Received: 2005.06.21
Accepted: 2006.03.19
Published: 2006.12.11

Cross-sectional and longitudinal correlations of serum leptin concentrations with generalized and abdominal obesity in children and adolescents

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

Roya Kelishadi[1ADEF], Alireza Shafiee[2BC], Mahin Hashemipour[3AD], Katayoun Rabiee[4B], Noushin Mohammadifard[5B], Zahra Amin[6B], Hasan Alikhasy[7D], Firouzeh Sajadi[8B]

[1] Preventive Pediatric Cardiology Department, Isfahan Cardiovascular Research Center, Isfahan University of Medical Sciences, Isfahan, Iran
[2] Pediatrics, Isfahan School of Medicine, Isfahan University of Medical Sciences, , Isfahan, Iran
[3] Pediatric Endocrinology, Isfahan Endocrine Research Center, Isfahan University of Medical Sciences, Isfahan, Iran
[4] Rehabilitation Department, Isfahan Cardiovascular Research Center, Isfahan University of Medical Sciences, Isfahan, Iran
[5] Nutrition Department Isfahan Cardiovascular Research Center, Isfahan University of Medical Sciences, Isfahan, Iran
[6] Research & Training Unit, Isfahan Provincial Physical Activity& Sport Organization. , Isfahan, Iran
[7] Nutrition Department Isfahan Cardiovascular Research Center, Isfahan University of Medical Sciences, Isfahan, Iran
[8] Nutrition Department Isfahan Cardiovascular Research Center, Isfahan University of Medical Sciences, Isfahan, Iran

Source of support: This study is funded by Bureau of Research, Isfahan University of Medical Sciences and Isfahan Cardiovascular Research Center.

Summary

Background: The relationship of leptin concentrations with short and long term weight excess and weight loss in obese children continues to be controversial. To determine the baseline and longitudinal correlations between leptin concentration and measures of generalized and abdominal obesity in children and adolescents following a weight loss program.

Material/Methods: This trial was performed on 74 obese children and adolescents (35 girls, 39 boys) participating in a weight loss program. Serum leptin concentration, body mass index and waist circumference were recorded at the beginning and at the end of a 3-months weight loss program, as well as one year after the baseline survey. Data were analyzed by SPSS v_{13}/win software using the Pearson correlation test at $P<0.05$.

Results: The mean age of the obese children and adolescents studied was 11.1±1.2 years. The baseline serum leptin concentration had a weak correlation with BMI (r=0.25, P=0.04), and a strong correlation with the waist (r=0.69 P=0.01 in girls, r=0.22 P=0.02 in boys, respectively) and hip circumferences (r=0.58, P=0.03 in girls, r=0.57,p=0.01 in boys, respectively). The changes in serum leptin levels at the end of the 3-months weight loss program and one year after the baseline survey had significant correlation only with the waist (r=0.65, r=0.54,respectively) and hip circumferences (r=0.61,r=0.51,respectively) and not with BMI (r=0.20, r=0.27, respectively) in both sexes.

Conclusions: In obese children and adolescents, significant strong cross-sectional and longitudinal correlations were found between serum leptin level and measures of abdominal, but not generalized obesity.

Key words: leptin • obesity • abdominal obesity • children • adolescents

Full-text PDF: http://www.jpn-online.org/get_pdf.php?IDMAN=7702

Word count: 1171
Tables: 2
Figures: –
References: 16

Author's address: Roya Kelishadi, MD, Head, Preventive Pediatric Cardiology Department, Isfahan Cardiovascular Research Center, Isfahan University of Medical Sciences, P.O.Box: 81465-1148, Isfahan, Iran, e-mail: Kelishadi@med.mui.ac.ir

BACKGROUND

Leptin is protein secreted by adipocytes into the general circulation, where it has a role in regulating body mass via the feedback between hypothalamus and adipocytes [1]. Serum leptin level is shown to be positively correlated with total body adiposity [2]. Caprio et al. found that leptin concentrations were more closely related with subcutaneous abdominal adipose tissue than with visceral adipose tissue [3].

The findings of dietary interventional studies in obese patients are controversial; in one of these studies on obese children, the effectiveness of the weight reducing programs was decreased in children with abnormal leptin levels, and suggested that leptin could provide predictive insight into a child's ability to lose weight [4]. In addition, the associations between circulating leptin and appetite-satiety rating suggest leptin involvement in short-term appetite regulation in adults [5]. Leptin concentrations as a predictor of weight excess and weight loss in obese children continue to be controversial.

The purpose of the present study was to determine the short and long term correlations between changes in leptin concentration and measures of generalized and abdominal obesity after a 3-months weight loss program and one year of follow-up.

MATERIAL AND METHODS

This interventional study was performed in 2003–2004 on 74 obese children and adolescents referred to the Childhood Obesity Research Clinic, Preventive Pediatric Cardiology Department, Isfahan Cardiovascular Research Center (a WHO Collaborating Center).

After describing the full protocol of the weight loss program for obese children and their parents, the interested children were invited to participate in a 3-months course. After obtaining written informed consent from parents, the children were included in the study. To be included, a child needed to be under 18 years of age, to have simple obesity (a BMI greater than the age and sex specific 95th percentile and without secondary causes of obesity such as genetic and endocrine disorders), to be mentally competent and not to have any disability for physical activity.

Weight (Wt) and height (Ht) were measured with subjects lightly clothed and barefoot to the nearest 0.5 cm and 0.1 kg, respectively. Based on the recommendations of Lohman et al, three Ht and Wt measurements were collected [6], and their average was used to compute the body mass index (BMI) as Wt (kg) divided by Ht (m) squared. BMI was converted to percentile by using the Center for Disease Control (CDC) reference data [7]. Waist circumference (WC) was measured at a point midway between the lower border of the rib cage and the iliac crest at the end of normal expiration, and hip circumference was measured at the widest part of the hip [8]. Waist-to-hip ratio (WHR) was computed by dividing the WC by the hip circumference. All measurements were performed by the same trained staff under the supervision of the same pediatrician.

Considering the diurnal pattern of serum leptin concentration, and the possible association of this pattern to the insulin response to meals [9], blood samples were obtained between 8 and 9 am. after 12 hours of fasting. Blood was drawn from the antecubital vein into sterile, EDTA-treated tubes. They were centrifuged to obtain plasma, which were frozen at –20°C until analyzed. Leptin concentration was measured by Enzyme-Linked Immunosorbent Assay (ELISA) method using the Bio Source International, Inc, human leptin kit (USA) according to the manufacturer's protocol. The intra-assay and inter-assay Coefficient of Variation (CV) for leptin were 3% and 3.9%, respectively.

All children and adolescents were referred to the Nutrition Department, Isfahan Cardiovascular Research Center where a registered dietitian gave them a mix based on the 'optimized mixed diet'; the energy (E) requirement was determined on an individual basis using kilocalories per centimeter of height containing 30E% fat, 15E% proteins and 55E% carbohydrates [10].

Supervised aerobic physical activities of moderate to vigorous intensities were performed for 1 hour 3 days a week, and the children were asked to continue similar activities at home on other days, as much as possible.

This program continued for 3 months, and all subjects were visited monthly for additional 9 months, and received consultations about their nutrition and physical activity. All baseline measurements were repeated at the end of the 3-month program and one year after the baseline survey.

Data were stored in a computer database and were analyzed by the SPSS v_{13}/win software using the Pearson correlation coefficient. The significance level was set at $P<0.05$.

RESULTS

In this trial, 74 obese children and adolescents with a mean age of 11.1±1.2 years were studied before and at the end of a 3-month weight loss program, as well as one year after the baseline survey.

The baseline characteristics of subjects studied and their correlations with fasting serum leptin level are presented in Table 1, and shows weak correlation between the baseline leptin concentration and BMI, but strong correlation with waist circumference in both sexes.

The mean changes in serum leptin concentration and the measures of generalized and abdominal obesity from baseline to the second (3rd month) and the third (12th month) measurements are presented in Table 2, and shows significant correlation with changes in the waist and hip circumferences but not with BMI, without any significant difference between sexes.

DISCUSSION

The findings of the present study showed significant cross-sectional and longitudinal correlations between serum leptin concentration and measures of abdominal obesity in both sexes.

The findings of the baseline survey are consistent with some previous studies. In the study of Gutin et al, various aspects of body composition were significantly correlated with lep-

Table1. Baseline characteristics of subjects studied and Pearson correlation with leptin concentration.

	Girls (n=35) (mean±SD)	r	P	Boys (n=39) (mean±SD)	r	P
Serum leptin (pg/ml)	143.21±40.82	–	–	139.12±43.32	–	–
Age (years)	11±1.61	0.39	0.10	11.92±1.75	0.09	0.63
Weight (kg)	45.05±15	0.22	0.04	51.53±15.27	0.20	0.03
Height (cm)	137.72±11.39	0.32	0.18	142.42±12.46	0.09	0.16
BMI (kg/m2)	23.12±4.40	0.25	0.04	24.80±3.3	0.22	0.02
Waist circumference (cm)	76±10.27	0.69	0.01	78.74±8.45	0.62	0.04
Hip circumference (cm)	84.72±10.72	0.58	0.03	87.74±12.52	0.57	0.01
Waist-to-Hip Ratio	0.90±0.10	0.52	0.02	0.87±0.09	0.50	0.04

Table2. Mean changes (Δ) serum leptin concentration and independent variables, and their correlations at the end of a 3-month weight loss program and one year after the baseline survey.

	After a 3-month weight loss program					One year after the baseline survey				
	Value (mean±SD)	Minimum	Maximum	r	P	Value (mean±SD)	Minimum	Maximum	r	P
Δ Serum leptin (pg/ml)	–3.24±1.1	–11.4	18.50	–	–	–5.6±1.9	–15.4	18.50	–	–
Sex				0.20	0.10				0.20	0.20
Δ Weight (kg)	–3.06±0.1	–7.5	10.00	0.14	0.30	–4.5±0.6	–6.0	15.00	0.23	0.10
Δ Body Mass Index (kg/m^2)	–1.1±0.4	–0.4	2.50	0.20	0.20	–1.9±0.3	–3.8	4.70	0.27	0.07
Δ Waist circumference (cm)	–2.5±0.3	–0.7	5.10	0.65	0.04	–3.5±1.1	–7.0	11.00	0.54	0.03
Δ Hip circumference (cm)	–3.4±1.1	–1.2	7.20	0.61	0.02	–4.1±1.8	–0.9	8.10	0.51	0.04
Δ Waist-to-Hip Ratio	0.71±0.4	0.2	0.92	0.52	0.04	0.84±0.2	–0.2	0.94	0.47	0.02

* Pearson correlation.

tin concentrations [11]. Pilcova and colleagues found strong positive associations of serum leptin concentrations with the hip and waist circumferences, whereas the association WHR was negative [12].

It is shown that leptin can provide predictive insight into an individual's ability to lose body fat [13]. In the study of Sudi et al, a 3-week weight loss program significantly lowered fat mass, abdominal fat distribution and leptin, and initial leptin was the lest determinant to explain the variability in changes in leptin [14].

Similar findings are reported in adults, as well. In a study on obese women, weight loss correlated significantly with decreases in serum leptin level [15]. In the study of Gutin et al, plasma leptin concentrations declined during the 4-month period of physical training and increased during the subsequent 4-month period without physical training [11], but such trend was not found in the present study which is suggested to be because of lower intensity and frequency of physical activity in the present study.

The findings of the current study are in line with the study of Reiterer et al. [16] and Pilkova et al. [12] in regard to the baseline correlation between leptin level and BMI but contrary to their findings. We found weak correlation with the changes in serum leptin concentrations and generalized obesity but significant correlation with measures of abdominal obesity.

Conclusions

The present study showed significant cross-sectional and longitudinal correlations between serum leptin concentration and measures of abdominal obesity among children and adolescents.

Acknowledgment

The authors would like to thank Mrs. Fatemeh Tafazoli for her supervision of training classes.

References:

1. Maffei M, Halaas J, Ravussin E: Leptin levels in human and rodent: measurement of plasma leptin and ob RNA in obese and weight-reduced subjects. Nat Med, 1995; 1: 1155–61
2. Lahlou N, Landais P, De Boissieu D, Bougneres PF: Circulating leptin in normal children and during the dynamic phase of Juvenile obesity. Diabetes, 1997; 46: 989–93

3. Capiro S, Tamborlane WV, Silver D: Hyperleptinemia: an early sign of Juvenile obesity. Relations to body fat depots and insulin concentrations. Am J Physiol, 1996; 271: E626–39
4. Miraglia del GE, Santoto N, Marotta A et al: Inadequate leptin level negatively affects body fat loss during a weight reduction programme for childhood obesity. Acta Paediatr, 2002; 91(2): 132–35
5. Tsofliou F, Pitsiladis YP, Malkova D et al: Moderate physical activity permits acute coupling between serum leptin and appetite- satiety measures in obese women. Int J Obes Relat Metab Disord, 2003; 27(11): 1332–39
6. Lohman TG, Roche AF, Martorell R: Anthropometric Standardization Reference Manual. Campaign, IL, Human Kinetics Publishers Inc., 1988
7. Kuczmarski RJ,Ogden CL,Grummer-Strawn LM: CDC growth charts: United States.Adv Data, 2000; 314: 1–27
8. WHO. Obesity: Prevention and managing the global epidemic. Geneva, WHO, 1998
9. Sinha MK, Ohannesian JP, Heiman ML: Nocturnal rise of leptin in lean, and non-insulin-dependent diabetes mellitus subjects. J Clin Invest, 1996; 97: 1344–47
10. Lucas B: Nutrition in Childhood.In: Mahan LK,Escott-Stumps. Kraue's Food, Nutrition& Diet Therapy. 10th ed, Philadelphia, Saunders, 2000: 242
11. Gutin B, Ramsey L, Barbeau P et al: Plasma leptin concentrations in obese children: changes during 4-mo periods with and without physical training. Am J Clin Nutr, 1999; 69(3): 388–94
12. Pilcova R, Sulcova J, Hill M et al: Leptin levels in obese children: effects of gender, weight reduction and androgens. Physiol Res, 2003; 52: 53–60
13. Miraglia del GE, Santoro N, Marotta A et al: Inadequate leptin level negatively affects body fat loss during a weight reduction programme for childhood obesity. Acta Paediatr, 2002; 91(2): 132–35
14. Sudi KM, Gallistl S, Borkenstein MH et al: Effects of weight loss on leptin, sex hormones, and measures of adiposity in obese children. Endocrine, 2001; 14(3): 429–35
15. Ozcelik O, Dogan H, Celik H et al: Effects of different weight loss protocols on serum leptin levels in obese females. Physiol Res, 2005; 54: 271–77
16. Reiterer EE, Sudi KM, Mayer A et al: Changes in leptin, insulin and body composition in obese children during a weight reduction program. J Pediatr Endocrinol Metab, 1999; 12: 853–62