

Reference curves of anthropometric indices and serum lipid profiles in representative samples of Asian and European children

Roya Kelishadi¹, Peter Schwandt^{2,3}, Gerda-Maria Haas², Mohsen Hosseini⁴, Parisa Mirmoghtadaee⁴

¹Isfahan Cardiovascular Research Centre, Isfahan University of Medical Sciences, Iran

²Arteriosklerose-Präventions-Institut Munich – Nuremberg, Germany

³Ludwig-Maximilians Universität Munich, Germany

⁴Isfahan University of Medical Sciences, Iran

Submitted: 4 May 2008

Accepted: 13 June 2008

Arch Med Sci 2008; 4, 3: 329–335

Copyright © 2008 Termedia & Banach

Corresponding author:

Prof. Roya Kelishadi MD

Preventive Paediatric Cardiology
Department

Isfahan Cardiovascular Research
Centre

(WHO Collaborating Centre in EMR)

Isfahan University of Medical
Sciences

PO Box 81465-1148

Isfahan, Iran

Phone: +98 311 3377881-8

Fax: +98 311 3373435

E-mail: Kelishadi@med.mui.ac.ir,

kroya@aap.net

Abstract

Introduction: To compare the reference curves and mean values of anthropometric indices and lipid profiles of a population-based sample of Asian and European children.

Material and methods: The data of 2076 Iranian and 1721 German children, aged 6–11 years, were compared. For anthropometric indices, we considered weight, height, body mass index (BMI), waist circumference (WC), hip circumference and waist-to-hip ratio. Fasting serum lipid profile including triglycerides, total, LDL and HDL cholesterol, and total cholesterol/HDL ratio were compared between the two populations studied. Smoothed age-specific percentiles for anthropometric indices and serum lipid profile were constructed by using the software package LMS Chart Maker.

Results: The mean of anthropometric indices was higher in Iranian than in German children. The mean triglycerides (TG) and total/HDL cholesterol ratio were higher, and the mean total, LDL and HDL cholesterol were lower in Iranian than in German children. The reference curves for BMI and WC were higher and had a sharper increase in Iranian than in German children. The reference curves of TG were higher, and those of total and HDL cholesterol were lower, in Iranian than in German children, whereas LDL cholesterol curves had no significant difference.

Conclusions: Reference curves and cut-off values should be provided for anthropometric indices and lipid profile of children with different ethnicities. Differences in lipid profiles in various populations, and the higher values of the components of the metabolic syndrome (high WC and TG as well as low HDL-C) in young Asian children, should be considered in the current guidelines for screening lipid disorders in the paediatric age group.

Key words: ethnicity, reference curve, anthropometric indices, lipid profile, metabolic syndrome.

Introduction

Nutritional disorders including malnutrition and obesity are health problems with medical, psychological and public health consequences for children and adolescents; such disorders may last through life. The body mass index (BMI) is routinely used to evaluate the weight status in children [1]. Population-based studies have documented that in children, as in adults, abdominal or upper body fat carries an increased risk for cardio-metabolic complications [2]. Given that fat distribution varies with age, sex, maturation rate, as well

as hormonal and nutritional status [3], and taking into account that ethnic differences are documented in several aspects of body size and proportions [4], population-specific reference curves should be provided for different anthropometric indices.

Primary lesions of atherosclerosis begin in early life [5] and are associated with serum lipid and lipoprotein concentrations [6]. Lipid profile is modulated by genetic, environmental and lifestyle factors [7]. Ethnic differences in lipid profile could be explained in part by the higher prevalence of some genes in certain populations [8]. Furthermore, there are differences in genetic response to diet in some populations, and it is well documented that Asians have an ethnic predisposition to abdominal fat deposition and metabolic syndrome [9]. Usually for clinical practice and epidemiological studies on serum lipid levels, the age- and gender-specific 95th percentiles of Lipid Research Clinic (LRC) standards provided in a US population of youths are used [10]. However, it remains unclear whether they are appropriate for various ethnic groups with different genetic backgrounds and lifestyle habits. Previous studies have documented higher mean and percentiles of serum triglycerides (TG), as well as lower mean and percentiles of total, low-density and high-density cholesterol (TC, LDL-C and HDL-C) in Iranian than in American children [11-13].

To the best of our knowledge, no previous study has compared the population-based reference curves of anthropometric indices and lipid profile between Asian and European children. Consequently, this study aimed to compare these reference curves between representative samples of Iranian and German children aged 6-11 years.

Material and methods

This study used the data obtained from two population-based studies; their full methodological details have been published previously [14-17]. The German data were obtained from the Prevention Education Program (PEP), a prospective study conducted in children aged 3-11 years in Nuremberg, Germany [14, 15]. The current paper reports on

the data obtained during 1994-1995 (1st survey) and 2003-2004 (10th survey) from 6-11-year-old German children; there was no significant difference between the yearly mean values of variables studied in these children during the recruitment period. The Iranian data were obtained from the Childhood and Adolescence Surveillance and Prevention of Adult Non-communicable disease (CASPIAN – Caspian is the name of the world’s largest lake, located in northern Iran) study conducted in the 6-18 years age group [16, 17]. Both studies followed standard protocols for anthropometric measurements by using calibrated instruments. For comparison of data in the lower age of children, we used the data of the 6-11 years age groups in both studies.

Statistical analysis

Statistical analyses were performed using SPSS for Windows software (version 14:0; SPSS, Chicago, IL), and $P < 0.05$ was considered as significant. Data are presented as mean \pm standard deviation (SD). Smoothed age- and gender-specific percentiles for anthropometric indices and serum lipid profile were constructed from the raw data and were entered into a spreadsheet separately for boys and girls and imported into the software package LMS Chart Maker Pro, version 2.3, April 2006. The LMS method assumes that the data can be normalized using power transformation. The percentile curves are the result of smoothing the age-specific curves: L for skewness, M for median and S for coefficient of variation [18]. As the reference curves had no significant difference in terms of gender, here we present the age-specific reference curves of the whole population studied in each country.

Results

The study population comprised 1721 German children (870 girls, 851 boys) and 2076 Iranian children (1085 girls, 991 boys) aged 6-11 years. The mean (SD) values of anthropometric indices in Iranian and German children are presented in Table I. In general, except height, Iranian children had higher anthropo-

Table I. Mean (SD) values of anthropometric indices in Iranian and German children

	Girls		Boys	
	Iranian	German	Iranian	German
Height [cm]	123.15 \pm 10.45	124.90 \pm 11.35	124.57 \pm 11.54	125.62 \pm 11.48
Weight [kg]	26.81 \pm 7.64	25.29 \pm 7.29	27.08 \pm 7.12	25.51 \pm 7.03
Body mass index [kg/m ²]	17.28 \pm 2.81	15.93 \pm 2.28	17.35 \pm 2.84	15.89 \pm 2.08
Waist circumference [cm]	58.14 \pm 8.32	56.55 \pm 6.19	58.72 \pm 8.34	57.46 \pm 6.20
Hip circumference [cm]	69.25 \pm 9.12	66.17 \pm 7.78	68.81 \pm 9.8	65.53 \pm 7.30
Waist-to-hip ratio	0.86 \pm 0.05	0.72 \pm 0.06	0.88 \pm 0.07	0.71 \pm 0.006

All differences are significant between Iranian and German children in each gender, except the difference of height

Table II. Mean (SD) values of serum lipid profile in Iranian and German children

	Girls		Boys	
	Iranian	German	Iranian	German
Total cholesterol [mg/dl]	149.87±34.78	176.95±30.48	153.13±34.30	172.33±28.86
LDL-C [mg/dl]	87.60±32.3	106.44±27.71	90.02±29.86	100.51±25.12
HDL-C [mg/dl]	44.03±12.27	56.92±14.09	44.10±12.35	59.57±13.64
Triglycerides [mg/dl]	94.15±32.43	67.96±28.08	93.29±31.53	60.15±25.04
Total cholesterol/HDL-C	3.56±1.16	3.26±0.92	3.57±1.23	3.01±0.81

All differences are significant between Iranian and German children in each gender

metric measures than German children did. Table II shows the mean (SD) of serum lipid profile in the two populations studied. The mean TG and the total/HDL cholesterol ratio were higher, and the mean total and HDL cholesterol were lower in Iranian than in German children.

The reference curves for anthropometric indices in the two populations studied are demonstrated in Figure 1. It shows that the reference curves for BMI and WC were higher and had a sharper increase in Iranian than in German children.

The reference curves of TG were higher, and those of total and HDL cholesterol were lower, in Iranian than in German children, whereas LDL cholesterol had no significant difference (Figure 2).

Discussion

This study comparing the age-specific reference curves for anthropometric measures and lipid profiles of population-based samples of Iranian and German children revealed that the mean and reference curves of BMI, WC and TG were higher in Iranian than in German children, whereas the mean and reference curves of total and HDL cholesterol were lower in Iranian than in German children. These differences are in line with the comparison of serum lipid profile in Iranian and American children [11, 12]. These differences may be because of genetic-environment interactions.

In both populations studied, the mean BMI increased with age but this rise had a sharper slope in Iranian than in German children. Our findings are consistent with a previous study that compared the BMI of Iranian and American children [1]; such variations might be because of differences in genetic background and lifestyle factors. A WHO expert consultation suggests that Asian populations have different associations between BMI, percentage body fat, and associated health risks than do European populations. The consultation concluded that Asian populations have high risks of type 2 diabetes and cardiovascular diseases at relatively lower BMI, which might be attributable to the higher proportion of body fat in this ethnic group. Therefore, it has been suggested that lower BMI cut-off points for obesity

appropriate for Asian populations should be adopted among adults [19]. Similarly, as the growth rate and fat patterning vary greatly between different populations [3], the current cut-offs used for childhood overweight might not be generalizable to different ethnic groups. This emphasizes the necessity of developing population-specific percentiles and cut-off values.

Although BMI is the most easily measured index for obesity, there is now considerable evidence that markers of abdominal obesity are better predictors of outcome than BMI. It is documented that compared with the European population, Asians have increased abdominal visceral fat and greater insulin resistance levels of BMI, which suggests that reliance on BMI alone may underestimate the true risk in Asians [20]. In our study, the mean WC increased with age in both populations, but in general, Iranian children had higher WC than their German counterparts. This difference was documented in all percentile curves of German children. The mean hip circumference was higher in Iranian children than in German children aged 9-11 years. The mean WHR decreased with increasing age in both populations but the mean WHR was higher in early ages in Iranian children and in older ages in German children. A previous study compared Iranian WC reference curves with British ones, and showed that in boys, the 5th and 50th percentile curves were similar in both populations, but the 95th percentile curve of Iranian children was higher than the British curves. For girls, the 5th percentile curves of both studies were similar, but the 50th and 95th percentile curves of our study were higher than the British ones [16].

There are many differences between various ethnic groups, e.g. biological, cultural and social differences. These may be a result of differences in skeletal dimensions, particularly of the pelvis [2]. Furthermore, the anthropometric differences found in this study are suggested to be because of an earlier age of rebound adiposity, as well as the ethnic predisposition of Asians to abdominal obesity.

Of special interest in the context of this study is our finding about the higher levels of components of the metabolic syndrome, i.e. high WC and TG

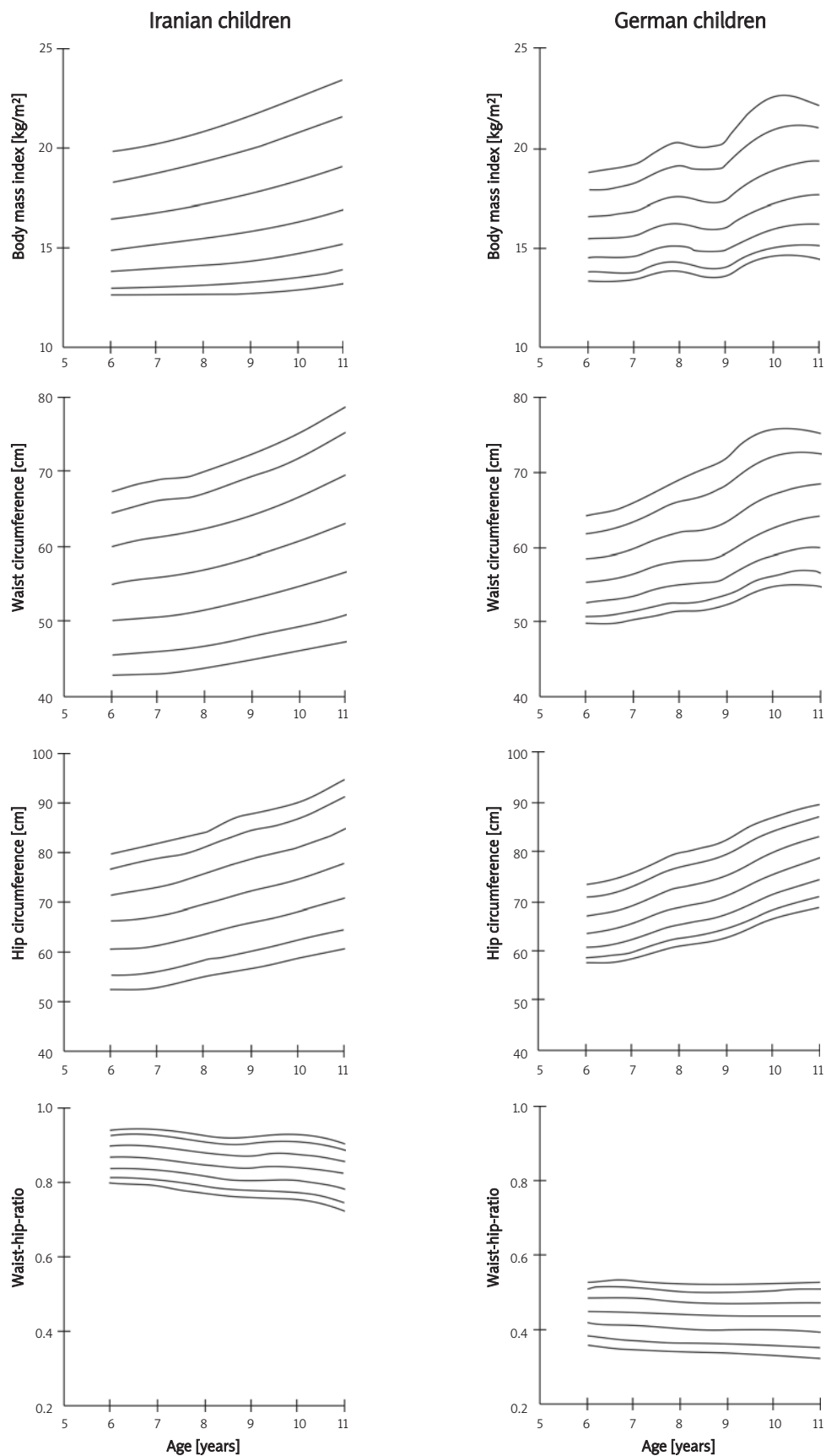


Figure 1. Comparison of age-specific reference curves for anthropometric indices in Iranian and German children aged 6-11 years

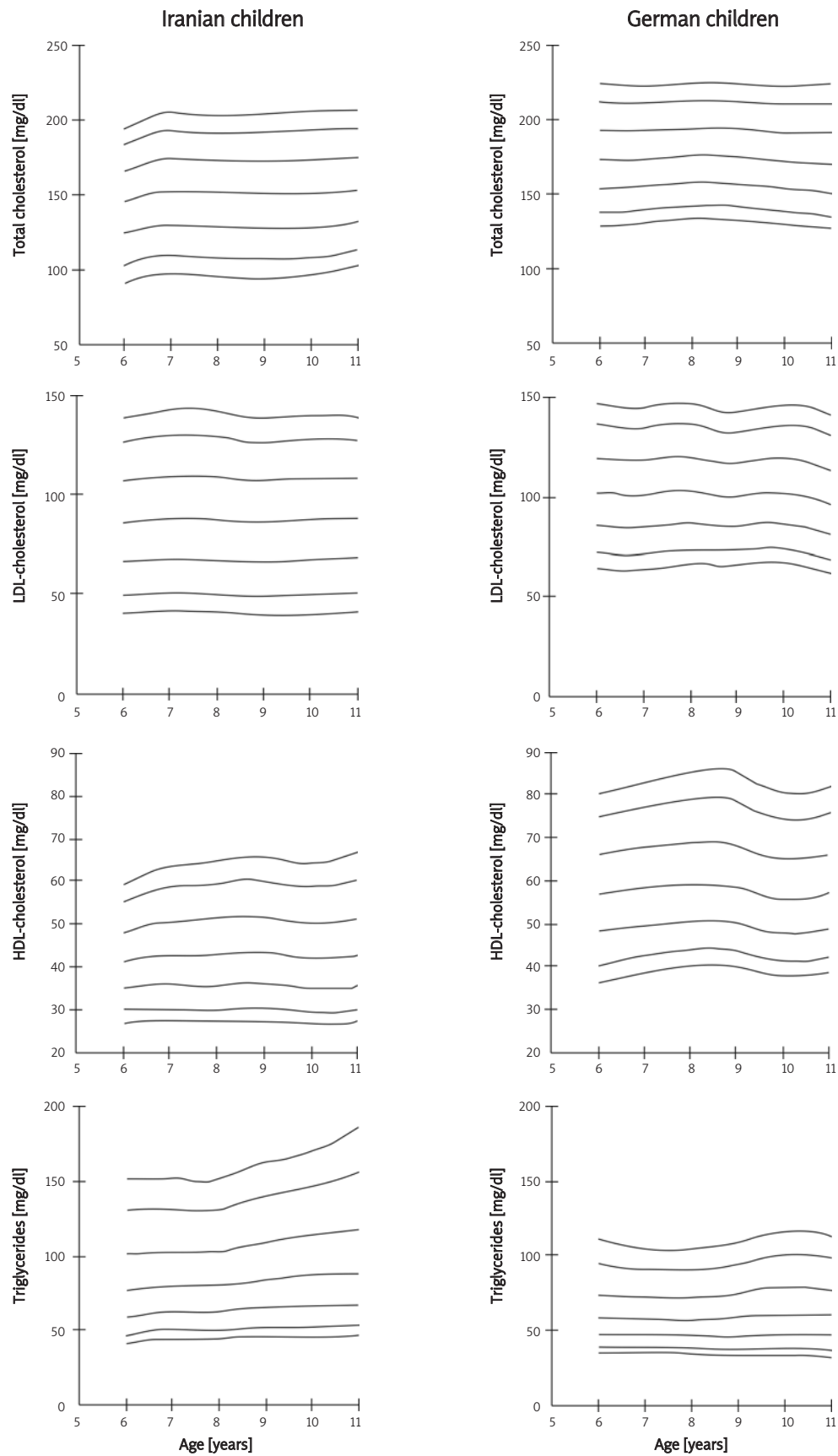


Figure 2. Comparison of age-specific reference curves for serum lipid profile in Iranian and German children aged 6-11 years

with low HDL-C, in Iranian than in German children. An underlying genetic tendency or adverse events in early life, such as low birth weight, may contribute to metabolic syndrome and its related complications, notably in non-European populations [21, 22].

The prevalence of the metabolic syndrome is high among Iranian children and adults, which confirms the supposed ethnic predisposition to this type of dyslipidaemia among Asians [9, 17, 23]. In a previous study, we found that birth weight, family history of chronic disease, educational level of parents, as well as dietary and physical activity habits, had a diverse association with the risk of metabolic syndrome in children and adolescents [22]. Iran has undergone a rapidly occurring nutritional transition. Fast food restaurants have increased in number and the consumption of fat rich in saturated and trans-fatty acids has become a very popular component of everyday life. This transition is suggested to be secondary to the rapid change in fertility and mortality patterns and to urbanization, which have led to a considerable imbalance in food consumption, with low nutrient density characterizing diets and over-consumption evident among more than a third of households [24].

Dyslipidaemia in terms of high TG and low HDL-C is prevalent in Iranian children and adults, even in normal-weight children [25]. Diets high in trans-unsaturated fat may lower HDL-C, increase TG levels, and interfere with fatty metabolism [22]. In addition, higher TG levels in Iranian children than in Western populations are suggested to be in part an effect of their high carbohydrate intake. Inadequate activity is also an important contributor to the differences in lipid profile of Iranian children [22, 25]. A genetic-environment interaction might explain the higher values of components of the metabolic syndrome in young Iranian children compared to their Western counterparts. The exact explanation of such differences between populations remains to be determined in longitudinal studies. Furthermore, children should be encouraged to maintain healthy lifestyle habits, especially healthy nutrition and physical activity.

Our results should be seen in the light of their strengths and weaknesses. The main limitation of the study is its cross-sectional nature; in addition we did not assess the factors influencing the anthropometric measures and lipid profile, e.g. pubertal stage and nutritional and physical activity habits. However, it is the first study comparing components of the metabolic syndrome between young Asian and European children, and as data collection in both countries followed the same methodology it can provide a basis for future international comparisons.

In conclusion, age- and gender-specific reference curves as well as cut-off values should be provided

for anthropometric indices and lipid profile of children with different ethnicities. Differences in lipid profiles in various populations should be considered in the current guidelines for screening lipid disorders in children.

References

- Hosseini M, Carpenter RG, Mohammad K, Jones ME. Standardized percentile curves of body mass index of Iranian children compared to the US population reference. *Int J Obes Relat Metab Disord* 1999; 23: 783-6.
- Daniels SR, Khoutry PR, Morrison JA. Utility of different measures of body fat distribution in children and adolescents. *Am J Epidemiol* 2000; 152: 1179-84.
- Goran MI, Nagy TR, Treuth MS, et al. Visceral fat in white and African American prepubertal children. *Am J Clin Nutr* 1997; 65: 1703-8.
- Patel S, Unwin N, Bhopal R, et al. A comparison of proxy measures of abdominal obesity in Chinese, European and South Asian adults. *Diabet Med* 1999; 16: 853-60.
- Charakida M, Deanfield JE, Halcox JP. Childhood origins of arterial disease. *Curr Opin Pediatr* 2007; 19: 538-45.
- Kautz L, Harrison GG. Comparison of body proportions of one-year-old Mexican-American and Anglo Children. *Am J Public Health* 1981; 71: 280-2.
- Couch SC, Cross AT, Kida K, et al. Rapid westernization of children's blood pressure in 3 countries: evidence for nutrient-gene interactions? *Am J Clin Nutr* 2007; 72: 1266S-74S.
- Pathobiological Determinants of Atherosclerosis in Youth (PDAY) Research group. Natural history of aortic and coronary atherosclerotic lesions in youth. *Arteriosclero Thromb* 1993; 13: 1291-8.
- Yusuf S, Reddy S, Ounpuu S, Anand S. Global burden of cardiovascular diseases. Part II. Variations in cardiovascular disease by specific ethnic groups and geographic regions and prevention strategies. *Circulation* 2001; 104: 2855-64.
- Tereshakovec AM, Rader J. Disorders of lipoprotein metabolism and transport. In: Behrman RE, Kliegman RM, Jenson HB (eds). *Nelson Textbook of Pediatrics*. 17th ed. Philadelphia: Saunders, 2004; 445-59.
- Kelishadi R, Ardalan G, Gheiratmand R, Ramezani A. Is family history of premature cardiovascular diseases appropriate for detection of dyslipidemic children in population-based preventive medicine programs? *CASPIAN study*. *Pediatr Cardiol* 2006; 27: 729-36.
- Kelishadi R, Pour MH, Zadegan NS, et al. Dietary fat intake and lipid profiles of Iranian adolescents: Isfahan Healthy Heart Program – Heart Health Promotion from Childhood. *Prev Med* 2004; 39:760-6.
- Azizi F, Mirmiran P, Azadbakht L. Predictors of cardiovascular risk factors in Tehranian adolescents: Tehran Lipid and Glucose Study. *Int J Vitam Nutr Res* 2004; 74: 307-12.
- Schwandt P, Geiss HC, Ritter MM, et al. The prevention education program (PEP). A prospective study of the efficacy of family-oriented life style modification in the reduction of cardiovascular risk and disease: design and baseline data. *J Clin Epidemiol* 1999; 52: 791-800.
- Ohrig E, Geiss HC, Haas GM, Schwandt P. The Prevention Education Program (PEP) Nuremberg: design and baseline data of a family oriented intervention study. *Int J Obes Relat Metab Disord* 2001; 25 Suppl 1: S89-92.
- Kelishadi R, Gouya MM, Ardalan G, et al.; CASPIAN Study Group. First reference curves of waist and hip circumferences in an Asian population of youths: CASPIAN study. *J Trop Pediatr* 2007; 53: 158-64.

17. Kelishadi R, Ardalan G, Gheiratmand R, Adeli K, Delavari A, Majdzadeh R, For The Caspian Study Group. Paediatric metabolic syndrome and associated anthropometric indices: the CASPIAN Study. *Acta Paediatr* 2006; 95: 1625-34.
18. Cole TJ, Green PJ. Smoothing reference centile curves: the LMS method and penalized likelihood. *Stat Med* 1992; 11: 1305-19.
19. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004; 363: 157-63.
20. Ehtisham S, Crabtree N, Clark P, Shaw N, Barrett T. Ethnic differences in insulin resistance and body composition in United Kingdom adolescents. *J Clin Endocrinol Metab* 2005; 90: 3963-9.
21. Onat A, Ceyhan K, Başar O, Erer B, Toprak S, Sansoy V. Metabolic syndrome: major impact on coronary risk in a population with low cholesterol levels-a prospective and cross-sectional evaluation. *Atherosclerosis* 2002; 165: 285-92.
22. Kelishadi R, Gouya MM, Adeli K, et al; for the CASPIAN Study Group. Factors associated with the metabolic syndrome in a national sample of youths: CASPIAN Study. *Nutr Metab Cardiovasc Dis* 2008; 18: 461-70.
23. Kelishadi R, Derakhshan R, Sabet B, et al. The metabolic syndrome in hypertensive and normotensive subjects: the Isfahan Healthy Heart Programme. *Ann Acad Med Singapore* 2005; 34: 243-9.
24. Ghassemi H, Harrison G, Mohammad K. An accelerated nutrition transition in Iran. *Public Health Nutr* 2002; 5: 149-55.
25. Kelishadi R, Cook SR, Motlagh ME, et al. Metabolically obese normal weight and phenotypically obese metabolically normal youths: the CASPIAN Study. *J Am Diet Assoc* 2008; 108: 82-90.