin, and potassium. While calcium intake was significantly lower in DS cases compared with siblings, other minerals did not show significance in difference between DS children and siblings. Although low sodium intake is beneficial for the health, its intake was significantly lower in DS children compared with their siblings.

Discussion. Advances in medical care have played a role in improving the quality of life and longevity of DS children. In the United States for example, the average age at death increased from 25 years in 1983, to 49 years in 1997, with approximately 44% of individuals surviving to age 60 years, and 13% to age 68 years.[30,31] As the life expectancy in DS has increased, the prevention of obesity in this population has become necessary to reduce the risk of obesity-related morbidities such as diabetes and cardiovascular diseases.[32]

Using the 85th and 95th percentile cut-off points of the Centers for Disease Control BMI references for defining overweight and obesity, this study showed that the percentages of overweight and obesity in DS children were markedly higher than for their corresponding siblings. The results of this study showed that DS children were shorter than their siblings, which are in agreement with other studies that found reduced stature at most ages from birth through to adolescence in DS children.[9,12]

Luke et al[6] compared the heights of prepubescent DS children with controls, using NCHS growth charts, and concluded that the percentile of mean height-for-age in prepubescent children with DS was 10.8±12, compared with 58.5±22.8 in controls, and the percentile of mean weight-for-age in DS children was 58.4±34, which was similar to the 58.3±32 in controls. Our results were consistent with these findings.

Despite the high prevalence of overweight and obesity in DS children, no significant difference in energy intake was found between the DS children and their siblings. Several studies have reported lower energy intakes in DS children though the relationship between caloric intake and weight gain in DS children failed to demonstrate an excessive caloric intake.[6,7] The DS children had a lower calcium intake than their siblings. Low calcium intake during childhood is known to be an important factor leading to low bone density and osteoporosis later in life.[13,14] Various studies have concluded that TV viewing is related to obesity in healthy children, because watching TV may be a strong marker of energy balance.[33-35] Despite the fact that the metabolic rate has been reported to fall during TV viewing, this activity may also promote snacking on more energy-dense foods.[36-38] However, no significant difference in time spent TV viewing was identified between normal-weight children, and overweight, and obese DS children in the current study. It is possible that cognitive impairment in DS children may limit their duration of TV viewing.

Our results indicated that obesity was associated with the mother's education and family income. The percentages of overweight or obese children increased in families with higher family incomes and with mothers with higher educational statuses. These results were consistent with those of other studies, in which overweight in healthy children was associated with either high income or mothers with high educational statuses.[38,39] This may be because more highly educated mothers have less time to control their children's food intakes and dietary habits. The results showed also that the percentage of children who are overweight or obese was increased with low family incomes less than SR5000. This was consistent with other studies in healthy children that reported that the prevalence of childhood obesity is increasing rapidly in low income countries and there is an inverse relationship between energy density and energy cost, such that energy dense foods composed of refined grains, added sugars, or fats may represent the lowest-cost options.[40,41]

In conclusion, obesity is a prominent feature among Saudi DS children, as found in several studies conducted in similar age groups in other countries. Early detection of excessive weight gain could correct the growth rate patterns of these children. The height and height-for-age percentiles were significantly lower in DS children compared with the siblings, suggesting that measuring BMI using age-related reference curves would provide a better indicator of overweight and obesity than using weight-for-age, which does not take account of the shorter stature of DS children. One limitation of the study is children with minor medical problems were included in the study, because exclusion of those known with medical problems would have significantly restricted the sample and because of the shortage in the records regarding medical condition status in these schools. There is a need to conduct a national study to assess the prevalence of obesity and evaluate the nutrition status among all DS age groups.

References

1. Murthy SK, Malhotra AK, Mani S, Shara ME, Al-Rowaished EE, Naveed S, Incidence of Down Syndrome in Dubai, UAE. ***Med Princ Pract*** 2007; 16: 25-28.
2. Niazi MA, al-Mazyad AS, al-Husain MA, al-Mofada SM, al-Zamil FA, Khashoggi TY, et al. Down's syndrome in Saudi Arabia: incidence and cytogenetics. ***Hum Hered*** 1995; 45: 65-69.
3. O'Neill KL, Shults J, Stallings VA, Stettler N. Child-feeding practices in children with down syndrome and their siblings. ***J Pediatr*** 2005; 146: 234-238.
4. Pisacane A, Toscano E, Pirri I, Continisio P, Andria G, Zoli B, et al. Down syndrome and breastfeeding. ***Acta Paediatr*** 2003; 92: 1479-1481.
5. Grammatikopoulou MG, Manai A, Tsigga M, Tsiligiroglou-Fachantidou A, Galli-Tsinopoulou A, Zakas A. Nutrient intake and anthropometry in children and adolescents with Down syndrome--a preliminary study. ***Dev Neurorehabil*** 2008; 11: 260-267.
6. Luke A, Sutton M, Schoeller DA, Roizen NJ. Nutrient intake and obesity in prepubescent children with Down syndrome. ***J Am Diet Assoc*** 1996; 96: 1262-1267.
7. Hopman E, Csizmadia CG, Bastiani WF, Engels QM, de Graaf EA, le Cessie S, et al. Eating habits of young children with Down syndrome in The Netherlands: adequate nutrient intakes but delayed introduction of solid food. ***J Am Diet Assoc*** 1998; 98: 790-794.
8. O'Neil KL, Shults J, Stallings VA, Stettler N. Child-feeding practices in children with down syndrome and their siblings. ***J Pediatr*** 2005; 146: 234-238.
9. Ekvall SW, editor. Paediatric Nutrition in Chronic Diseases and Developmental Disorders. New York (NY): Oxford University Press; 1993.
10. Chad K, Jobling A, Frail H. Metabolic rate: a factor in developing obesity in children with Down syndrome? ***Am J Ment Retard*** 1990; 95: 228-235.
11. Melville CA, Cooper SA, McGrother CW, Thorp CF, Collacott R. Obesity in adults with Down syndrome: a case-control study. ***J Intellect Disabil Res*** 2005; 49 (Pt 2): 125-133.
12. Cooley WC, Graham JM. Common Syndromes and management issues for primary care physicians. ***Clinical Paediatric***s 1991; 30: 233-253.
13. Sharav T, Bowman T. Dietary practices, physical activity, and body-mass index in a selected population of Down syndrome children and their siblings. ***Clin Pediatr (Phila)*** 1992; 31: 341-344.
14. Cabana MD, Capone G, Fritz A, Berkovitz G. Nutritional rickets in a child with Down syndrome. ***Clin Pediatr (Phila)*** 1997; 36: 235-237.
15. Freedman DS, Dietz WH, Srinivasan SR, Berenson GS. The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa heart study. ***Pediatrics*** 1999; 103: 1175-1182.
16. Al-Hazzaa HM. Physical activity, fitness and fatness among Saudi children and adolescents: implications for cardiovascular health. ***Saudi Med J*** 2002; 23: 144-150.
17. Wang F, Wild TC, Kipp W, Kuhle S, Veugelers PJ. The influence of childhood obesity on the development of self-esteem. ***Health Rep*** 2009; 20: 21-27.
18. El-Hazmi MA, Warsy AS. A comparative study of prevalence of overweight and obesity in children in different provinces of Saudi Arabia. ***J Trop Pediatr*** 2002; 48: 172-177.
19. De S, Small J, Baur LA. Overweight and obesity among children with developmental disabilities. ***J Intellect Dev Disabil*** 2008; 33: 43-47.
20. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. ***BMJ*** 2000; 320: 1240-1243.

21. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R, et al. CDC growth charts: United States. ***Adv Data*** 2000; (314): 1-27.
22. Shabayek MM. Assessment of the nutritional status of children with special needs in Alexandria. Part II: Anthropometric measures. ***J Egypt Public Health Assoc*** 2004; 79: 363-382.
23. Al Husain M. Body mass index for Saudi children with Down's syndrome. ***Acta Paediatr*** 2003; 92: 1482-1485.
24. Kawana H, Nonaka K, Takaki H, Tezuka F, Takano T. [Obesity and life style of Japanese school children with Down syndrome]. ***Nippon Koshu Eisei Zasshi*** 2000; 47: 87-94. Japanese.
25. Pueschel SM. Clinical aspects of Down syndrome from infancy to adulthood. ***Am J Med Genet*** 1990; 7: 52-56.
26. Al-Jarallah AS. Down's syndrome and the pattern of congenital heart disease in a community with high parental consanguinity. ***Med Sci Monit*** 2009; 15: CR409- CR412.
27. Must A, Dallal GE, Dietz WH. Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ ht2) and triceps skin fold thickness. ***Am J Clin Nutr***1991; 53: 839-846.
28. Dietz WH, Robinson TN. Use of the body mass index (BMI) as a measure of overweight in children and adolescents. ***J Pediatr*** 1998; 132: 191-193.
29. Cameron N. The methods of auxologic anthropometry. In: Falkner F, Tanner J, editors. Human growth. Vol 3. New York (NY): Plenum Press; 1986. p. 3-43.
30. Glasson EJ, Sullivan SG, Hussain R, Petterson BA, Montgomery PD, Bittles AH. The changing survival profile of people with Down's syndrome: implications for genetic counselling. ***Clin Genet*** 2002; 62: 390-393.
31. Yang Q, Rasmussen SA, Friedman JM. Mortality associated with Down's syndrome in the USA from 1983 to 1997: a population-based study. ***Lancet*** 2002; 359: 1019-1025.
32. Abalkhail BA, Shawky S, Soliman NK. Validity of self-reported weight and height among Saudi school children and adolescents. ***Saudi Med J*** 2002; 23: 831-837.
33. Hancox RJ, Poulton R. Watching television is associated with childhood obesity: but is it clinically important? ***Int J Obes (Lond)*** 2006; 30: 171-175.
34. Caroli M, Argentieri L, Cardone M, Masi A. Role of television in childhood obesity prevention. ***Int J Obes Relat Metab Disord*** 2004; 28(Suppl 3): S104-S108. Review.
35. Salmon J, Campbell KJ, Crawford DA. Television viewing habits associated with obesity risk factors: a survey of Melbourne schoolchildren. ***Med J Aust*** 2006; 184: 64-67.
36. Blass EM, Anderson DR, Kirkorian HL, Pempek TA, Price I, Koleini MF. On the road to obesity: Television viewing increases intake of high-density foods. ***Phsiol Behav*** 2006; 80: 597-604.
37. Gable S, Chang Y, Krull JL. Television watching and frequency of family meals are predictive of overweight onset and overweight onset and persistence in a national sample of school-aged children. ***J Am Diet Assoc*** 2007; 107: 53-61.
38. Pakpour AH, Yekaninejad MS, Chen H. Mothers' perception of obesity in schoolchildren: a survey and the impact of an educational intervention. ***J Pediatr (Rio J)*** 2011; 87: 169-174.
39. Al-Nuaim A, Al-Rubean K, Khoja T. The Saudi national epidemiological study on chronic metabolic diseases (part 2). Riyadh (KSA): Ministry of Health and King Saud University; 1997. p. 135-141.
40. Verstraeten R, Roberfroid D, Lachat C, Leroy JL, Holdsworth M, Maes L, et al. Effectiveness of preventive school-based obesity interventions in low- and middle-income countries: a systematic review. ***Am J Clin Nutr*** 2012; 96: 415-438.
41. Drewnowski A, Specter SE. Poverty and obesity: the role of energy density and energy costs. ***Am J Clin Nutr*** 2004; 79: 6-16.

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Saadah OI, Al-Aama JY, Alaifan MA, Bin Talib YY, Al-Mughales JA. Prevalence of celiac disease in children with Down syndrome screened by anti-tissue transglutaminase antibodies. ***Saudi Med J*** 2012; 33: 208-210.

Abdul-Wahab A, Janahi IA, Al-Rawi F, Mostafa OA. Diagnostic role of pediatric flexible bronchoscopy in Down's syndrome associated with congenital heart disease. ***Saudi Med J*** 2006; 27: 1431-1433.